AE 168 - Aerospace Vehicle Dynamics and Control, Fall 2020

Instructor Information:	Professor Long Lu Long.Lu@sjsu.edu
ISA (Grader):	Gregory Kessing
Credit:	3 units
Class Times & Locations:	Tue and Thu 10:30 AM-11:45 AM (on Zoom)
Office Hours & Locations:	Mon and Wed 6 PM - 7 PM (on Zoom)
Prerequisites:	AE 140, AE 157, AE 165 and Math 129A with a grade of 'C-' or better in each
Required Text:	*Aerospace Vehicle Dynamics and Control 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-lu/>.

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*.

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.

Zoom Meeting Links and Course Materials

Zoom meeting links and course materials such as the syllabus, homework assignments and solutions,... will be available on Canvas. You 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.

Course Learning Objectives:

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.

Grading:

Homework and lab assignments:	400 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

Notes:

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. **Please remember to check Canvas for important class announcements**. For analytical problems, please remember to type or scan your work and save it as a PDF file. For computational problems, please remember to publish all MATLAB-Simulink programs to a PDF file. Please then 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.

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>.

Approximate Schedule

Week/Dates	Discussions Topics/Class Activities
Week 1 Th 08/20	Welcome to AE 168
Week 2 T 08/25 & Th 08/27	Rigid Body Notation for Aircraft Dynamics and Control Linearizing the Equations of Motion of an Aerospace Vehicle
Week 3 T 09/01 & Th 09/03	Linearizing the Equations of Motion of an Aerospace Vehicle (cont.)
Week 4 T 09/08 & Th 09/10	Dimensional Stability and Control Derivatives
Week 5 T 09/15 & Th 09/17	Aircraft Static Stability
Week 6 T 09/22 & Th 09/24	Aircraft Control Surface Effectiveness
Week 7 T 09/29 & Th 10/01	Aircraft Dynamic Stability
Week 8 T 10/06 & Th 10/08	Review of Classical and Modern Control Methods
Week 9 **T 10/13** & **Th 10/15**	**Exam 1 Review on Tue 10/13** **Exam 1: 10:30 AM-11:45 AM on Thu 10/15**
Week 10 T 10/20 & Th 10/22	Aircraft Longitudinal Open-Loop Dynamics and Feedback Control
Week 11 T 10/27 & Th 10/29	Aircraft Lateral/Directional Open-Loop Dynamics and Feedback Control

Week 12 T 11/03 & Th 11/05	Fundamentals of System Identification Spacecraft Equations of Motion
Week 13 T 11/10 & Th 11/12	Gravity Gradient Stabilization
Week 14 T 11/17 & Th 11/19	Attitude Control Using Reaction Wheels Attitude Control Using Thrusters
Week 15 T 11/24 & **Th 11/26**	Feedback Control of Spacecraft Pitch Attitude **No class on Thu 11/26 (Thanksgiving Holiday)**
Week 16 **T 12/01** & **Th 12/03**	**Exam 2 Review on Tue 12/01** **Exam 2: 10:30 AM-11:45 AM on Thu 12/03**
Final Exam Week Tuesday 12/15	**Final project reports and code folders are due to Canvas by 11:59 PM on Tuesday 12/15/2020.**