San José State University
College of Engineering, Department of Aerospace Engineering
AE 168: Aerospace Vehicle Dynamics and Control, Fall 2022

Course and Contact Information

Instructor:	Professor Long Lu
Email:	Long.Lu@sjsu.edu
Office Hours:	Friday 3 PM-5 PM (Online via Zoom)
Class Times and Location:	Lecture: Tuesday and Thursday 10:30 AM-11:45 AM at ENG 189 Lab Section 2: Tuesday 12 PM-2:50 PM at ENG 164 Lab Section 3: Thursday 12 PM-2:50 PM at ENG 164
Prerequisites:	"C" or better in AE 140, AE 157, AE 165 and Math 39

Course Description:

Aircraft/spacecraft dynamics, stability and control. Linearization and Euler transformations. Eigenvalues and eigenvectors. State space and transfer function analysis of dynamics of aerospace vehicles. Feedback control design and synthesis using advanced control techniques. Aerospace dynamics and control laboratory experiments.

Course Materials and Format

Class materials such as the course syllabus, assignments, solutions, lecture notes... will be available on our class Canvas site. Students will also use Canvas to submit assignments. Students are responsible for regularly checking Canvas to learn of any updates and announcements. For help with using Canvas, please see Canvas Student Resources page.

Course Goals

Introduce students to:

1. the review of aircraft static stability
2. the development of aircraft dynamic stability concepts
3. the understanding of aircraft motion
4. the development of the means to control aircraft motion
5. the principles of automatic feedback control for aircraft
6. the derivation of spacecraft equations of motion
7. the design of passive and active spacecraft control methods
8. aerospace dynamics and control experiments.

Course Learning Outcomes (CLO)

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

1. Understand the standard conventions and notation for rigid body aircraft dynamics and control
2. Understand the principles of aircraft static stability
3. Represent orientation using Euler angles
4. Derive rigid body equations of motion and develop a linearized form of these equations
5. Develop perturbation equations for six degree-of-freedom motion of an aerospace vehicle
6. Define stability and control dimensional derivatives and their physical meanings
7. Estimate lateral and longitudinal stability derivatives from aircraft geometry
8. Understand why deflecting ailerons produces a yawing moment
9. Derive expressions for aircraft control surface effectiveness
10. Develop the principles of aircraft dynamic stability
11. Understand and apply the principles of feedback control
12. Learn the fundamentals of feedback loop architecture
13. Determine the natural frequencies and damping ratios of short period and phugoid modes
14. Derive short period and phugoid approximations
15. Develop spiral, roll, and Dutch roll approximations
16. Derive system transfer functions and plot its time responses
17. Design closed-loop control systems for rate damping, attitude and altitude control
18. Understand and apply the fundamentals of system identification
19. Derive the equations of motion for a spacecraft
20. Understand passive spacecraft control methods such as gravity gradient stabilization
21. Understand active spacecraft control methods such as momentum wheels and thrusters
22. Design a spacecraft attitude feedback control system
23. Utilize modern tools such as MATLAB and Simulink for designing aircraft and spacecraft control systems and analyzing their performance.
24. Work effectively in teams to design and conduct laboratory experiments to study the stability and control of aerospace systems
25. Work effectively in teams to design and conduct a course project to analyze the stability and to design automatic control systems to augment the stability and performance of an aircraft or spacecraft.

Course Relationship to BSAE Program Outcomes

CLOs	*BSAE Program Outcomes*						
	1	2	3	4	5	6	7
1 –23	++		O	O			++
24 -25	++	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 Texts/Readings

Required Textbook

AE168 Course Reader by Professor Jeanine Hunter. This course reader is available at Maple Press, 330 S 10th St #200, San Jose, CA 95112. Also available for online order at <https://maplepress.net/readers/product/ae-168-01-hunter/>.

Additional References

[1] Nelson, R. C. Flight Stability and Automatic Control.
[2] Roskam, J. Airplane Flight Dynamics and Automatic Flight Controls-Parts I and II.
[3] Cook, M. V. Flight Dynamics Principles.
[4] Anderson, J. D. Introduction to Flight.
[5] Ogata, K. Modern Control Engineering.
[6] Nise, N. S. Control Systems Engineering.

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 and the course project 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 Reports:	200 points
Examination 1:	200 points
Examination 2:	200 points
Course Project:	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

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' 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 F 08/19	Start of the Fall 2022 Semester
Week 2 T 08/23 & Th 08/25	Welcome to AE 168, Class Orientation, Syllabus Discussion Rigid Body Notation for Aircraft Dynamics and Control
Week 3 T 08/30 & Th 09/01	Linearizing the Equations of Motion of an Aerospace Vehicle
Week 4 T 09/06 & Th 09/08	Dimensional Stability and Control Derivatives
Week 5 T 09/13 & Th 09/15	Aircraft Static Stability
Week 6 T 09/20 & Th 09/22	Aircraft Control Surface Effectiveness
Week 7 T 09/27 & Th 09/29	Aircraft Dynamic Stability
Week 8 T 10/04 & Th 10/06	Review of Classical and Modern Control Methods
Week 9 **T 10/11 & Th 10/13**	**Exam 1 Review on Tue 10/11** **Exam 1 on Thu 10/13**
Week 10 T 10/18 & Th 10/20	Aircraft Longitudinal Open-Loop Dynamics and Feedback Control
Week 11 T 10/25 & Th 10/27	Aircraft Lateral/Directional Open-Loop Dynamics and Feedback Control
Week 12 T 11/01 & Th 11/03	Spacecraft Equations of Motion, Gravity Gradient Stabilization
Week 13 T 11/08 & Th 11/10	Spacecraft Attitude Control Using Reaction Wheels and Thrusters
Week 14 T 11/15 & Th 11/17	Feedback Control of Spacecraft Pitch Attitude

Week 15 T 11/22 & **Th 11/24**	Fundamentals of System Identification **No class on Thu 11/24 (Thanksgiving Holiday)**
Week 16 **T 11/29** & **Th 12/01**	**Exam 2 Review on Tue 11/29** **Exam 2 on Thu 12/01**
Week 17 **Tue 12/06** **Tue 12/13**	 **No class on Tue 12/06. Please work on your course project.** **Course project reports and code folders are due to Canvas by 11:59 PM on Tue 12/13.**