ME 430
Dynamics
(4 credit hours)

Objectives

1. Obtain a thorough understanding of the fundamental concepts of vector mechanics of particles and rigid bodies in motion. (kinematics: relationships between position, velocity and acceleration – both translational and angular; kinetics: Newton's laws of translational and rotational motion, work/energy methods, impulse/momentum relations, and vibrations)
2. Learn how to determine: relationships between velocity and acceleration of moving bodies, relationships between forces acting on a body and it's position, and velocity and acceleration
3. Develop a systematic approach to solving problems, including careful sketching, precise mathematical notation, clear presentation of solution, and computer generated plotting of results

Prerequisites

Any of the following courses or equivalent:
ME H210, Honors Statics
ME 400, Introduction to Solid Mechanics
ME 410, Statics

Before taking this class, the students should specifically know:

1. Algebra and Trigonometry
2. Vectors (graphical representation, components, dot product, cross product)
3. Calculus of a single variable
4. Physics (mechanics of a particle, Newton's laws, energy)
5. Statics (free body analysis, forces, couples, moments, centers of mass, mass moments of inertia)

Topics

1. Kinematics of Particles
2. Kinetics of Particles
3. Kinematics of Rigid Bodies
4. Kinetics of Rigid Bodies
5. Vibration
6. Computer Mini-Projects

Basis of Grading

1. Midterm
2. Final
3. Homework
4. Quizzes
5. Computer Projects

Kinematics of Particles

1. Rectilinear motion
2. Curvilinear motion - cartesian, polar and normal-tangential coordinates
3. Projectile motion
4. Relative motion
5. Constrained motion of connected particles

Kinetics of Particle Rectilinear and Curvilinear Motion

1. Determine acclerations from applied forces using Newton's 2nd law (equation of motion) in all three kinds of coordinates
2. Determine velocity from applied forces using work/energy methods
3. Determine velocity from applied forces using linear and angular impulse-momentum relations
4. Central and oblique impact
5. Analysis of particle systems

Kinematics of Rigid Bodies

1. Angular motion, velocity and acceleration
2. Absolute motion analysis of connected mechanisms and rolling objects
3. Relative velocity of points on a rotating rigid body
4. Instantaneous Center of Velocity of a rigid body
5. Relative acceleration of points on a rotating rigid body
6. Rotating reference frames and the Coriolis acceleration

Kinetics of Rigid Bodies Rectilinear and Curvilinear Motion

1. Determine translational/angular accelerations from applied forces using Newton's 2nd law (equation of motion) in all three kinds of coordinates
2. Determine translational/angular velocities from applied forces/couples using work/energy methods
3. Determine translational/angular velocity from applied forces using linear and angular impulse-momentum relations

Geometric and Inertial Properties of Solid Bodies

1. Free vibration of a mass-spring system (elastic restoring forces, natural frequency, and mode shape)
2. Forced vibration of a particle (resonance)
3. Vibration of rigid bodies (spring systems and gravitational restoring forces - the pendulum)

Computer Mini-Projects

Several parameter study and graphing exercises on the computer will be assigned