San José State University
Aerospace Engineering Department
AE 243, Advanced Astrodynamics, Spring 2021

Course and Contact Information

Instructor(s):	Dr. Lucía Capdevila
Office Location:	Engineering Building 272 E
Email:	lucia.capdevila@sjsu.edu
Office Hours:	Tuesdays 10 - 11 am, Thursdays 3 -4 pm
Class Days/Time:	Tuesdays/Thursdays 4:30 - 5:45 pm
Classroom:	http://sjsu.instructure.com
Prerequisites:	AE 242

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 astrodynamic problems.

Course Format

Technology Intensive, Hybrid, and Online Courses

This course adopts a synchronous online format. Access to a computer that can connect to the internet, a device that can scan written work, and a device with a camera are required to participate in classroom activities and/or submit assignments.

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on Canvas Learning Management System course login website at http://sjsu.instructure.com. You are responsible for regularly checking with the messaging system through Canvas to learn of any updates. For help with using Canvas see Canvas Student Resources page (http://www.sjsu.edu/ecampus/teaching-tools/canvas/student_resources) If I cannot reach you via Canvas messaging, I will email you at the address provided in MySJSU. Please note that your email address listed in MySJSU may be different from your @sjsu.edu address.

Course Goals

1. Model satellite dynamics in multi-gravity fields
2. Calculate various types of solutions for satellite motion under the influence of multi-gravity fields
3. Analyze stability of satellite motion
4. Construct numerical tools for trajectory design in multi-gravity fields

5. Become familiar with astrodynamics literature

Course Learning Outcomes (CLO)

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

1. Derive and simulate the Circular Restricted Three-Body Problem (CR3BP) equations of motion
2. Calculate CR3BP Jacobi constant
3. Calculate CR3BP zero-velocity curves
4. Calculate equilibrium solutions or libration points in the CR3BP
5. Linearize CR3BP motion about the collinear and equilateral libration points
6. Calculate a periodic orbit about a libration point in the CR3BP
7. Calculate the State Transition Matrix (STM) associated with motion in the CR3BP
8. Calculate the monodromy matrix associated with periodic motion in the CR3BP
9. Determine the stability of a periodic orbit in the CR3BP using the STM
10. Calculate the manifold associated with a periodic orbit in the CR3BP
11. Calculate a Poincaré map of flow in the CR3BP
12. Demonstrate ability to understand and reproduce work published in astrodynamics journals

Required Texts/Readings (Required - Delete the word "Required" in final draft)

Textbook

None

Other Readings

- Notes and handouts
- References:
    1. Szebehely, V. (1967). *Theory of orbits, the restricted problem of three bodies.* New York: Academic Press. This book will be available at the MLK
    2. Roy, A. (1982). *Orbital motion* (2nd ed.). Bristol: A. Hilger.
    3. Parker, T., & Chua, L. (1989). *Practical numerical algorithms for chaotic systems*. Berlin ; New York: Springer Verlag.
    4. Maruskin, J. (2018). *Dynamical systems and geometric mechanics: An introduction* (De Gruyter studies in mathematical physics ; volume 48). Berlin/Boston: De Gruyter.

Availability: References listed above are available through the SJSU Dr. Martin Luther King Jr. Library. The links above will take you to the SJSU MLK reference record, but you must log on as an SJSU student to see all resources available to you. If the resource is available online, you will see a link that says "Online access". Maruskin is available online. Some of these references are available as hard copies, but emergency access is now available through the Hathi Trust Digital Library! Follow the SJSU link to the Hathi Trust Digital Library and search for the Szebehely, Roy, and Parker & Chua references to read them online. Additionally, all references are available for purchase online, but please check the school library before purchasing anything.

Other technology requirements / equipment / material

Access to a computer that can connect to the internet, a device that can scan written work, and a device with a camera are required to participate in classroom activities and/or submit assignments.

Course Requirements and Assignments (Required - Delete the word "Required" in final draft)

Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.

Final Examination or Evaluation

The culminating activity for this class will be an individual final project. Details will be provided during class.

Grading Information

- Grade Scale:
  - 100 to 97% A plus
  - less than 97% and above or equal to 93% A
  - less than 93% and above or equal to 90% A minus
  - less than 90% and above or equal to 87% B plus
  - less than 87% and above or equal to 83% B
  - less than 83% and above or equal to 80% B minus
  - less than 80% and above or equal to 77% C plus
  - less than 77% and above or equal to 73% C
  - less than 73% and above or equal to 70% C minus
  - less than 70% and above or equal to 67% D plus
  - less than 67% and above or equal to 63% D
  - less than 63% and above or equal to 60% D minus
  - less than 60% F
- Grade Components Weight:
  - Homework assignments: 70 %
  - Project: 30 %
- All assignments will be submitted via *Canvas Learning Management System course login website at http://sjsu.instructure.com* by the due date posted on Canvas.
- Late work is not accepted for credit without a valid justification and proper documentation.
- Extra credit opportunities will be announced in class.
- Project details will be provided during class.

Classroom Protocol

It is expected that everyone will treat each other and themselves with the highest respect at all times. It is also expected that students will share video during online meetings whenever possible to make the online class environment as personable as possible. We all benefit from each other's contributions to the class, so everyone's timely attendance and participation are also expected.

University Policies (Required - Delete the word "Required" in final draft)

Each student is responsible for understanding the following information and let me know if you have any questions:

- Academic Integrity Policy F15-7 at https://www.sjsu.edu/senate/docs/F15-7.pdf
- Student Conduct and Ethical Development at https://www.sjsu.edu/studentconduct/
- AE Program Policies at http://www.sjsu.edu/ae/programs/policies/
- Accessibility: If you need course adaptations or accommodations because of a disability, or if you need 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 AEC to establish a record of their disability.

AE 243 / Advanced Astrodynamics, Spring 2021, Course Schedule

The following is an *approximate* course schedule that is subject to change with fair notice given during class and/or via email and/or Canvas messaging.

Course Schedule

Week	Date	Topics
1	Thursday, January 28, 2021	Intro & orientation HW 0
2	Tuesday, February 2, 2021	N-body problem
2	Thursday, February 4, 2021	2BP EOMs and conic equation
3	Tuesday, February 9, 2021	CR3BP EOMs & Jacobi constant
3	Thursday, February 11, 2021	HW 1
4	Tuesday, February 16, 2021	Libration Points
4	Thursday, February 18, 2021	HW 2
5	Tuesday, February 23, 2021	Regions of Motion (ZVCs)
5	Thursday, February 25, 2021	HW 3
6	Tuesday, March 2, 2021	Motion about Li
6	Thursday, March 4, 2021	Motion about Li
7	Tuesday, March 9, 2021	Motion about Li
7	Thursday, March 11, 2021	Project PROPOSAL Presentations
8	Tuesday, March 16, 2021	Motion about Li
8	Thursday, March 18, 2021	HW 4
9	Tuesday, March 23, 2021	Differential Corrections and STM
9	Thursday, March 25, 2021	Differential Corrections and STM
10	Tuesday, March 30, 2021	Spring Recess - No class
10	Thursday, April 1, 2021	Spring Recess - No class
11	Tuesday, April 6, 2021	Differential Corrections and STM
11	Thursday, April 8, 2021	HW 5
12	Tuesday, April 13, 2021	Periodic Orbits
12	Thursday, April 15, 2021	Project PROGRESS Presentations
13	Tuesday, April 20, 2021	Periodic Orbits

Week	Date	Topics
13	Thursday, April 22, 2021	Periodic Orbits - working class
14	Tuesday, April 27, 2021	HW 6
14	Thursday, April 29, 2021	Stability
15	Tuesday, May 4, 2021	Manifolds
15	Thursday, May 6, 2021	HW 7
16	Tuesday, May 11, 2021	Maps
16	Thursday, May 13, 2021	Maps
Final Exam (Slot)	Friday, May 21, 2021	14:45-17:00 Project FINAL Presentations