

AE 245 - Spacecraft Dynamics and Control Fall 2018

Instructor Information:	Professor Long Lu Long.Lu@sjsu.edu
Credit:	3 units
Class Times & Locations:	Mon and Wed 18:00-19:15 at CL 234
Office Hours & Locations:	Mon and Wed 17:00-18:00 at the AE Conference Room (inside the AE Department at ENG 272)
Prerequisites:	BSAE or Instructor Consent
Main Textbook:	Wie, B. <i>Space Vehicle Dynamics and Control</i> . AIAA.
Additional References:	[1] Sidi, M. J. <i>Spacecraft Dynamics and Control: A Practical Engineering Approach</i> . Cambridge University Press. [2] Curtis, H. <i>Orbital Mechanics for Engineering Students</i> . Elsevier Butterworth-Heinemann. [3] Thomson, W. T. <i>Introduction to Space Dynamics</i> . Dover Publications. [4] Nelson, R. C. <i>Flight Stability and Automatic Control</i> . McGraw-Hill Education. [5] Ogata, K. <i>Modern Control Engineering</i> . Pearson.

SJSU Catalog Course Description:

Rigid body dynamics review. Attitude kinematical representations. Development and solution of general equations of motion. Single and dual-spin, zero and biased-momentum spacecraft. Control system design strategies. Common torquer elements. Computer simulations.

Course Goals:

Introduce students to:

1. Fundamental knowledge of rotational kinematics and rigid body dynamics
2. Space vehicles dynamics and motions
3. Modern control system analysis and design techniques
4. Development of optimal spacecraft control strategies

Course Learning Objectives:

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

1. Derive the governing equations of motion for a rigid-body spacecraft
2. Mathematically model a spacecraft as a dynamical system
3. Utilize state-space representation for system analysis
4. Determine the eigenvalues and eigenvectors of the state matrix of a state-space system
5. Derive the state-transition matrix by the Laplace transformation technique and the exponential method
6. Utilize the state-transition matrix to investigate the response of the system to an input
7. Perform canonical transformations of the system to examine the characteristics of a state equation
8. Analyze the controllability and observability of a spacecraft system
9. Use modern control design techniques to design spacecraft control systems
10. Design an optimal control system to stabilize a spacecraft
11. Reconstruct state variables by designing a state observer
12. Utilize gravity gradient and spin stabilization methods
13. Implement quaternion feedback control method
14. Use reaction wheels and thrusters for attitude control
15. Analyze the spacecraft structural dynamics and the effect of liquid sloshing
16. Utilize modern tools such as MATLAB and Simulink for designing spacecraft control systems and analyzing their performance

Grading:

Homework assignments:	400 points
Midterm examination:	300 points
Final examination:	300 points

Total:	1000 points

Letter Grade Determination:

≥ 950 points: A+	≥ 670 points: C+
≥ 900 points: A	≥ 650 points: C
≥ 850 points: A-	≥ 630 points: C-
≥ 800 points: B+	≥ 600 points: D
≥ 750 points: B	< 600 points: F
≥ 700 points: B-	

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 at the beginning of class on the announced due dates.
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 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	Discussion Topics/Class Activities
1	Wed 08/22	Welcome to AE 245
2	Mon 08/27	Mathematical Modeling of Dynamical Systems
	Wed 08/29	Introduction to Simulation and Analysis with MATLAB and Simulink
3	Mon 09/03	No class: Labor Day
	Wed 09/05	State-Space Modeling of Dynamical Systems The State-Transition Matrix
4	Mon 09/10	Canonical Transformation
	Wed 09/12	
5	Mon 09/17	Controllability and Observability
	Wed 09/19	State-Feedback Control System Design
6	Mon 09/24	Optimal Control System Design
	Wed 09/26	State Observer Design for the Reconstruction of State Variables
7	Mon 10/01	Direction Cosine Matrix
	Wed 10/03	Euler Angles
8	Mon 10/08	Kinematic Differential Equations
	Wed 10/10	Equations of Translational and Rotational Motion
9	Mon 10/15	Angular Momentum and Applied Moment Euler's Equations of Motion
	Wed 10/17	Gravity Gradient Stabilization
10	Mon 10/22	
	Wed 10/24	
11	Mon 10/29	Spin Stabilization
	Wed 10/31	
12	Mon 11/05	Midterm Exam Review
	Wed 11/07	In-Class Midterm Exam
13	Mon 11/12	No class: Veteran's Day (Observed)
	Wed 11/14	Quaternion Feedback Control
14	Mon 11/19	
	Wed 11/21	No class: Non-Instructional Day
15	Mon 11/26	Attitude Control Using Reaction Wheels
	Wed 11/28	Reaction Thruster Attitude Control
16	Mon 12/03	Structural Dynamics and Liquid Sloshing
	Wed 12/05	Final Exam Review
17	Mon 12/10	Take-Home Final Exam Assigned on Canvas at 6 PM No class: Please work on the take-home final exam.
	Wed 12/12	Take-Home Final Exam Due to Canvas by 11:59 PM