ECE4550 Course Syllabus

ECE4550

Control System Design (3-0-3-4)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Selected Elective for the EE degree. * (Selected Elective means this course is one of a few choices that are required for the degree.)

Lab Hours
3 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Taylor,David G

Prerequisites
ECE 2031 or ECE 20X2 [min C] and ECE 3084 or ECE 3085 or ECE 3550

Corequisites
None

Catalog Description
Design of control algorithms using state-space methods, microcontroller implementation of control algorithms, and laboratory projects emphasizing motion control applications.

Textbook(s)
Franklin, Powell & Emami-Naeini, *Feedback Control of Dynamic Systems* (8th edition), Prentice Hall, 2019. ISBN 9780134685717(optional)

Course Outcomes
Upon successful completion of this course, students should be able to:

1. Apply the laws of physics to obtain mathematical models describing the dynamic behavior of several types of physical systems.
2. Approximate the constant coefficients parameterizing the dynamic model of a given physical system by utilizing measured input-output data.
3. Develop a state-space model for a given physical system, and use it to analyze the system?s response and to characterize the system?s stability.
4. Perform controllability and observability analyses to guide the selection of suitable actuators and sensors for a given physical system.
5. Design a digital control algorithm incorporating state estimation, state regulation and error integration to impose command following.
6. Program a computer to simulate a digital control system, accounting for the influence of disturbances, noise, quantization, sampling and saturation
7. Program a microcontroller to implement a digital control algorithm, using interrupt-based timing and on-chip peripherals for interfacing.
8. Develop microcontroller code for motion control systems incorporating various types of electric motors and associated switched-mode drive circuits.

9. Evaluate the performance of motion control system implementations by analyzing and interpreting experimental data obtained from measurement.
10. Prepare documentation describing control system designs and associated laboratory measurements, conforming to appropriate technical standards.

Student Outcomes

In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (M) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (LN) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (LN) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (M) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (M) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

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State-Space Methods for Analysis and Design
        System Models, Responses, and Stability
        Numerical Simulation Techniques
        Objectives and Specifications in Control Applications
        State Feedback, Controllability, Actuator Selection
        State Estimation, Observability, Sensor Selection
        Integral Control, Command Following, Disturbance Rejection
        Controller Discretization, Indirect Design
        Plant Discretization, Direct Design
        Parameter Identification Methods
        Time-Scale Separation, Reduced-Order Design Models
        Optimization-Based Design and Stability Robustness
Microcontrollers and Control Applications
        Computer Representation of Numbers
        Interrupt-Based Program Flow
        Clocks and Timers
        General Purpose Inputs and Outputs
        Communications, Chip-to-Chip, System-to-System
        Analog-to-Digital Converters
        Pulse-Width Modulators
        Quadrature Encoders
        DC Motors, AC Motors, Drive Circuits
        Electromechanical Motion Systems
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Switched-Mode Power Converters