

Course alpha, number, title	ME 451 Control Systems
Required or elective	Required
Course (catalog) description	Mathematical modeling of dynamic systems. Standard feedback control formulation. Transient and sinusoidal steady state analysis. Time and frequency domain controller synthesis.
Prerequisite(s)	(ME 361 and ECE 345) and completion of Tier I writing requirement.
Textbook(s) and/or other required material	Math Works In, Prentice Hall, Student Edition of Matlab (windows or MAC), Phillips, Feedback Control Systems, Prentice Hall
Class/Lab schedule:	Total Credits: 4 <i>Lecture/Recitation/Discussion Hours: 3 Lab Hours: 3</i>
Topics covered	<ul style="list-style-type: none"> a. Mathematical Preliminaries b. Laplace Transforms c. Transfer Functions d. State Space Formulation e. Modeling of Dynamic Systems f. Mechanical Systems g. Electrical Systems h. Electromechanical Systems i. Fluid Power Systems j. Thermal Systems
Course learning objectives	<ol style="list-style-type: none"> 1. Math Review: Students can <ul style="list-style-type: none"> a) use matrices to solve algebraic equations b) use Laplace transforms to find system transfer function models 2. Models of Physical Systems: Students can <ul style="list-style-type: none"> a) model coupled electromechanical systems b) linearize non-linear input/output models about a non-zero operating point. 3. System Time Response: Students can <ul style="list-style-type: none"> a) solve for 1st and 2nd order system time responses b) analyze system systems for time response specifications settling time, overshoot, rise time 4. Control System Characteristics: From transfer function models, students can <ul style="list-style-type: none"> a) analyze system characteristics including <ul style="list-style-type: none"> i) Stability via root locus and Routh-Hurwitz ii) Sensitivity to parameter variation iii) Disturbance Rejection and iv) Steady-State Accuracy b) design PID controllers to specifications for system characteristics 5. Frequency Response Analysis & Design: From transfer function models, students can <ul style="list-style-type: none"> a) solve for system frequency response from transfer functions b) sketch Bode diagrams for open loop frequency response function c) determine gain and phase margin from a Bode diagram d) design PID controllers from an open loop frequency response function e) design lead and lag controllers from an open loop frequency response function

Relationship of course to ME program outcomes

The following measurement standard is used to evaluate the relationship between the course outcomes and the educational-program outcomes:

3 = Strong Emphasis, 2 = Some Emphasis, 1 = Little or No Emphasis.

- (a) an ability to apply knowledge of mathematics, science, and engineering—3
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data—3
- (c) an ability to design a system, component, or process to meet desired needs—2
- (d) an ability to function on multi-disciplinary teams—3
- (e) an ability to identify, formulate, and solve engineering problems—3
- (f) an understanding of professional and ethical responsibility—1
- (g) an ability to communicate effectively—3
- (h) the broad education necessary to understand the impact of engineering solutions in a global/societal context—2
- (i) a recognition of the need for and the ability to engage in life-long learning—1
- (j) a knowledge of contemporary issues—1
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice—3
- (l) design, build, and test in mechanical systems area—1
- (m) design, build, and test in thermal/fluids area—1
- (n) application of advanced mathematics—3
- (o) capstone design experience—1

Contribution to professional component:

50% Engineering Science 50% Engineering Design

Person(s) who prepared this description

Ranjan Mukerjee and Clark Radcliffe

Date of Preparation