AE 2220–Dynamics

HOURS: 3-0-3

CATALOG DESCRIPTION:

Kinematics and kinetics of rigid bodies in plane motion; introduction to kinematics and kinetics of rigid bodies in three-dimensional motion.

PREREQUISITES:

COE 2001 Statics
With concurrency
Math 2552 Differential Equations

COURSE OBJECTIVES:

The purpose of this course is to introduce the students to the kinematics and dynamics of rigid bodies in both plane and 3-D motion. Aerospace engineers subsequently study such things as flight mechanics of aircraft or spacecraft, orbital mechanics, mechanical vibration, structural dynamics and aeroelasticity – all of which demand a fundamental understanding of dynamics.

LEARNING OUTCOMES:

Students will gain a master level understanding of:

1. Solving problems involving the kinematics of point motion
2. Kinematics of rigid bodies in both plane and three-dimensional motion, including a treatment of Euler-type orientation angles
3. Solving problems related to the kinetics of rigid bodies in plane and three-dimensional motion

Students will gain a basic level understanding of:

4. Use of impulse-momentum principles for solving collision problems and work-energy principles

TOPICAL OUTLINE:

Topic

1. Kinematics of material points or particles

a. Reference frames and vector derivatives; position, velocity, and acceleration
b. Kinematics of a point in rectilinear motion
c. Rectangular Cartesian coordinates
d. Cylindrical coordinates
e. Tangential and normal components

2. Review of kinetics of particles and mass centers of bodies

3. Kinematics of a rigid body in plane motion

a. Velocity/angular velocity for two points of the same rigid body
b. Translation
c. Instantaneous center of zero velocity
d. Acceleration/angular acceleration for two points of the same rigid body
e. Rolling

4. Kinetics of a rigid body in plane motion

a. Rigid bodies in translation

Topic

b. Moment of momentum (angular momentum)

c. Moments and products of inertia; the parallel-axis theorems

d. The mass-center form of the momentequation of motion

e. The pivot form of the moment equation

5. Special integrals of the equations of plane motion of rigid bodies: work-energy and impulse-momentum methods

a. The principles of work and kinetic energy

b. The principles of impulse and momentum

6. Kinematics of a rigid body in three-dimensional motion

7. Relation between derivatives; the angular velocity vector

a. Properties of angular velocity

b. The angular acceleration vector

c. Velocity and acceleration in moving frames of reference

d. The earth as a moving frame

e. Velocity and acceleration equations for two points of the same rigid body

f. Describing the orientation of a rigid body

g. Rotation matrices

8. Kinetics of a rigid body in general motion

a. Moment of momentum (angular momentum) in three dimensions

b. Transformations of inertia properties

c. Principal axes and principal moments of inertia

d. The moment equation governing rotational motion

e. Gyroscopes

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