Instructor J. M. Hunter

Office Location Engineering 272F

Email jeanine.hunter@sjsu.edu

Office Hours Monday & Wednesday 10:30 - 11:30, Monday 2-4, Wednesday 2-3

Class Days / Time Monday & Wednesday 12:00 – 1:15pm

Classroom Engineering 327

Prerequisites C or better in AE 138 & AE 165

Course Website <https://sjsu.instructure.com> Under the courses tab, select this course.

Final Examination Friday, May 17, 9:45am – 12:00pm

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 Δv.
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

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>15%</td>
</tr>
<tr>
<td>Project &amp; Presentation</td>
<td>25%</td>
</tr>
<tr>
<td>Two Hour Exams</td>
<td>40%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
</tr>
</tbody>
</table>

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 – 75% C+; 74.9 – 70% C; 69.9 – 67% C-; 66.9 – 63% D+; 62.9 – 60% D; 59.9 – 55% D-; < 54.9% F.
All exams must be taken to receive a passing grade.
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.

POLICIES

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/licatedrops/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 with 1 of the hours used for lecture) 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**

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