San Jose State University
Aerospace Engineering Department
AE140: Rigid Body Dynamics
Spring 2020

Instructor	J. M. Hunter
Office Location	Engineering 272F
Email	jeanine.hunter@sjsu.edu
Office Hours	Monday & Wednesday 10:30am – 1:00pm, Monday 3 – 4pm
Class Days / Time	Monday & Wednesday 1:30 – 2:45pm
Classroom	Engineering 331
Prerequisites	C or better in AE 138
Course Website	<https://sjsu.instructure.com>
Final Examination	Monday May 18, 2020 12:15 – 2:30pm

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 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 Objectives

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.

Text Hunter: *Rigid Body Dynamics Course Reader* (Maple Press)

References
Mitiguy*: Dynamics of Mechanical, Aerospace and Biomechanical Systems*
Thomson: *Introduction to Space Dynamics*
Synge & Griffith: *Principles of Mechanics*
Cannon: *Dynamics of Physical Systems*
Greenwood: *Principles of Dynamics*
Kane: *Dynamics*

Determination of Grades

Homework	10%
Project	20%
Paper Review	5%
Midterms	40%
Final Exam	25%

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.
All exams must be taken to receive a passing grade.

Late Homework Policy: Homework is due at the beginning of class, either on Canvas or as a paper submission (as specified). Late homework will be accepted for 70% credit on Canvas until 11:59pm on the due date.

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.

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 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) for instruction or preparation/studying or course related activities including labs and clinical practice. Other course structures will have equivalent workload expectations as described in the syllabus.

Spring 2020 Semester Schedule

Lecture	Lecture Outline
1	Class Overview
2	Vector dynamics review
3&4	Rigid body translational kinematics
5&6	General motion with respect to the rotating Earth
7	Euler angles
8&9	Rigid body rotational kinematics
10&11	Angular momentum of a rigid body
12&13	Moments / products of inertia, principal axes
14&15	Euler's moment equation
16&17	Solution of general gyro equations
18	General rigid body gyroscopic motion
19&20	Gyroscopic instruments
21	Stable platform for inertial guidance
22&23	Six degree-of-freedom rigid body equations of motion
24	Satellite despinning
25	Spacecraft attitude drift
26&27	Lagrange's equations
28	Final exam review