Course Specification for
EE 3261 Classical Control Systems

Curricular Designation: EE: elective CpE: elective RE: required

Catalog Description:

EE 3261 – Classical Control Systems

Mathematical formulation of control problems via transfer functions; analysis of feedback control systems (stability, transient performance, steady-state error, robustness, disturbance rejection, and control magnitude); design using root locus, frequency response, and analytic methods; analog and digital simulation and computation; and experiments with physical systems.

Credits: 3.0 *Lec-Rec-Lab:* (2-0-2)
Semesters Offered: Fall, Spring
Pre-requisites: EE 3160

Textbooks(s) and/or Other Required Materials:

Control Systems Engineering, Seventh Edition, N. S. Nise, John Wiley & Sons, Inc., 2015

Prerequisites by Topic:

- Introduction to system properties and terminology, including stability, linearity, and time-invariance
- Familiarity with linear differential equation solution, including initial conditions, initial condition response, forced response, and total response
- Familiarity with Laplace transforms and Laplace transform poles; familiarity with application of Laplace transforms to differential equation solution and an introduction to the relationship between poles and system response
- Familiarity with linear time-invariant system frequency response, including the computation of steady state response to sinusoidal inputs and the generation of Bode plots (amplitude and phase)

Course Objectives:

- A mastery of the analysis of feedback control systems, including determining stability, transient performance, steady-state error, stability margins, disturbance rejection, and control magnitude
- A mastery of the relationship between closed loop poles and system performance
- A mastery of control system design using proportional, derivative, and integral control
- A mastery of the use of the root locus design methodology; an abiliy to use root locus to design proportional control, add zeros to influence transient behavior, and apply root locus to selecting general control parameters
- A mastery of frequency domain analysis of control systems with time delay
- Application of control system implementation using operational amplifier circuits

Topics Covered:

1. Introduction to the modeling of physical systems, including linear dynamics, rotational dynamics, and motors
2. Block diagrams and signal flow graphs, and transfer functions, including the conversion between models and the generation of closed loop transfer functions from block diagrams and signal flow graphs

3. Digital simulation theory and application using Matlab and Simulink
4. Analysis of feedback control systems:
   a. Stability using pole locations
   b. Transient performance analysis, including settling time, damping ratio, and percent overshoot The relationship between transient performance and pole locations should be highlighted
   c. Steady-state error computation, system type, and error constants
   d. Computation of the control magnitude
   e. Evaluations of disturbance rejection
5. Root locus design including the rules of construction, proportional controller design via root locus, and PD controller design via root locus
6. Frequency response techniques including Bode plots, the Nichol's chart, the phase margin, and the gain margin, with application to the analysis of systems with time delays
7. Control system design and case studies: P, PD, PI, and PID design using analytic, heuristic, and time domain techniques

Relationship of the Course Content to Program Outcomes:

Outcome	Topic and level of coverage
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Important
2. 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	Important
3. an ability to communicate effectively with a range of audiences	Minimally important
4. 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	Minimally important
5. 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	Minimally important
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Important
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Important

Contribution of Course to Meeting Degree Requirements:

3 Credit Hours – Engineering Topics

Class/Laboratory Schedule (note: 1 hour = 50 minutes)**:**

Lecture: 28 hours = 2 hours/week for 14 weeks Laboratory: 28 hours = 2 hours/week for 14 weeks

Prepared by: Jeffrey Burl, Associate Professor   Date: October 2020