ENGR A230: DYNAMICS

Item	Value
Curriculum Committee Approval Date	10/30/2024
Top Code	090100 - Engineering, General (requires Calculus) (Transfer)
Units	3 Total Units
Hours	54 Total Hours (Lecture Hours 54)
Total Outside of Class Hours	0
Course Credit Status	Credit: Degree Applicable (D)
Material Fee	No
Basic Skills	Not Basic Skills (N)
Repeatable	No
Open Entry/Open Exit	No
Grading Policy	Standard Letter (S), • Pass/No Pass (B)

Course Description

This course is an introduction to kinematics and kinetics of particles and rigid bodies. Vector analysis and calculus are used extensively as the tool to describe the motion of the systems and also to study the kinetics of particles and rigid bodies. Topics involved are the geometry of the motion (kinematics), and the methods of analysis, which include second law of motion, work-energy and momentum-impulse methods as applied to particles, system of particles and the rigid bodies. The mechanical vibration of particles and the rigid bodies are also studied in detail. It includes free and forced vibration, with and without damping. PREREQUISITE: ENGR A280. Transfer Credit: CSU; UC. C-ID: ENGR 230.**C-ID:** ENGR 230.

Course Level Student Learning Outcome(s)

1. Upon completion of the course the student will be able to derive and apply the laws of kinematics to analyze the motion of a partical, system of particles, and a rigid body in translation, rotation and general motion in 2-D and 3-D, and analyze the system in plane motion relative to a rotating frame of reference.
2. Upon completion of the course the student will be able to Newton's second law to analyze a particle in rectilinear or curvilinear motion and a rigid body in plane motion under the influence of forces and moments.
3. Upon completion of the course the student will be able to solve problems involving systems modeled as a particle, system of particles or rigid body using the work-energy method and impulse-momentum method.

Course Objectives

- 1. Applying the concepts of kinetics and kinematics solve problems of engineering nature and show the understanding of the concepts by effectively communicating the solution in detail according to the standards of problem presentation for engineering problem solutions to be understood by engineers both in and out of the disciplines.
- 2. Draw Free Body Diagrams for systems modeled as particles or rigid bodies to apply the concepts of dynamics for analysis.
- 3. Describe possible types of motions for particles, and derive and apply the geometry of motion (displacement, velocity, and acceleration) for a particle using rectangular and polar and normal-tangential coordinate systems.
- 4. Describe possible types of motions for a rigid body and derive and apply the geometry of motion (displacement, velocity, acceleration) for a rigid body in translation, rotation about center of mass and in general motion in plane and in three dimensions.
- 5. Derive the equation for the system in plane motion relative to a rotating frame of reference and determine the Coriolis acceleration.
- 6. Calculate the work of a force using different coordinate systems and apply the method of work-energy and conservation of energy to systems modeled as particle, system of particles or rigid body in plane motion.
- 7. Apply the method of impulse-momentum and the conservation of momentum to systems modeled as particle, system of particles or rigid body in plane motion, also apply the concept of impulse and momentum to systems involved in direct, oblique and eccentric collision
- 8. Solve dynamics problems by selecting the best suited method or combination of methods and concepts for analysis.
- 9. Apply second law of motion to analyze systems with and without damping executing the vibration motion.

Lecture Content

Kinematics of Particles Rectilinear motion Uniform rectilinear motion Accelerated rectilinear motion Dependent rectilinear motion of several particles Curvilinear motion in 2-D and 3-D Curvilinear motion using rectangular coordinate system Relative independent and dependent motion Curvilinear motion using tangential-normal component system Curvilinear motion using cylindrical coordinate system Kinetics of Particles Newton s Second law of Motion p; Equation of motion Rate of change of linear momentum Rate of change of angular momentum Equation of motion in rectangular coordinate system Equation of motion in normal-tangential coordinate system Equation of motion in cylindrical coordinate system Central-force motion and space mechanics Newton s law of gravitation Work-Energy Method Work of force using rectangular, n-t and cylindrical axes systems. Kinetic energy and potential energy Principle of work and en ergy Efficiency and power Conservative forces and potential energy Conservation of energy. Impulse and Momentum Principle of linear impulse and momentum Impulsive motion of particles Impact Elastic and inelastic impact Central and oblique impact Impact process (deformation restitution) coefficient of restitution Principle of Angular impulse and momentum Conservation of angular momentum Dynamics of a system of particles System of particle and influencing factors Newton s second law of motion of a system of particles Linear and angular momentum of a system of particles Kinetic energy of a system of particles Work-energy principle for a system of particles Impulse-momentum principle for a system of particles Conservation of energy and conservation of momentum of a system of particles Motion of a system with variable mass Kinematics of Rigid Bodies in a plane and 3-D Types of motion of rigid bodies Rotational motion of rigid bodies in a plane Rotational motion of rigid body about fixed axis General motion of rigid bodies in a plane Absolute and relative velocity in a plane motion Absolute and relative acceleration in a plane motion Instantaneous center of rotation in plane Plane motion with respect to a rotation frame of reference Coriolis acceleration Motion of a rigid body in 3-D Motion about a fixed point General motion in 3-D ; 3-D motion relative to rotating frame of reference Coriolis acceleration Kinetics of Rigid Bodies in a Plane Newton s second law of motion Mass moment of inertias Equation of motion in a plane D Alembert s principle Equation of

motion for translation and rotation about fixed axis Equation of motion for general motion Work-energy method Work of forces acting rigid body Kinetic energy of a rigid body ; Work-energy principle for rigid body Conservation of energy Power Momentum-impulse method Linear and angular momentum of a rigid body Principle of Impulse-momentum Conservation of momentum Eccentric impact Coefficient of restitution for rigid body Mechanical Vibration Free vibration of a particle using 2nd law of motion and energy method Damped free vibration of a particle Forced undamped vibration of a particle Forced damped vibration of a particle

Method(s) of Instruction

- Lecture (02)
- DE Live Online Lecture (02S)
- DE Online Lecture (02X)

Instructional Techniques

The primary mode of instruction is the lecture/demonstration method

Reading Assignments

Student will be assigned at least two hours per week worth of material form the textbook and articles

Writing Assignments

Student will be assigned approximately at least two hours per week worth of writing assignments, including explanation and discussion of results and findings in light of the theory and the application related to problem solving, open-ended problems, and material research/design projects.

Out-of-class Assignments

Student will be assigned at least three hours per week worth of problem solving and open-ended problems and material research/design projects.

Demonstration of Critical Thinking

Solve open-ended problems involving multiple engnieering concepts, complete design project/problems using kinmatic and kinetic concepts.

Required Writing, Problem Solving, Skills Demonstration

Problem solving exercises, and open-ended problems assigned as homework assignments, and question on tests, examination and quizzes requiring documentation and written responses.

Eligible Disciplines

Engineering: Master's degree in any field of engineering OR bachelor's degree in any of the above AND master's degree in mathematics, physics, computer science, chemistry, or geology OR the equivalent. (NOTE: A bachelor's degree in any field of engineering with a professional engineer's license is an alternative qualification for this discipline.) Master's degree required. Title 5, section 53410.1

Textbooks Resources

1. Required Beer and Johnston. Vector Mechanics: Dynamics, 11th ed. McGrw Hill, 2014 2. Required R.C. Hibbiler. Engineering Mechnics: Dynamics, 12th ed. Printice Hall, 2014