San Jose State University
Aerospace Engineering Department
AE142 (AE199 Section 2): Astrodynamics
Spring 2017

Instructor	J. M. Hunter
Office Location	Engineering 272F
Email	jeanine.hunter@sjsu.edu
Office Hours	Monday & Wednesday 10:30 – 1:15; Monday 4:30 – 6pm
Class Days / Time	Monday & Wednesday 3:00 – 4:15pm
Classroom	Engineering 164
Prerequisites	"C-" or better in AE 138 & AE 165
Course Website	<https://sjsu.instructure.com> Under the courses tab, select this course.
Final Examination	Wednesday, May 24 12:15 – 2:30pm

Course Description

Two-body and restricted three-body problem analysis and orbit design; Kepler's Laws; Keplerian elements; Single-impulse orbit transfers; Hohmann transfers; Circularization; Plane changes; Kepler's Equation; Planetary sphere of influence; Interplanetary flight; Patched conic trajectory model; Gravity-assist trajectories.

Course Goals

1. Provide a fundamental knowledge of orbital mechanics.
2. Understand the assumptions of the various astrodynamics models.
3. Apply the equations of three-dimensional particle dynamics to orbits & trajectories.
4. Use vector mechanics to model interplanetary flight.
5. Examine case studies and develop an understanding of optimal orbit design strategies.
6. Model the Earth/Moon/spacecraft system using the assumptions of the restricted three-body problem.

Course Learning Objectives

1. Derive two-body problem equations of motion.
2. Model two-body orbit as a conic section.
3. Solve for velocity variation as a function of position along orbit.
4. Define elliptical orbit from burnout conditions.
5. Orbit determination from two observations.
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. Calculate velocity along a hyperbolic orbit, turn angle, aiming radius, hyperbolic excess speed, etc.
11. Model orbits from case studies and discuss the tradeoffs made in the design decisions.
12. Design single impulse Δv burns for orbit transfers.
13. Calculate total Δv for a Hohmann transfer around a single central force body.
14. Optimize the circularization maneuver.
15. Find wait time and phasing angle for a rendezvous scenario.
16. Design an impulse burn to pivot the orbital plane and calculate the required □V.
17. Compute the sphere of influence of a given central force body.
18. Using appropriate reference frames and knowledge of relative motion, design patched conic trajectories for interplanetary travel.
19. Design & analyze planetary flyby opportunities for changing heliocentric orbital energy.
20. Derive equations of motion for the restricted three body problem and solve simple cases.

Text Hunter: Astrodynamics Course Reader (Maple Press)

References
Curtis: *Orbital Mechanics for Engineering Students*
Anderson: *Introduction to Flight*
Szebehely: *Adventures in Celestial Mechanics*
Sellers: *Understanding Space*
Thomson: *Introduction to Space Dynamics*
Bate, Mueller & White: *Fundamentals of Astrodynamics*
Mitiguy: *Dynamics of Mechanical, Aerospace and Biomechanical Systems*

Determination of Grades

Homework	15%
Project & Presentation	25%
Two Hour Exams	40%
Final Exam	20%

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.

Lecture Schedule

Lecture	Topic
1	Course Introduction
2&3	The Two-Body Problem
4	Conic Section Solution to the Equations of Motion
5&6	Orbit Energy
7	Relationship of Orbit Energy to Orbit Type
8&9	Escape Velocity, Circular Velocity
10	Orbit Determination from Observations
11	History of Celestial Mechanics
12&13	Kepler's Laws of Planetary Motion
14&15	The Six Keplerian Elements
16	Hohmann Transfer, Single Central Force Body
17	Rendezvous and Phasing
18&19	Interplanetary Flight Strategies & Case Studies
20&21	Sphere of Influence; Patched Conic Trajectory Approximation
22&23	Gravity-Assist (Flyby) Trajectory
24 – 27	The Restricted Three-Body Problem
28	Final Exam Review

Academic integrity

- Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University Academic Integrity Policy S07-2 at http://www.sjsu.edu/senate/docs/S07-2.pdf requires you to be honest in all your academic course work.
- Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development.
- The Student Conduct and Ethical Development website is available at http://www.sjsu.edu/studentconduct/.
- Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade in the course and sanctions by the University. Assignments are to be completed by the individual student unless otherwise specified. If your name appears on a team paper, you are expected to be able to explain whatever answer / solution / derivation is on the paper. Failure to explain the team's answer by any individual will result in a grade of zero for the team.
- If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Integrity Policy S07-2 requires approval of instructors.
- For help with paraphrasing and referencing please see the SJSU Library Tutorial on Plagiarism. The following websites also show you how to paraphrase properly and avoid plagiarism: http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml http://owl.english.purdue.edu/handouts/research/index.html