

San José State University
Aerospace Engineering
AE142 Astrodynamics, Spring 2016

Instructor:	Prof. Jeanine Hunter
Office Location:	E272F
Email:	jeanine.hunter@sjsu.edu
Office Hours:	TBA
Class Days/Time:	TBA
Classroom:	E164
Prerequisites:	“C-“ or better in AE 138 & AE 165
Course Website:	https://sjsu.instructure.com Under the courses tab, select this course

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; Planetary sphere of influence; Vector mechanics and relative motion of interplanetary flight; Patched conic trajectory model; Gravity-assist trajectories; Case studies; Introduction to the restricted three-body problem.

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 Outcomes (CLO)

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

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 v burns for orbit transfers.
13. Calculate total v 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.

Required Texts/Readings

Textbook

Hunter: *Astrodynamics Course Reader* (Maple Press)

Other Readings

Curtis: *Orbital Mechanics for Engineering Students*

Anderson: *Introduction to Flight*

Szebehely: *Adventures in Celestial Mechanics*

Sellers: *Understanding Space*

Bate, Mueller & White: *Fundamentals of Astrodynamics*

Grading Information

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

Determination of Grades

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.

University 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](http://www.sjsu.edu/gup/syllabusinfo/) at <http://www.sjsu.edu/gup/syllabusinfo/>.

AE Department and SJSU policies are also posted at <http://ae.sjsu.edu/program-policies>.

AE 142 Astrodynamics Spring 2016 Course Schedule

Course Schedule

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