UNIVERSITY OF CALIFORNIA
UCMERCED

Syllabus for ME141-01: Linear Controls

Spring 2017
Instructor: Yousef Sardahi

Designation:	senior level undergraduate technical elective
Catalog Description:	Dynamics of Linear Systems, Concepts of Stability, Feedback Control, Root Locus Design, Frequency-Domain Analysis and Compensator Design, State-Space Representation, Controllability and Observability, Linear Observers, Matrix Methods for Control Design, Linear Quadratic Regulator (LQR) Optimal Control
Text Books and Other Required Materials:	Textbook (Required) Feedback Control of Dynamic Systems (6th edition) by G.F. Franklin, J.D. Powell and A. Emami-Naeini, Prentice Hall. Reference Books • Modern Control Engineering (1970) by K. Ogata, Prentice-Hall, Inc. • Automatic Control Systems (6th ed. 1991) by B.C. Kuo, Prentice-Hall, Inc. • Modern Control Systems (1987) by R. C. Dorf, Addison-Wesley Publishing Company.
Course Objectives/ Student Learning Outcomes:	After successful completion of this class, students will be able to: • Apply advanced skills to analyze dynamics of linear systems • Apply the knowledge of matrix theory to analyze linear systems and to design linear controls for regulating the dynamics of the system • Gain a thorough understanding of the theory of feedback controls and stability as well as contemporary research issues of control design • Apply methods of control design including root locus, frequency domain, state space designs • Understand the concepts of controllability and observability • Apply the concepts of optimization to design optimal controls • Apply control theories, control methods, and critical thinking skills to control problems of engineering systems Students will practice and demonstrate these abilities in homework exercises and control design projects. They will demonstrate their proficiency formally in the midterm and final examinations.
Program Learning Outcomes:	
Prerequisites by Topic:	Calculus, Ordinary Differential Equations, Complex Analysis, Linear Algebra, Matrix Theory, Vibration, and Dynamics.
Course Policies:	1. Turn in completed assignments in class. 2. No makeup exams will be given provided the absence was due to illness or accident documented by a physician's statement. 3. Students are expected to abide by the UCM Code of Academic Conduct and UC Merced Principles of Community (http://studentlife.ucmerced.edu and http://studentaffairs.ucmerced.edu/principles-community).

Academic Dishonesty Statement:	a. Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work. b. You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e mail, an e mail attachment file, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action. c. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.
Disability Statement:	Accommodations for Students with Disabilities: The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. I am available to discuss appropriate academic accommodations that may be required for student with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with Disability Services Center to verify their eligibility for appropriate accommodations.
Topics:	• Review of mathematical foundation for analysis of dynamics of linear systems. • Concepts of stability, the Laplace domain description of stability, Nyquist stability • Feedback controls for linear systems, compensators, frequency domain analysis • State space representation of dynamic systems, controllability, observability, pole placement, and linear quadratic regulator (LQR) optimal control
Class/laboratory Schedule:	
Midterm/Final Exam Schedule:	Final Exam F 3:00-6:00pm KOLLIG 396, May 12, 2017
Course Calendar:	Duration Topics Reading 1.5wks Introduction to Control Systems Review of mathematical foundation Modeling of mechanical systems Ch 1-2 (FPE) Appdx. A, C (FPE) 1.5wks Response Analysis of Mechanical Systems Laplace transforms Transfer functions Time domain specifications Effects of poles and zeros Ch 3 (FPE) 3.5wks Properties of Feedback Controls Speed control

PID controller
Steady-state tracking
Stability
Stability of Poles/Eigenvalues
Lyapunov stability
Root locus
Ch 4-5 (FPE)

½wk, Oct 15 Wed 1st Midterm on Response Analysis, Feedback Controls and Root Locus

4wks Control System Design Methods
Frequency domain
State space
Controllability and Observability
Optimal controls, State estimation
Compensation techniques
Ch 5-7 (FPE)

3.5wks Digital Controls
Digitization, Nyquist frequency
Anti-aliasing
Ch 8 (FPE)
½wk, Dec 10 Wed Second Midterm on Control Design Methods and Digital Controls

Total 15 weeks

Professional Component:	Engineering practice of vibration analysis, stability analysis, feedback control design and optimal control of linear dynamic systems.
Assessment/Grading Policy:	This is a co-listed graduate course MEAM 210 and undergraduate course ME 141 with the same title. Undergraduate students will be given different homework assignments and tests from those for graduate students. Graduate students will do one or two more difficult problems for all the homework assignments and examinations. All the students will attend the same lectures and control demonstrations.
Coordinator:	
Contact Information:	SE2-230A-Desk#7, (209)600-8058, ysardahi@ucmerced.edu
Office Hours:	MW 2-3pm or by appointment