

**San José State University**  
**Aerospace Engineering Department**  
**AE243, Advanced Astrodynamics, Fall 2017**

**Course and Contact Information**

<b>Instructor:</b>	J. M. Hunter
<b>Office Location:</b>	Engineering 272F
<b>Telephone:</b>	1-408-924-3965
<b>Email:</b>	<a href="mailto:jeanine.hunter@sjsu.edu">jeanine.hunter@sjsu.edu</a>
<b>Office Hours:</b>	Monday & Wednesday 10:30 – 1:15pm
<b>Class Days/Time:</b>	Monday & Wednesday 4:30 – 5:45pm
<b>Classroom:</b>	Engineering 164
<b>Course Format</b>	Seminar

**Course Description**

Analysis of spacecraft motion using different dynamic models and perturbations. Use of the state transition matrix and differential corrections technique for trajectory computation. Orbit determination and station-keeping methods. Introduction to the three-body problem. Application of computational and analytic methods to solve astrodynamics problems.

**Course Goals**

1. Simulate Earth orbits and trajectories with realistic perturbation models.
2. Develop an orbit correction strategy for low Earth orbiting spacecraft.
3. Estimate orbital elements using range, azimuth or elevation measurements in successive time.
4. Model gravity gradient spacecraft dynamics in planetary orbit.
5. Explore the feasibility of orbit maintenance at unstable Lagrange points.
6. Using actual data, model Apollo missions with three body problem physics.
7. Model and evaluate asteroid deflection options.

**Course Learning Outcomes (CLO)**

1. Create a computational algorithm for orbit estimation using Gibbs' Method and evaluate its effectiveness.
2. Solve Lambert's problem using actual spacecraft data, evaluate accuracy and consider error sources.
3. Create a Matlab model of an Earth orbit including perturbations from oblateness, atmospheric drag and solar pressure.
4. Model finite impulsive burn orbit dynamics in Earth orbit.
5. Write a batch least-squares nonlinear orbit estimation algorithm and verify it with actual data.
6. Simulate Earth orbits with Systems Tool Kit (STK) and compare with the results of in-class assignments.
7. Propagate orbit states and adjust with differential correction technique.
8. Model a gravity gradient spacecraft in Earth orbit.
9. Evaluate efficacy of halo orbits at unstable Lagrange points using a station keeping budget.

10. Model planetary atmospheres, e.g. Mars and Venus.
11. Create models of planetary ephemerides in preparation for solar system work.
12. Model aerobraking orbit adjustment of known Mars mission and compare results with actual data.
13. Develop a Matlab model of the Earth-Moon-spacecraft three-body problem and compare results with Apollo data.
14. Evaluate strategies for Earth-threatening asteroid deflection.

**Textbook** Hunter: *Astrodynamics Course Reader* (Maple Press)

**References** Bate, Mueller & White: *Fundamentals of Astrodynamics*  
 Chao: *Applied Orbit Perturbation and Maintenance*  
 Curtis: *Orbital Mechanics for Engineering Students*  
 Koon, Lo, et al: *Dynamical Systems, the Three-Body Problem and Space Mission Design*  
 Mitiguy: *Dynamics of Mechanical, Aerospace and Biomechanical Systems*  
 Sellers: *Understanding Space*  
 Sidi: *Spacecraft Dynamics & Control*  
 Szebehely: *Adventures in Celestial Mechanics*  
 Thomson: *Introduction to Space Dynamics*  
 Wie: *Space Vehicle Dynamics & Control*

### Course Requirements and Assignments

This course consists of 8 - 10 homework assignments, two midterm exams, a project and a written final exam. The assignments are both analytical and computational. Computational assignments will be done with code written by the student, either in Matlab or MotionGenesis. The homework assignments and project are designed to directly support the Course Learning Objectives. More details can be found from [University Syllabus Policy S16-9](http://www.sjsu.edu/senate/docs/S16-9.pdf) at <http://www.sjsu.edu/senate/docs/S16-9.pdf>.

### Final Examination

A comprehensive written final exam will be given during the university's final exam week.

### Grading Information

Grades are derived from homework, exams and the project. Each homework problem is worth 10 points. Partial credit is assigned based on the demonstrated understanding of concepts and analytical/numerical results. More guidelines on grading information and class attendance can be found from the following two university policies:

- [University Syllabus Policy S16-9](http://www.sjsu.edu/senate/docs/S16-9.pdf) (<http://www.sjsu.edu/senate/docs/S16-9.pdf>)
- [University policy F15-12](http://www.sjsu.edu/senate/docs/F15-12.pdf) (<http://www.sjsu.edu/senate/docs/F15-12.pdf>)

### Determination of Grades

Homework (Analytical & Computational)	30%
Project & Presentation	30%
Midterm Exam	20%
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.

## 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 Policies** <http://www.sjsu.edu/ae/programs/policies/>

## AE243 / Astrodynamics, Fall 2017, Course Schedule

Week	Date	Topics
1	8/21/2017	Course Introduction
2	8/28/2017	Earth Orbit Perturbation Models
3	9/4/2017	Gibbs Method, Lambert's Problem
4	9/11/2017	Finite Propulsive Burn Modeling
5	9/18/2017	Nonlinear Orbit Estimation with Batch Least-Squares Algorithm
6	9/25/2017	STK
7	10/2/2017	Orbit Propagation and Differential Correction
8	10/9/2017	Dynamics of Gravity Gradient Spacecraft
9	10/16/2017	Midterm
10	10/23/2017	Station Keeping of Halo Orbits at Unstable Lagrange Points
11	10/30/2017	Planetary Ephemerides & Atmospheric Models
12	11/6/2017	Aerobraking Orbit Adjustments at Mars
13	11/13/2017	Apollo Mission Trajectory Reconstruction
14	11/20/2017	Asteroid Deflection Strategies
15	11/27/2017	Project Presentations
16	12/4/2017	Project Presentations
17	12/11/2017	Final Exam Review
Final Exam		During the assigned Final Exam period