San José State University
College of Engineering, Aerospace Engineering Department
AE 157: Aerospace Automatic Control Systems Design, Spring 2022

Course and Contact Information

Instructor:	Professor Long Lu
Email:	Long.Lu@sjsu.edu
Office Hours:	Monday and Wednesday 2:30 PM-3:30 PM (Online via Zoom)
Class Times and Locations:	Lecture: Tuesday and Thursday 1:30 PM-2:20 PM (Online via Zoom until 02/11/2022 and at Engineering Building 189 for the rest of the semester)
	Lab Section 02: Tuesday 2:30 PM-5:20 PM (Engineering Building 395)
	Lab Section 03: Thursday 2:30 PM-5:20 PM (Engineering Building 395)
Prerequisites:	"C" or better in MATH 33A, MATH 39, and AE 138, or graduate standing

Course Description

Modeling and analysis of aerospace feedback control systems. Stability analysis, root locus design, and frequency response methods for aerospace vehicles and associated automatic control systems. Bode diagrams, gain and phase margins. Controllability and observability. Lead-lag, state-feedback control system, proportional-integral-derivative controller, linear quadratic regulator design for aircraft and spacecraft. State-observer design for the reconstruction of state variables.

Course Materials

Zoom meeting links and course materials such as the syllabus, assignments, lecture notes... will be available on our class Canvas site. Students will also use Canvas to submit assignments and exams. Students are responsible for regularly checking Canvas to learn of any updates and announcements.

Course Goals

Introduce students to:

1. Mathematical modeling of aerospace control systems
2. Analysis and design of aerospace automatic control systems based on classical and modern control techniques
3. Development of optimal control strategies to improve the stability and performance of aircraft and spacecraft

Course Learning Outcomes (CLO)

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

1. Derive and obtain mathematical models of aerospace control systems
2. Understand and apply fundamental concepts of classical and modern control strategies with applications to aircraft and spacecraft
3. Describe and analyze transient responses in aircraft and spacecraft
4. Analyze frequency responses of aerospace automatic control systems
5. Explain the concept of feedback and its role in the stabilization and control of aerospace vehicles
6. Define and analyze stability margins in aerospace vehicle motions
7. Determine the natural frequencies and damping ratios of aircraft and spacecraft dynamics
8. Evaluate the effect of feedback on aircraft and spacecraft system performance
9. Derive transfer functions for aircraft and spacecraft control systems
10. Plot aerospace vehicle time and frequency responses
11. Design closed-loop control systems to improve the stability and performance of aircraft and spacecraft using classical control design techniques
12. Derive the state-space models for dynamic systems
13. Determine the state-transition matrix and use it to obtain the state response functions
14. Analyze the controllability and observability of aerospace systems
15. Design state-feedback control systems based on modern control design techniques
16. Design optimal control systems such as the linear quadratic regulator (LQR) to stabilize and improve the performance of aircraft and spacecraft
17. Design a state-observer for the reconstruction of state variables
18. Utilize modern tools such as MATLAB and Simulink for designing aircraft and spacecraft control systems and analyzing their performance.
19. Work effectively in teams to design and conduct laboratory experiments to study the open-loop stability of control systems and to design closed-loop controllers based on classical and modern control methods to improve the stability and performance of these systems.

Course Relationship to BSAE Program Outcomes

CLOs	*BSAE Program Outcomes*						
	1	2	3	4	5	6	7
1 -18	++		O	O			++
19	++	O	+++	O	+++	+++	+++

+: Skill level 1 or 2 in Bloom's Taxonomy
++: Skill level 3 or 4 in Bloom's Taxonomy
+++: Skill level 5 or 6 in Bloom's Taxonomy
O: Skill addressed but not assessed

Required Textbook

Ogata, K. *Modern Control Engineering*. Pearson.

Additional References

[1] Dorf, R. C. and Bishop, R. H. *Modern Control Systems*. Prentice Hall.
[2] Nelson, R. C. *Flight Stability and Automatic Control*. McGraw-Hill Education.
[3] Nise, N. S. *Control Systems Engineering*. John Wiley & Sons, Inc.

Grading Information

1. All examinations must be taken in order to receive a passing grade.
2. No make-up examinations will be granted without a valid reason and proof.
3. Late assignment submissions will not be accepted.
4. Homework assignments will be posted to Canvas and due to Canvas (using Canvas assignment submission) by the announced due dates on Canvas. Please remember to check Canvas regularly. For analytical problems, please remember to type or scan your work and save it as a PDF file. For computational problems, please use MATLAB-Simulink and remember to publish all MATLAB-Simulink programs to a PDF file. Please combine the PDF files of your analytical and computational parts into one PDF file and submit it to Canvas.
5. Homework assignments are individual-effort assignments. Students are encouraged to have intellectual discussions about the homework problems. However, all students must prepare and submit their own solutions to the homework problems which reflect their understanding and problem-solving methodologies. Any form of cheating or plagiarism such as copied/shared solutions or code will not be tolerated.
6. Lab assignments are team-effort assignments. For a team-effort assignment, all members of a team will share the same score. Therefore, please make sure to be professional, work effectively, and contribute equally to the team-effort assignments so that every team member has the opportunity to learn and improve themselves.

Grading

Homework Assignments:	200 points
Laboratory Assignments:	200 points
Midterm Exam 1:	200 points
Midterm Exam 2:	200 points
Final Exam:	200 points
Total:	1000 points

Letter Grade Determination

Total ≥ 950 points: A+
Total ≥ 900 points: A
Total ≥ 850 points: A-
Total ≥ 800 points: B+
Total ≥ 750 points: B
Total ≥ 700 points: B-
Total ≥ 670 points: C+
Total ≥ 650 points: C
Total ≥ 630 points: C-
Total ≥ 600 points: D
Total < 600 points: F

SJSU & AE Department 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' Syllabus Information web page at <http://www.sjsu.edu/gup/syllabusinfo/>.
- AE Department and SJSU policies are also posted at <http://www.sjsu.edu/ae/programs/policies>.

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Approximate Course Schedule

Week/Dates	Discussions Topics/Activities
Week 1 Th 01/27	Welcome to AE 157! Class Orientation, Syllabus Discussion
Week 2 T 02/01 & Th 02/03	Introduction to Control Engineering
Week 3 T 02/08 & Th 02/10	Fundamentals of Dynamic Systems Modeling and Simulation with MATLAB-Simulink
Week 4 T 02/15 & Th 02/17	Laplace Transforms
Week 5 T 02/22 & Th 02/24	Mathematical Modeling of Control Systems
Week 6 **T 03/01** & **Th 03/03**	**Review for Midterm Exam 1 on Tue 03/01/2022** **Midterm Exam 1 on Thu 03/03/2022**
Week 7 T 03/08 & Th 03/10	Transient Response Analysis Routh's Stability Criterion
Week 8 T 03/15 & Th 03/17	Control Systems Analysis and Design by the Root-Locus Method
Week 9 T 03/22 & Th 03/24	Control Systems Analysis and Design by the Frequency-Response Method
Week 10 **T 03/29 & Th 03/31**	**Spring Recess**
Week 11 T 04/05 & Th 04/07	PID Control System Design and Analysis
Week 12 **T 04/12** & **Th 04/14**	**Review for Midterm Exam 2 on Tue 04/12/2022** **Midterm Exam 2 on Thu 04/14/2022**
Week 13 T 04/19 & Th 04/21	State-Space Representation of Control Systems Solutions to State-Space Systems Using the State-Transition Matrix
Week 14 T 04/26 & Th 04/28	Controllability and Observability State-Feedback Control System Design
Week 15 T 05/03 & Th 05/05	Optimal Control System Design with the Linear Quadratic Regulator (LQR)
Week 16 T 05/10 & **Th 05/12**	State Observer Design for the Reconstruction of State Variables **Review for the Final Exam on Thu 05/12/2022**
Final Exam Week **Mon 05/23**	**Final exam is held on Mon 05/23/2022 at 12:15 PM-2:30 PM.**