SAN JOSE STATE UNIVERSITY
Aerospace Engineering
AE242: Orbital Mechanics and Mission Design
Spring 2016

Instructor:	Prof. J.M. Hunter
Class Time:	Wednesday 4:00 – 6:45pm
Office Hours:	Wednesday 10:30 - 11:45am and 3:00 - 3:45pm Sometimes: Monday 10:30 - 11:45am and 3:00 - 4:45pm
Class Code:	26653
Class Website:	https://sjsu.instructure.com Under the courses tab, select this course.
Exams:	One Midterm (one hour) and one Final Exam (two hours and 15 minutes)
Final Exam:	Thursday May 19, 2:45 – 5:00pm
Pre-requisite:	BSAE or Instructor Consent
Course Description:	Two-body problem analysis and orbit design, Kepler's Laws, Keplerian elements, Single-impulse orbit transfers, Hohmann transfers, Circularization, Plane changes, Kepler's Equation, Gibbs' method of orbit determination, Terminal phase rendezvous, Orbital Perturbations including atmospheric drag and Earth oblateness, Planetary sphere of influence, Vector mechanics and relative motion of interplanetary flight, Patched conic trajectory model, Gravity-assist trajectories, Case studies, Introduction to the circular and elliptical restricted three-body problems.
Texts:	Hunter: Astrodynamics Course Reader (Maple Press)
References:	Curtis: *Orbital Mechanics for Engineering Students* Szebehely: *Adventures in Celestial Mechanics* Sellers: *Understanding Space* Thomson: *Introduction to Space Dynamics* Sidi: *Spacecraft Dynamics and Control* Bate, Mueller & White: *Fundamentals of Astrodynamics* Vallado: *Fundamentals of Astrodynamics and Applications* Wie: *Space Vehicle Dynamics and Control*

Week	Lecture Outline
1	The Two-Body Problem
2	Orbit Energy & Relationship to Orbit Type
3	Kepler's Laws of Planetary Motion
4	Keplerian Elements
5	Orbit Determination from Observations
6	Hyperbolic Trajectory Design
7	Planar Orbital Maneuvers
8	Plane Change Maneuver & Rendezvous Phasing
9	Terminal Phase Rendezvous
10	Patched Conic Trajectory Design
11	Gravity Assist Maneuvers
12	Orbital Perturbations: Atmospheric Drag, J_2
13	Circular Restricted Three-Body Problem
14	Lagrange Points
15	Case Studies
16	Final Exam Review

Course Goals:

1. To provide a fundamental knowledge of orbital mechanics.
2. To understand the assumptions of the various astrodynamics models.
3. To apply the equations of three-dimensional particle dynamics to orbits & trajectories.
4. To apply Gibbs' Method of orbit determination.
5. To use vector mechanics to model interplanetary flight.
6. To design trajectories with the Patched-Conic technique.
7. To examine case studies and develop an understanding of optimal orbit design strategies.
8. To model the Earth/Moon/spacecraft system using the assumptions of the circular and elliptical restricted three-body problems.
9. To create computer algorithms for the above applications.

Student Learning Objectives:

1. Derive two-body problem equations of motion.
2. Determine why astronauts feel weightless.
3. Model two-body orbit as a conic section.
4. Solve for velocity variation as a function of position along orbit.
5. Define elliptical orbit from burnout conditions.
6. Calculate circular velocity and escape velocity as a function of altitude.
7. Derive and understand the significance of Kepler's Laws of Planetary Motion.
8. Calculate Earth-centered Newtonian position and velocity from Keplerian elements.
9. Find time along the orbit (time since periapsis passage) using Kepler's equation.
10. Use Gibbs' Method of Orbit Determination with three radius observations.
11. Calculate velocity along a hyperbolic orbit, turn angle, aiming radius, hyperbolic excess speed, etc.
12. Model orbits from case studies and discuss the tradeoffs made in the design decisions.
13. Design single impulse Δv burns for orbit transfers.
14. Calculate total Δv for a Hohmann transfer around a single central force body.
15. Optimize the circularization maneuver.
16. Find wait time and phasing angle for a rendezvous scenario.
17. Determine the velocity increment required for a terminal phase rendezvous.
18. Design an impulse burn to pivot the orbital plane and calculate the required Δv.
19. Compute the sphere of influence of a given central force body.
20. Using appropriate reference frames and knowledge of relative motion, design patched conic trajectories for interplanetary travel.
21. Design & analyze planetary flyby opportunities for changing heliocentric orbital energy.
22. Determine the effect of radius of periapsis variation on heliocentric trajectory.
23. Determine the effect of perturbations to an idealized Keplerian orbit: atmospheric drag, Earth oblateness, etc.
24. Derive equations of motion for the circular restricted three body problem and solve simple cases.

Grading for Course:		
	Homework	20%
	Project & Presentation	30%
	Midterm Exam	25%
	Final Exam	25%

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.