San Jose State University Department of Mechanical Engineering

ME 187 Automatic Control System Design

Spring 2022

Lecture Instructor Dr. Lin Jiang,

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Office Hours T/Th: 13:00PM – 15:00PM (E310C), or Zoom by appointment

Course schedule MW: 10:30AM - 11:45AM

Prerequisites ME 111, ME 130, ME147

Required Texts & Materials:

Feedback Control of Dynamic Systems, 7th Edition, by Franklin, Powell and Emani-Naeini

MathWorks MATLAB

Suggested Readings/Texts: MATLAB/Simulink User Guides (http://www.mathworks.com/help/techdoc/)

Course Description

Introduction to linear control theory. General structure of control systems. Mathematical models including differential equations, transfer functions, and state space. Transient response and steady-state error. Performance, stability, root locus method, Bode diagram, and Nyquist plot. Compensation design using PID, phase-lead, and phase-lag controllers. State space control design.

Student Learning Objective

Upon successful completion of the course, the students will be able to:

1. Derive and analyze dynamic models of mechanical, electrical and electromechanical systems using time-domain and frequency-domain representations
2. Explain the concept of feedback control system and its purpose
3. Analyze stability and performance of control systems in time domain
4. Analyze stability and performance of control systems in the frequency domain
5. Design control laws based on time-domain and frequency-domain specifications using Root Locus and Bode Plot methods
6. Demonstrate the ability to conduct control system design through lead, lag, lead-lag, and PID compensation methods.
7. Demonstrate the ability to use MATLAB and the Control System toolbox as in designing and simulating linear feedback control systems.

Grading Scheme

Homework	10%				
Exam I	25%				
Exam II	25%				
Final Exam	40%				
A+: 95-100;	A: 90-94.9;	A-: 87-89.9;			
B+: 85-86.9;	B: 80-84.9;	B-: 77-79.9;			
C+: 75-76.9;	C: 70-74.9;	C-: 67-69.9;			
D+: 65-66.9;	D: 60-64.9;	D-: 57-59.9;	F:	< 57	

The due dates will be announced at the time when assigned. No late submissions will be accepted.
Exceptions: Any grading appeals or petitions must be communicated promptly in writing (or email). Exceptions will normally be evaluated at the very end of the semester in context with overall semester track record and all other exceptions class-wide. Special consideration for truly unavoidable and extenuating circumstances will depend on timeliness and strength of supporting documentation (e.g., doctor's note, police report, military orders).

Course Requirements and Assignments

According to the Office of Graduate and Undergraduate Programs

http://www.sjsu.edu/gup/syllabusinfo/, "*Success in this course is based on the expectation that students will spend, for each unit of credit, a minimumof 45 hours over the length of the course (normally 3 hours per unit per week with 1 of the hours used for lecture) for instruction or preparation/studying or course related activities including but not limited to internships, labs, clinical practice. Other course structures will have equivalent workload expectations as described in the syllabus*."

- *Homework:* Homework problems are usually assigned on each Thursday and due by the midnight of the following Wednesday. They will be assigned corresponding to lecture topics. Some of the homework may be software-based. Students are encouraged to discuss general strategies collaboratively, but each student is expected to prepare and submit his or her own individual work. Your lowest HW grade will be dropped when calculating your final grade.
- *Exams:* All students are expected to complete three exams in class as scheduled. Special accommodations for disabilities must be coordinated through the Accessible Education Center: http://www.sjsu.edu/aec/.

Classroom Protocol

Although University Policy F15-12 at http://www.sjsu.edu/senate/docs/F15-12.pdf states that "Attendance shallnot be used as a criterion for grading", the policy also states, "Students are expected to attend all meetings for the courses in which they are enrolled as they are responsible for material discussed therein" and furthermore, "Participation may be used as a criterion for grading when the parameters and their evaluation are clearly defined in the course syllabus and the percentage of the overall grade is stated."

University Policies

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' SyllabusInformation web page at http://www.sjsu.edu/gup/syllabusinfo/

Tentative Schedule

This schedule is tentative and subject to change at the discretion of the Professor.

Date	Chapter	Topic
		Intro, Modeling, Laplace Transforms
1/26	**1**	Overview of Feedback Control
1/31	**2**	Math Review, Complex variable
2/2	**3**	Laplace Transforms and ODEs
2/7	**3**	Block Diagrams, Time Domain Specs, Dynamic Response
2/9	**4**	Stability
		Feedback
2/14	**4**	The Basic Equation of Control
2/16	**4**	Steady State Error
2/21	**4**	PID Control
2/23	**4**	PID Control
2/28	**1-4**	Overflow Material, Exam Review
3/2	**1-4**	**Exam 1**
		The Root Locus Method
3/7	**5**	Root Locus of a Basic Feedback System
3/9	**5**	Guidelines for Sketching a Root Locus
3/14	**5**	Root Locus Design Method
3/16	**5**	Root Locus Design Method
		Frequency Response Design method
3/21	**6**	Frequency Response
3/23	**6**	Frequency Response and Stability
3/28		SPRING RECESS, NO CLASS
3/30		SPRING RECESS, NO CLASS
4/4		Nyquist Stability Criterion
4/6		Frequency Domain Design
		State Space Design method
4/11	**7**	State Space Representations
4/13	**7**	State Space Examples and Canonical Forms
4/18	**7**	State Space Design: Full State Feedback
4/20	**5-7**	Overflow Material, Exam Review
4/25		**Exam 2**
4/27	**7**	State Space Design: State Transfer, LQR
5/2	**7**	Observability and State Estimation
		Controller Design with MATLAB
5/4		Root Locus Method
5/9		Frequency Response Analysis
5/11	**1-7**	Overflow Material, Final Exam Review
5/16		**Final Exam**