ECE3550 Course Syllabus

ECE3550

Feedback Control Systems (3-0-0-3)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Verriest,Erik I

Prerequisites
ECE 2040 [min C]

Corequisites
None

Catalog Description
Analysis and design of control systems. Laplace transforms, transfer functions, and stability. Feedback systems: tracking and disturbance rejection. Graphical design techniques.

Textbook(s)
Franklin, *Feedback Control of Dynamic Systems* (8th edition), Prentice Hall, 2018. ISBN 9780134685717 (required)

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

1. Demonstrate thorough knowledge of the concept of system dynamics.
2. Demonstrate an understanding of the concept of feedback and its application to control systems.
3. Analyze signals commonly arising in control applications and derive their Laplace transforms.
4. Apply the concepts of system response (including transients and steady-state) and of system stability.
5. Apply the principles of feedback control in a broad context of engineering systems.
6. Design control systems for steady-state tracking of reference inputs, disturbance rejection, and sensitivity reduction.
7. Apply graphical design techniques (root locus plots, Bode plots, Nyquist plots) to control systems analysis and design.

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. (LN) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (P) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

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1. Signal Operations - System Properties
(a) Elementary Operations on Signals
(b) Systems as Operators
(c) Time Invariance, Linearity, Causality, Memorylessness, Finite-D
2. Linear Time Invariant Ordinary Differential Equations
(a) Differential Operators
(b) Homogenous equations
(c) Driven Equations and Convolution Representation
3. Laplace Transform
(a) Definition and Relation to Fourier Transform
(b) Properties and Inverse Laplace Transform
(c) Transient Response
4. Transfer Function and Stability
(a) Transfer Function Representation of Systems
(b) Frequency Response and Bode Plots
(c) Stability and Routh-Hurwitz Criterion
5. Connection Algebra
(a) Interconnections: Series, Parallel and Feedback
(b) Systems Modeling from Physical Principles
(c) Similarity and Analog Simulation
6. Feedback Control
(a) Modal Control and Stabilization
(b) Tracking and Steady State Error
(c) Sensitivity Reduction
(d) Disturbance Rejection
7. Root Locus Method
(a) Complex Maps and Parameterized Representations
(b) Analysis of Closed Loop Pole Locations
(c) Root Locus Meta-rules
(d) Application to Control System Design
8. Nyquist Plot and Criterion
(a) Notions from Analytic Function Theory
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(b) Principle of the Argument
(c) Nyquist Criterion
(d) Rouche's Theorem and Compensator Design
9. Topics to be selected from (time permitting)
(a) Systems with Delays
(b) Discrete-time Systems and Discretization
(c) Identification from Input-output Data