San Jose State University
Aerospace Engineering Department
AE142: Astrodynamics
Spring 2020

Instructor	J. M. Hunter
Office Location	Engineering 272F
Email	jeanine.hunter@sjsu.edu
Office Hours	Monday & Wednesday 10:30am – 1:00pm, Monday 3 – 4pm
Class Days / Time	Monday & Wednesday 4:30 – 5:45pm
Classroom	Engineering 331
Prerequisites	C or better in AE 138
Course Website	<https://sjsu.instructure.com>
Final Examination	Tuesday, May 19, 2:45 – 5:00pm

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

Determination of Grades

Homework	10%
Project & Presentation	25%
Two Hour Exams	40%
Final Exam	25%

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

Late Homework Policy: Homework is due at the beginning of class, either on Canvas or as a paper submission (as specified). Late homework will be accepted for 70% credit on Canvas until 11:59pm on the due date.

For issues related to Canvas, please contact the eCampus Help Desk. The Help Desk can give technical support for issues encountered in Canvas Courses. Phone: (408) 924-2337 Submit a help ticket using the following URL: https://isupport.sjsu.edu/ecampus/ContentPages/Incident.aspx. While logged into Canvas, click on the word **Help** on the upper right corner of the screen.

University Policies

Dropping and Adding Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's Catalog Policies section at http://info.sjsu.edu/static/catalog/policies.html. Add/drop deadlines can be found on the current academic calendar web page located at http://www.sjsu.edu/academic_programs/calendars/academic_calendar/. The Late Drop Policy is available at http://www.sjsu.edu/aars/policies/latedrops/policy/. Students should be aware of the current deadlines and penalties for dropping classes. Information about the latest changes and news is available at the Advising Hub at http://www.sjsu.edu/advising/.

Academic Integrity Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University's Academic Integrity policy, located at http://www.sjsu.edu/senate/S07-2.htm, 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.sa.sjsu.edu/judicial_affairs/index.html.

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 for the course* and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. 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 Policy S07-2 requires approval of instructors.

Campus Policy in Compliance with the American Disabilities Act If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Disability Resource Center (DRC) at http://www.drc.sjsu.edu/ to establish a record of their disability.

Time Required Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of forty-five hours over the length of the course (normally 3 hours per unit per week) for instruction or preparation/ studying or course related activities including but not limited to internships, labs, clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.

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