AE 246 - Advanced Aircraft Stability and Control, Fall 2020

Instructor Information: Professor Long Lu
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Credit: 3 units

Class Times & Locations: Mon and Wed 4:30 PM-5:45 PM (on Zoom)

Office Hours & Locations: Fri 7:30 PM - 9:30 PM (on Zoom)

Prerequisites: BSAE or Instructor Consent

Textbook: Stevens, B. and Lewis, F. *Aircraft Control and Simulation.*

Additional References:

1. Cook, M. V. *Flight Dynamics Principles*.
2. Hunter, J. *Aerospace Vehicle Dynamics and Control Course Reader.*
3. Nelson, R. C. *Flight Stability and Automatic Control*.
4. Roskam, J. *Airplane Flight Dynamics and Automatic Flight Controls-Parts I and II.*
5. Nise, N. S. *Control Systems Engineering*.
6. Ogata, K. *Modern Control Engineering*.

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.

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 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 Objectives:

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 an attitude control system
9. Design a directional (heading) control system
10. Use modern computational tools such as MATLAB-Simulink to develop autopilot control systems for aircraft.

Grading:

Homework Assignments:	400 points
Quizzes:	200 points
Course Project Presentation:	100 points
Course Project Report and Code Folder:	300 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. Quizzes are unannounced and will be held during lectures.

2. Late submissions will not be accepted.

3. 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.

4. 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 W 08/19	Welcome to AE 246
Week 2 M 08/24 W 08/26	Kinematics and Dynamics of Aircraft Motion
Week 3 M 08/31 W 09/02	Equations of Motion of an Aircraft
Week 4 **M 09/07** W 09/09	**No class on Mon 09/07 (Labor Day)** Aircraft Longitudinal Open-Loop Dynamics
Week 5 M 09/14 W 09/16	Aircraft Longitudinal Open-Loop Dynamics (cont.) Aircraft Lateral/Directional Open-Loop Dynamics
Week 6 M 09/21 W 09/23	Aircraft Lateral/Directional Open-Loop Dynamics (cont.) Classical Control Theory and Design Techniques
Week 7 M 09/28 W 09/30	Classical Control Theory and Design Techniques (cont.)
Week 8 M 10/05 W 10/07	Modern Control Theory and Design Techniques
Week 9 M 10/12 W 10/14	Modern Control Theory and Design Techniques (cont.)
Week 10 M 10/19 W 10/21	Lyapunov Stability Analysis
Week 11 M 10/26 W 10/28	Observer, LQR, and Augmented LQR Design
Week 12 M 11/02 W 11/04	Kalman Filter and LQG Design
Week 13 M 11/09 W 11/11	Aircraft System Identification **No class on W 11/11 (Veteran's Day Observed)**

Week 14 M 11/16 W 11/18	Aircraft System Identification (cont.) Dynamic Inversion Design
Week 15 M 11/23 W 11/25	Dynamic Inversion Design (cont.) **No class on W 11/25 (Non-Instructional Day)**
Week 16 **M 11/30** **W 12/02**	**Course Project Presentations**
Week 17 **M 12/07** **W 12/09**	**No lecture on Mon 12/07. Please work on your course project.** **Course project reports and code folders are due to Canvas by 11:59 PM on Wed 12/09/2020.**