

*San Jose State University*  
*Department of Aerospace Engineering*

**AE 246: Advanced Aircraft Stability and Control**



INSTRUCTOR: Dr. Sean Swei  
NASA Ames Research Center  
(650) 604-0314 (O)  
[seanswei@gmail.com](mailto:seanswei@gmail.com)

TIME/ROOM: MoWe: 6:00~7:15PM ENG 403

Office Hours: 7:15~8:00PM ENG 403

PREREQUISITE: BSAE or instructor consent

TEXTBOOK: Class notes

REFERENCES: Schmidt, D.K., *Modern Flight Dynamics*, McGraw-Hill  
Bryson, A.E. Jr., *Control of Spacecraft and Aircraft*, Princeton University Press  
Ogata, K., *State Space Analysis of Control Systems*, Prentice Hall

McRuer, D., Ashkenas, I., and Graham, D., *Aircraft Dynamics and Automatic Control*, Princeton University Press  
McLean, D., *Automatic Flight Control Systems*, Prentice Hall

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

The contents of this course include:

- Review of longitudinal/lateral/directional aircraft dynamics.
- Introduction of aeroelastic wing aircraft.
- Structural dynamics.
- State space representation of dynamics and models of systems.
- Stability, controllability, and observability.
- Optimal Linear Quadratic Regulator (LQR) design.
- Linear Quadratic Gaussian (LQG) and Loop Transfer Recovery (LTR) approach
- Flight control design and analysis using Linear Matrix Inequality (LMI) approach.

**GOALS:** The goals of this course are to:

- Introduce the topics in aircraft stability and control.
- Provide the fundamental background in aircraft dynamic characteristics and handling qualities.
- Develop flight controls for aircraft with aeroelastic wings.
- Analyze and synthesize the flight control systems using modern control techniques.

**LEARNING**

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

- Analyze aircraft stability in state-space description.
- Solve eigenvalue/eigenvector problems.
- Calculate the transfer functions related to aircraft longitudinal/lateral/directional motions.
- Design a stabilizing controller for multi-input multi-output (MIMO) systems.
- Design a stability augmentation system (SAS).
- Design aircraft attitude control systems.
- Use MATLAB/Simulink to develop aircraft control systems.

**GRADING:** Grading is based on the following:

- Homework/Labs: 40%
- Final project: 60%

## APPROXIMATE WEEKLY SCHEDULE:

### Lecture Topic(s)

- Introduction: Aircraft equations of motion (Longitudinal, lateral/directional dynamics)
- Lab exercise: Build a Simulink model for aircraft dynamics
- State-space representation. Stability and controllability
- Kalman Controllable Canonical Decomposition
- Design of full state feedback controllers
- Flight envelope protection (utilizing PCH-based approach)
- Observability. Separation principle, design of an observer
- Lab exercise: Build a state feedback with observer
- LQR optimal control
- **LQG/LTR controls**
- **Aircraft with aeroelastic wings (Generic Transport Model, GTM)**
- Structural dynamics, flexible modes
- Introduction to Variable Camber Continuous-Trailing Edge Flap (VCCTEF)
- Lab exercise: Flight control design for GTM (longitudinal direction)
- **Characterization of control systems using LMI**
- LMI-based optimal flight control system design
- Final project presentation