

AE 138 – Vector-Based Dynamics for Aerospace Applications

Instructor Info	Prof. J.M. Hunter
Credit	3 units
Online Class:	Some Mondays
Class Days / Time	MW 10:30 – 11:45pm, E164
Office Hours	Wednesday and sometimes Monday E272 9:30 – 10:15 am 2:00 – 3:30pm, or by appointment
Classroom	Engr. 164
Prerequisites	“C-” or better in AE140, AE157, AE165 and Math 129A
Course Website select this course.	https://sjsu.instructure.com Under the courses tab,
Final Exam	Tuesday December 15, 9:45 to 12:00pm

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.

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Texts: Hunter: Aerospace Vehicle Dynamics & Control Course Reader (Maple Press)
Roskam: Airplane Flight Dynamics and Automatic Flight Controls, Parts I & II

<https://shop.darcorp.com/index.php?route=product/category&path=60>

References: Etkin: Dynamics of Atmospheric Flight
Blakelock: Automatic Control of Aircraft and Missiles
McGruer: Aircraft Dynamics and Automatic Control
Perkins & Hage: Airplane Performance and Stability & Control
Nise: Control Systems Engineering
Agrawal: Design of Geosynchronous Spacecraft
Ogata: Modern Control Engineering

Course Goals

1. To review aircraft static stability and develop the concepts of aircraft dynamic stability.
2. To learn the principles of automatic feedback control.
3. To gain an understanding of aircraft motion and develop the means to control that motion.
4. To derive spacecraft equations of motion.
5. To design passive and active control of spacecraft.

Student Learning Objectives:

1. Review the principles of static longitudinal aircraft stability.
2. Represent vehicle orientation using Euler angle rotations.
3. Develop perturbation equations for aerospace vehicle six degree-of-freedom motion.
4. Estimate lateral and longitudinal stability derivatives from aircraft geometry.
5. Understand why deflecting the ailerons produces a yawing moment.
6. Determine the natural frequencies and damping ratios of the short period and phugoid modes.
7. Evaluate the effect of compressibility on aircraft handling qualities.
8. Understand the significance of the Cooper-Harper rating scale.
9. Evaluate the effect of altitude on aircraft handling qualities.
10. Derive transfer functions and plot vehicle time response.
11. Use root locus and frequency response techniques to design closed-loop control systems: rate-damping, attitude control, altitude control.
12. Derive the equations of a satellite using gravity-gradient passive control.
13. Design a satellite control law using a momentum wheel.
14. Design a control law for a spacecraft which is 3-axis controlled by cold-gas jets.

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Grading: Homework	15%
Project + Presentation	25%
Two Hour Exams	40%
Final Exam	20%

Week	Lecture Outline
1	Airplane Static Longitudinal Stability
2	Airplane Static Lateral / Directional Stability
3	Rigid body equations of motion & linearization
4	Perturbation equations: longitudinal & lateral / directional
5	Longitudinal stability derivatives
6	Lateral / directional stability derivatives
7	Dimensional perturbation equations
8	Longitudinal dynamic stability
9	Closed loop control
10	Attitude-hold & altitude-hold autopilot design
11	Lateral / directional control
12	Launch vehicle control
13	Gravity gradient dynamics & passive control
14	Spacecraft attitude dynamics & 3-axis control
15	Thruster control
16	Final Exam Review

Grading Scale: 100 – 97% A+; 96.9 – 93% A; 92.9 – 90% A-; 89.9 – 87% B+; 86.9 – 83% B; 82.9 – 80% B-; 79.9 – 77% C+; 76.9 – 73% C; 72.9 – 70% C-; 69.9 – 67% D+; 66.9 – 63% D; 62.9 – 60% D-; < 59.9% F. All exams must be taken to receive a passing grade.

AE Department & SJSU Policies are posted at: < <http://ae.sjsu.edu/node/86>>