AE 138 – Vector-Based Dynamics for Aerospace Applications

Instructor Info	Prof. J.M. Hunter
Credit	3 units
Online Class:	Some Mondays
Class Days / Time	MW 4:30 – 5:45pm
Office Hours	Wednesday and sometimes Monday E272 9:30 – 10:15 am 2:00 – 3:30pm, or by appointment
Classroom	Engr. 164
Prerequisites	"C-" or better in MATH32
Course Website	https://sjsu.instructure.com Under the courses tab, select this course.
Exams	Two Midterms (one hour) and one Final Exam (two hours and 15 minutes)
Final Exam	Thursday, December 10, 2:45 – 5pm

Description

Vector mechanics of three degree-of-freedom particle motion. Particle kinematics, reference frames and rotational relative motion. Two degree-of-freedom rigid body

motion, moments/products of inertia. Particle & rigid body equations of motion and numerical time histories.

Text: Mitiguy: Dynamics of Mechanical, Aerospace and Biomechanical Systems, MotionGenesis, Inc.

References: Hibbeler: Engineering Mechanics and Dynamics
Greenwood: Principles of Dynamics
Kane: Dynamics
Thomson: Introduction to Space Dynamics
Anderson: Introduction to Flight

Course Goals

1. To provide a fundamental knowledge of vector dynamics.
2. To establish the basics of reference frame mechanics and relative motion.
3. To provide the fundamentals of particle kinematics of using Newtonian methods.
4. To write three-dimensional equations of motion using vector mechanics.
5. To understand the influence of moments/products of inertia on rigid body rotational motion.
6. To develop physical intuition about dynamic systems by examining the connection between the differential equations (equations of motion) and their time history solution.

Student Learning Objectives:

1. Combine and solve for vectors using the operations of vector algebra.
2. Find area using vector algebra.
3. Set up basis vectors and use them to express and solve for particle position.
4. Set up a direction cosine matrix relating the planar orientation of two reference frames.
5. Express and resolve vectors into reference frames related by direction cosine matrices.
6. Differentiate scalars; differentiate vectors in arbitrary reference frames.
7. Express angular velocity/acceleration and relate these concepts to the direction cosine matrix.
8. Solve kinematic (position/velocity/acceleration) problems when multiple reference frames are involved.
9. Express particle and rigid body constraints for rolling and sliding (slipping) situations.
10. Calculate mass center of a system of particles and of a rigid body.
11. Calculate rigid body mass moments/products of inertia (mass properties). Intuitively understand the relationship between mass properties and rigid body motion.
12. Write the linear/angular momentum vectors of a dynamic system.
13. Inertially differentiate linear/angular momentum vectors, set them equal to applied forces/moments and thereby write the equations of motion of the system.
14. Write the total kinetic energy and use it to solve for the motion/reaction forces, etc. of

a dynamic system.
15. Use MotionGenesis to model the equations of motion of a dynamic system.

Lecture	Lecture Outline
1	Class Overview
2	Vector dynamics review
3	Position vectors and vector geometry
4	Vector basis
5&6	Direction cosine matrices
7	Vector differentiation and integration
8&9	Angular velocity & angular acceleration
10&11	Points: Velocity and acceleration
12&13	Constraints
14&15	Particles
16	Mass, center of mass, centroid
17&18	Moments / Products of inertia
19&20	Inertia properties
21	Rigid Bodies, force and momentum
22&23	Force, impulse and resultant
24&25	Moments and torque
26&27	Equations of motion
28	Final exam review

Grading for Course:	Homework	15%
	Project	25%
	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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