San José State University
College of Engineering, Department of Aerospace Engineering
AE 246: Advanced Aircraft Stability 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:	Tuesday and Thursday 4:30 PM-5:45 PM at ENG 339
Prerequisites:	BSAE or Instructor Consent

Course Description:

Natural longitudinal and lateral/directional motion of aircraft; mode shapes, eigenvalues, eigenvectors. Analysis and synthesis of various aircraft autopilots using classical and state space formulations.

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 topics in aircraft stability and control
2. The fundamental background in aircraft dynamic characteristics and handling qualities
3. Identifying aircraft dynamic parameters from frequency response
4. Analyzing and synthesizing the flight control systems using classical and modern control techniques

Course Learning Outcomes (CLO)

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

1. Analyze aircraft stability characteristics
2. Perform linearization to obtain state-space system description
3. Solve eigenvalue/eigenvector problems
4. Calculate the transfer functions related to aircraft longitudinal and lateral/directional motion
5. Design a stabilizing controller for multi-input multi-output (MIMO) systems
6. Design a stability augmentation system (SAS)
7. Design a control augmentation system (CAS)
8. Design attitude control systems
9. Design a directional (heading) control system

10. Use modern computational tools such as MATLAB-Simulink to develop autopilot control systems for aircraft.
11. 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.

Required Texts/Readings

Textbook

Stevens, B. L., Lewis, F. L., and Johnson, E. N. *Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems*. Free access for SJSU students at <https://csu-sjsu.primo.exlibrisgroup.com/permalink/01CALS_SJO/tu4ck5/alma991068490046602901>.

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] Hunter, J. *Aerospace Vehicle Dynamics and Control Course Reader.*
[4] Cook, M. V. *Flight Dynamics Principles.*
[5] Ogata, K. Modern Control Engineering.
[6] Nise, N. S. Control Systems Engineering.

Grading Information

1. The dates of quizzes will be announced on Canvas one week in advance. Quizzes will be held in lecture.
2. No make-up quizzes 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. The course project is a team-effort assignment. 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 assignment so that every team member has the opportunity to learn and improve themselves.

Grading:

Homework Assignments:	400 points
Quizzes:	200 points
Course Project:	400 points
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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 246, Class Orientation, Syllabus Discussion Kinematics and Dynamics of Aircraft Motion
Week 3 T 08/30 & Th 09/01	Equations of Motion of an Aircraft
Week 4 T 09/06 & Th 09/08	Aircraft Longitudinal Open-Loop Dynamics
Week 5 T 09/13 & Th 09/15	Aircraft Lateral/Directional Open-Loop Dynamics
Week 6 T 09/20 & Th 09/22	Classical Control Theory and Design Techniques
Week 7 T 09/27 & Th 09/29	Classical Control Theory and Design Techniques (cont.)
Week 8 T 10/04 & Th 10/06	Modern Control Theory and Design Techniques
Week 9 T 10/11 & Th 10/13	Modern Control Theory and Design Techniques (cont.)
Week 10 T 10/18 & Th 10/20	Observer and LQR Design
Week 11 T 10/25 & Th 10/27	Observer-Controller Design
Week 12 T 11/01 & Th 11/03	Kalman Filter and LQG Design

Week 13 T 11/08 & Th 11/10	Aircraft System Identification
Week 14 T 11/15 & Th 11/17	Dynamic Inversion Design
Week 15 T 11/22 & **Th 11/24**	Lyapunov Stability Analysis **No class on Thu 11/24 (Thanksgiving Holiday)**
Week 16 T 11/29 & Th 12/01	Lyapunov Stability Analysis (cont.)
Week 17 **Tue 12/06** **Thu 12/08**	**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 Thu 12/08.**