San José State University
Aerospace Engineering Department
AE 140, Rigid Body Dynamics, Spring 2022

Course and Contact Information

Instructor:	Prof. J.M. Hunter
Office Hours Link:	https://sjsu.zoom.us/j/96580183367
Class links:	https://sjsu.zoom.us/j/81038605385?pwd=eExxc210am55UFNLak9DbzBYanhCUT09 (9:00 section) https://sjsu.zoom.us/j/85639652171?pwd=U1VOOEdiTllHV0R3TmVXVjJiVmhKdz09 (1:30 section)
Email:	jeanine.hunter@sjsu.edu
Office Hours:	MW 12:00 – 1:00pm
Class Days/Time:	MW 9:00 – 10:15am and 1:30 – 2:45pm
Canvas Link:	https://sjsu.instructure.com Under the courses tab, select this course.
Prerequisites:	C or better in AE138

Course Description

Co-ordinate frames and descriptions of absolute and relative motion. Particle motion with respect to the rotating Earth. General equations of rotational motion in Newtonian and Lagrangian formulations. Spinning body motions. Gyroscopic instruments. Stable platform for inertial guidance. Applications to aerospace vehicles.

Course Format

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

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.

Course Goals

1. To provide the fundamentals of intermediate dynamics of rigid bodies using Newtonian, Lagrangian and Eulerian dynamics.
2. To provide a review of point-mass dynamics.
3. To show the different approaches available in analyzing an equation of motion.
4. To demonstrate the connection between modeling, simulation, numerical solution and analytical solutions to equations of motion.

Course Learning Outcomes (CLO)

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

1. Develop a direction-cosine matrix and use it to transform vectors among reference frames.
2. Differentiate a vector in multiple reference frames.
3. Choose the appropriate reference frames for writing equations of motion.
4. Derive point-mass equations of motion using Newton's or Lagrange's method.
5. Write equations which define the motion of a particle with respect to the rotating Earth; identifying Coriolis and centripetal contributions.
6. Integrate Earth-relative particle equations to determine particle position.
7. Predict Earth-relative particle position using engineering judgment.
8. Describe the differences between northern- and southern-hemisphere motion, e.g. rotation of low-pressure systems.
9. Calculate rigid body mass properties and transform them among reference frames.
10. Compose the angular momentum vector and differentiate it in the Newtonian frame.
11. Write rigid body equations of motion using Newtonian and Lagrangian methods.
12. Apply concepts of nutation and precession in describing the motion of aerospace vehicles.
13. Compute and draw the orientations of the space & body cones.
14. Distinguish between direct and retrograde motion; understand and predict the differences in dynamic response from the equations of motion.
15. Understand and predict the motion of a top.
16. Apply the principles of rigid body motion to gyroscopic instruments.

Required Texts/Readings

Textbook

Hunter, J.M., *Rigid Body Dynamics Course Reader* (Maple Press)

Other Readings

Mitiguy, P., Dynamics of Mechanical, Aerospace and Biomechanical Systems
Kane, T.R., Dynamics
Thomson, W. T., Introduction to Space Dynamics, ISBN 978-0486651132
Synge, J. L., & Griffith, B.A., Principles of Mechanics, ISBN 978-0070626584
Cannon, R.H., Dynamics of Physical Systems, ISBN 978-0070097544
Greenwood, D.T., Principles of Dynamics, ISBN 978-0080105710

Other technology requirements / equipment / material

- A computer with internet connectivity and the video conferencing software ZOOM is required. Please follow this link for more information to set it up: https://ischool.sjsu.edu/zoom

- Basic proficiency with Matlab is required. Matlab can be freely accessed from the computers in College of Engineering through VPN (for details on how to setup the Cisco VPN client on your PC use the following link: https://www.sjsu.edu/it/services/network/vpn/index.php). Microsoft Excel is part of the Office 365 package that SJSU provides for free to all students (for more details use the following link: https://www.sjsu.edu/it/services/collaboration/software/instructions.php). Additional ways of accessing the software may be available. For more information contact the IT department.

Course Requirements and Assignments

Homework	5%
Quizzes	20%
Oral Quiz	10%
Daily Problem Team Participation	10%
Daily Problems	10%
Paper Review	5%
Project	25%
Oral Final Exam	15%

"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 practical. Other course structures will have equivalent workload expectations as described in the syllabus."

Final Examination or Evaluation

"Faculty members are required to have a culminating activity for their courses, which can include a final examination, a final research paper or project, a final creative work or performance, a final portfolio of work, or other appropriate assignment."

Grading Information

Determination of Grades
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.
Homework & project assignments are due at the beginning of the class period.

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 individually 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.

AE140/Rigid Body Dynamics, Spring 2022, Course Schedule

Schedule is subject to change with fair notice

Course Schedule

Week	***Lecture Outline***
1	Vector dynamics review
2	Rigid body translational kinematics
3	General motion with respect to the rotating Earth
4	Euler angles
5	Rigid body rotational kinematics
6	Angular momentum of a rigid body
7	Moments / products of inertia, principal axes
8	Euler's moment equation
9	Solution of general gyro equations
10	General rigid body gyroscopic motion
11	Gyroscopic instruments
12	Six degree-of-freedom rigid body equations of motion
13	Satellite despinning
14	Lagrange's equations
15	Final Exam Review
Final Exam	Zoom 15 minute appointments