Lecture Contact Hours: 48-54; Homework Hours: 96-108; Total Student Learning Hours: 144-162

CUYAMACA COLLEGE
COURSE OUTLINE OF RECORD

ENGINEERING 220 – ENGINEERING MECHANICS–DYNAMICS

3 hours lecture, 3 units

Catalog Description
Motion of particles, particle systems and rigid bodies, and the effects thereon of applied forces and moments. Newtonian laws of motion, work and energy; linear and angular momentum. Application to engineering problems.

Prerequisite
"C" grade or higher or "Pass" in ENGR 200 or equivalent

Entrance Skills
Without the following skills, competencies and/or knowledge, students entering this course will be highly unlikely to succeed:
1) Apply principles of vector algebra to determine the resultant of several concurrent forces acting on a particle in both 2D and 3D space.
2) Apply the principle of particle equilibrium vector algebra to determine unknown forces acting on a static particle.
3) Apply cross- and dot-products of vectors to determine the moment of a force about a point in space and an axis in space.
4) Simplify a system of forces and couples applied to a rigid body into a single resultant force and couple.
5) Apply the principle of rigid body equilibrium and #4 above to determine unknown forces and moments acting on a static rigid body. Determine reactions at supports for 2D and 3D rigid bodies, recognizing if these reactions are statically determinant or indeterminant.
6) Determine centroids and centers of gravity of mathematically definable areas and bodies as well as composite areas and bodies made of standard geometric shapes.
7) Determine the area- and mass-moments of inertia and the radii of gyration of mathematically definable areas and bodies, as well as composites areas and bodies made of standard geometric shapes.
8) In general, model real-life mechanically static situations both graphically and mathematically, applying simplifying assumptions as needed while estimating the effects those assumptions have on the solution. Also identify those situations that cannot be modeled using particles or rigid bodies.

Course Content
1) Kinematics of Particles
   a. Rectilinear Motion: Uniform motion and uniformly accelerated motion
   b. Curvilinear Motion: Rectangular, tangential and normal, radial and transverse components
2) Kinematics of Particles: Newton's Second Law
   a. Linear and angular momentum of a particle
   b. Equations of motion in terms of rectangular components and with radial and transverse components
   c. Conservation of momentum
   d. Newton's Law of Gravitation and trajectory of a particle under a central force
3) Kinetics of Particles: Energy and Momentum Methods

   a. Work of a force and principle of work and energy using both potential energy and conservation of energy
   b. Motion under a conservative central force; space mechanics
   c. Principle of impulse and momentum applied to impulsive motion
   d. Concept of both direct and oblique central impact
4) Systems of Particles
   a. Linear and Angular momentum
   b. Motion of the mass center
   c. Angular momentum about the mass center
   d. Conservation of momentum and energy, kinetic energy principles, conservation of energy and impulse and momentum for systems of particles
5) Kinematics of Rigid Bodies
   a. Equations defining translation and rotation about a fixed axis
   b. General plane motion
   c. Absolute and relative velocity and acceleration and instantaneous center of rotation in plane motion
6) Plane Motion of Rigid Bodies: Forces and Accelerations
   a. Equations of motion, angular momentum, D'Alembert's Principle
   b. Solution of problems involving the motion of a rigid body
   c. Systems of rigid bodies and constrained plane motion
7) Plane Motion of Rigid Bodies: Energy and Momentum Methods
   a. Principle of work and energy and work of forces acting on a rigid body
   b. Conservation of energy applied to systems of rigid bodies
   c. Principle of impulse and momentum and conservation of angular momentum for rigid bodies
   d. Impulsive motion and eccentric impact

Course Objectives

Students will be able to:

1) Describe and compute the position, velocity, and acceleration (the kinematics) of particles in both rectilinear and curvilinear motion.
2) Apply Newton's Second Law to determine the relationship between applied forces and resulting motion (the kinetics) of a particle.
3) Compute the work of a force and apply the principle of work and energy and the concepts of potential energy and conservation of energy to determining resulting motion of a particle.
4) Apply the principle of impulse and momentum to impulsive motion and both direct and oblique impact to predict the motion of particles.
5) Predict the motion of systems of particles using linear and angular momentum, motion of mass center, conservation of momentum and energy and impulse and momentum principles.
6) Apply kinematic principles to predict and describe free and constrained motion of rigid bodies and interconnected systems of rigid bodies.
7) Apply Second Law kinetic principles to rigid bodies to determine plane motion of a rigid body, and interconnected systems of rigid bodies.
8) Apply the principle of work and energy to determine the plane motion of a rigid body.
9) Apply the concepts of linear and angular momentum, linear and angular impulse, and direct and eccentric impact to predict the motion of rigid bodies and systems of rigid bodies.

Method of Evaluation

A grading system will be established by the instructor and implemented uniformly. Grades will be based on demonstrated proficiency in subject matter determined by multiple measurements for evaluation, one of which must be essay exams, skills demonstration or, where appropriate, the symbol system.

1) Classroom assessment tools, such as reading quizzes, concept quizzes, attention quizzes, muddiest point questions, and one-minute papers, that measure students' ability to apply concepts just discussed in class. An example would be a multiple choice question answered using an audience

response system in which students rapidly compute the time needed for a particle to move a given distance in a gravity field.
2) Homework assignments that measure students' ability to extend the classroom and reading experience to novel situations. Questions are almost exclusively word problems. An example would be a problem in which students determine whether a beer bottle on a grocery store checkout conveyer belt will tip or not when the belt accelerates.
3) Periodic quizzes and exams that evaluate student learning and retention of the material on the time scale of weeks. Questions are mostly word problems, but with some short answer conceptual questions. An example would be a problem in which students determine the angular velocities and accelerations of all parts of a piston/crankshaft/flywheel system.
4) Final examination that evaluates students' ability to integrate the course material as a whole and to assess overall retention of the material. Questions are mostly word problems, but with some short answer conceptual questions. An example would be a problem in which students determine the final motion of two cars after a collision that sends both of them spinning and sliding.

Special Materials Required of Student
Scientific graphical calculator

Minimum Instructional Facilities
Smart classroom with document camera

Method of Instruction
1) Lecture and discussion
2) Homework
3) Group problem solving

Out-of-Class Assignments
1) Weekly homework including reading and writing assignments
2) Group projects

Texts and References
1) Required (representative example): Hibbeler, R.C. *Engineering Mechanics: Dynamics*. 15th edition. Prentice-Hall, 2021.
2) Supplemental: Meriam, J.,Kraige, L., Bolton, J. Engineering Mechanics: Statics. 9th edition. Wiley, 2019.

Exit Skills
Students having successfully completed this course exit with the following skills, competencies and/or knowledge:
1) Describe and compute the position, velocity, and acceleration (the kinematics) of particles in both rectilinear and curvilinear motion.
2) Apply Newton's Second Law to determine the relationship between applied forces and resulting motion (the kinetics) of a particles.
3) Compute the work of a force and apply the principle of work and energy and the concepts of potential energy and conservation of energy to determining resulting motion of a particle.
4) Apply the principle of impulse and momentum to impulsive motion and both direct and oblique impact to predict the motion of particles.
5) Predict the motion of systems of particles using linear and angular momentum, motion of mass center, conservation of momentum and energy and impulse and momentum principles.
6) Apply kinematic principles to predict and describe free and constrained motion of rigid bodies and interconnected systems of rigid bodies.
7) Apply Second Law kinetic principles to rigid bodies to determine plane motion of a rigid body, and interconnected systems of rigid bodies.
8) Apply the principle of work and energy to determine the plane motion of a rigid body.

9) Apply the concepts of linear and angular momentum, linear and angular impulse, and direct and eccentric impact to predict the motion of rigid bodies and systems of rigid bodies.

Student Learning Outcomes

Upon successful completion of this course, students will be able to:

1) Evaluate the position, velocity, and acceleration (kinematics) of a particle.
2) Evaluate the position, velocity, and acceleration (kinematics) of a rigid body.
3) Evaluate the motion of a particle using theorems derived from Newton's Second Law.
4) Evaluate the motion of a rigid body using theorems derived from Newton's Second Law.