San José State University
College of Engineering, Department of Aerospace Engineering
AE 142: Astrodynamics, Spring 2022

Course and Contact Information

Instructor:	Professor Long Lu
Email:	Long.Lu@sjsu.edu
Office Hours:	Monday and Wednesday 2:30 PM-3:30 PM (Online via Zoom)
Class Times and Location:	Monday and Wednesday 4:30 PM-5:45 PM (Online via Zoom until 02/11/2022 and at Engineering Building 303 for the rest of the semester)
Prerequisites:	A grade of "C" or better in AE 138 or graduate standing

Course Description

Two-body problem analysis and orbit design; Kepler's Laws; 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; Restricted three-body problem.

Course Materials and Format

Zoom meeting links and course materials such as the syllabus, assignments, lecture notes... will be available on our class Canvas site. Students will also use Canvas to submit assignments and exams. Students are responsible for regularly checking Canvas to learn of any updates and announcements.

Course Goals

Introduce students to:

1. Fundamental knowledge of orbital mechanics
2. Various astrodynamics models and their assumptions
3. Application of three-dimensional particle dynamics equations to orbits and trajectories
4. Modeling interplanetary flight by vector mechanics
5. Case studies and development of optimal orbit design strategies
6. The restricted three-body problem to model the Earth-Moon-spacecraft system

Course Learning Outcomes (CLO)

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

1. Derive equations of motion for the two-body problem and model a two-body orbit as a conic section
2. Find velocity variation as a function of position along an orbit
3. Use burnout conditions to define elliptical orbits
4. Determine orbits from two observations
5. Compute circular and escape velocities as a function of altitude
6. Derive Kepler's Laws of Planetary Motion and understand their significance
7. Find Earth-centered Newtonian position and velocity from Keplerian elements
8. Calculate time since periapsis passage using Kepler's equation
9. Compute velocity along a hyperbolic orbit, turn angle, aiming radius, hyperbolic excess speed, etc.
10. Investigate case studies to model orbits and discuss the tradeoffs in the design process
11. Design single impulse Δv burns for orbit transfers
12. Calculate total Δv for a Hohmann transfer around a single central force body
13. Design the optimal circularization maneuvers
14. Calculate wait time and phasing angle for a rendezvous scenario
15. Design an impulse burn to pivot the orbital plane and calculate the required Δv
16. Compute the sphere of influence of a given central force body
17. Use appropriate reference frames and knowledge of relative motion and design patched conic trajectories for interplanetary travel
18. Design and analyze planetary flyby opportunities for changing heliocentric orbital energy
19. Derive equations of motion for the restricted three body problem
20. Work effectively in teams to define, propose, and solve an astrodynamics problem for a course project incorporating the use of modern computational tools such as MATLAB-Simulink.

Required Texts/Readings

Required Textbook

Astrodynamics Course Reader by Professor Jeanine Hunter. This course reader is available at Maple Press, 330 S 10th St #200, San Jose, CA 95112. Also available for online order at <https://maplepress.net/readers/product-tag/spring-2022/> (please select AE-142-01-LU).

Additional References

[1] Curtis, H. *Orbital Mechanics for Engineering Students*. Elsevier Butterworth-Heinemann.
[2] Anderson, J. *Introduction to Flight*. McGraw-Hill Education.

Grading Information

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 to Canvas (using Canvas assignment submission) by the announced due dates on Canvas. Please remember to check Canvas regularly. For analytical problems, please remember to type or scan your work and save it as a PDF file. For computational problems, please use MATLAB-Simulink and remember to publish all MATLAB-Simulink programs to a PDF file. Please combine the PDF files of your analytical and computational parts into one PDF file and submit it to Canvas.
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 such as copied/shared solutions or code will not be tolerated.
6. The course project is a team-effort assignment. For a team-effort assignment, all members of a team will share the same score. Therefore, please make sure to be professional, work effectively, and contribute equally to the team-effort assignment so that every team member has the opportunity to learn and improve themselves.

Grading

Homework Assignments:	400 points
Examination 1:	200 points
Examination 2:	200 points
Course Project:	200 points
Total:	1000 points

Letter Grade Determination

Total ≥ 950 points: A+
Total ≥ 900 points: A
Total ≥ 850 points: A-
Total ≥ 800 points: B+
Total ≥ 750 points: B
Total ≥ 700 points: B-

Total ≥ 670 points: C+
Total ≥ 650 points: C
Total ≥ 630 points: C-
Total ≥ 600 points: D
Total < 600 points: F

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 at <http://www.sjsu.edu/gup/syllabusinfo>.
- AE Department and SJSU policies are also posted at <http://www.sjsu.edu/ae/programs/policies>.

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Approximate Course Schedule

Week/Dates	Discussions Topics/Activities
Week 1 W 01/26	Welcome to AE 142! Class Orientation, Syllabus Discussion
Week 2 M 01/31 & W 02/02	Motion under a Central Force: The Restricted Two-Body Problem
Week 3 M 02/07 & W 02/09	Orbit Energy
Week 4 M 02/14 & W 02/16	Kepler's Laws of Planetary Motion
Week 5 M 02/21 & W 02/23	The Six Keplerian Elements
Week 6 M 02/28 & W 03/02	The Six Keplerian Elements (cont.)
Week 7 **M 03/07** & **W 03/09**	**Exam 1 Review on Mon 03/07/2022** **Exam 1 on Wed 03/09/2022**
Week 8 M 03/14 & W 03/16	Geometry of a Hyperbolic Trajectory
Week 9 M 03/21 & W 03/23	Orbital Maneuvers
Week 10 **M 03/28 & W 03/30**	**Spring Recess**
Week 11 M 04/04 & W 04/06	Orbital Maneuvers
Week 12 M 04/11 & W 04/13	Orbital Maneuvers (cont.)
Week 13 M 04/18 & W 04/20	Interplanetary Trajectories
Week 14 M 04/25 & W 04/27	Interplanetary Trajectories (cont.)
Week 15 M 05/02 & W 05/04	The Restricted Three-Body Problem
Week 16 **M 05/09** & **W 05/11**	**Exam 2 Review on Mon 05/09/2022** **Exam 2 on Wed 05/11/2022**
Week 17 **M 05/16**	**No class on Mon 05/16/2022. Please work on your course project.**
Week 18 **M 05/23**	**Course project report and code folder are due to Canvas by 11:59 PM on Mon 05/23/2022.**