AE 140 – Rigid Body Dynamics

Instructor Info	Prof. J. M. Hunter jeanine.hunter@sjsu.edu
Office Hours:	Wednesday 10:30 - 11:45am and 3:00 - 3:45pm Sometimes: Monday 10:30 - 11:45am and 3:00 - 4:45pm
Class Code:	23529
Credit	3 units
Class Days / Time	MW 1:30 – 2:45 pm (Monday class is sometimes online, on WebEx)
Final Exam	Wednesday May 18, 12:15 to 2:30pm
Classroom	Engr. 164
Prerequisites	"C-" or better in AE138
Textbook	Hunter: Rigid Body Dynamics Course Reader (Maple Press) Thomson Introduction to Space Dynamics
References:	Mitiguy: Dynamics of Mechanical, Aerospace and Biomechanical Systems Synge & Griffith: Principles of Mechanics Cannon, Robert: Dynamics of Physical Systems Greenwood: Principles of Dynamics Kane: Dynamics
Course Website	https://sjsu.instructure.com under the courses tab, select this course.

AE 140 – Rigid Body Dynamics

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 bod motions. Gyroscopic instruments. Stable platform for inertial guidance. Applications to aerospace vehicles.

Exams: Two Midterms (one hour) and one Final Exam (two hours and 15 minutes)

Spring 2016 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

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.

Student 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.

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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 inertially.
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.

Grading: for Course:

Homework 15%
Project 20%
Paper Review 5%
Two Hour Exams 40%
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.

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