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

CUYAMACA COLLEGE
COURSE OUTLINE OF RECORD

ENGINEERING 225 – MECHANICS FOR CIVIL ENGINEERS

3 hours lecture, 3 units

Catalog Description
Engineering applications of the principles of static equilibrium of force systems acting on particles and rigid bodies; structural analysis of trusses, frames, and machines; forces in beams; centroids and moments of inertia; kinematics and Newtonian laws of motion for particles.

Prerequisite
"C" grade or higher or "Pass" in PHYC 201 or equivalent

Corequisite
MATH 280 or previous enrollment

Recommended Preparation
Review of materials covered in the prerequisite for the course.

Entrance Skills
Without the following skills, competencies and/or knowledge, students entering this course will be highly unlikely to succeed:
1) Use trigonometry to resolve forces and moments into their components.
2) Use the relationship between force, mass, and acceleration to solve static/dynamic problems.
3) Use vectors to represent forces and moments in 2D and 3D analytical problems.

Course Content
1) Concepts of particles and rigid bodies
2) Vector arithmetic and operations (e.g., dot- and cross-products). Forces as vectors. Resultants of concurrent forces.
3) Particle equilibrium in 2D and 3D space. Free-body diagrams. Use of equilibrium to determine unknown forces applied to a particle.
4) Moment of a force about a point and about an axis, moment of a couple. Resultants of force and couple systems. Reduction of force-couple systems to a single force. Distributed loads.
5) Rigid body equilibrium in 2D and 3D space. Free-body diagrams of rigid bodies. Use of equilibrium to determine unknown forces and moments applied to a rigid body. Use of constraints to limit degrees of freedom.
6) Analysis of structures: trusses using method of joints and method of sections, frames and machines involving multiforce members
7) Internal and external forces in beams, shear and bending moment diagrams
8) Centroids and centers of gravity for lines, areas, and volumes.
9) Moments of inertia of areas, polar moment of inertia, radius of gyration, parallel-axis theorem. Mass moment of inertia of objects.
10) Particle Rectilinear Kinematics using continuous motion.
11) Particle Rectilinear Kinetics using Newton's Second Law of Motion and Free Body Diagrams.

Course Objectives
Students will be able to:
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 and #1 above 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) Perform basic structural analysis of trusses using the methods of joints and sections. Perform basic structural analysis of frames and machines.
7) Calculate the internal forces within beams subjected to various types of loading and supports and draw shear and bending moment diagrams.
8) Determine centroids and centers of gravity of mathematically definable areas and bodies as well as composite areas and bodies made of standard geometric shapes.
9) Determine the area- and mass-moments of inertia and the radii of gyration of mathematically definable areas and bodies, as well as composite areas and bodies made of standard geometric shapes.
10) 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. Identify those situations that cannot be modeled using particles or rigid bodies.
11) Describe and compute the position, velocity, and acceleration (the kinematics) of particles in rectilinear motion.
12) Apply Newton's Second Law to determine the relationship between applied forces and resulting motion (the kinetics) of a particle.

Method of Evaluation

A grading system will be established by the instructor and implemented uniformly. Grades will be based on demonstrated proficiency in the 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, possibly including reading quizzes, concept quizzes, attention quizzes, muddiest point questions, lecture activities working through example problems with students, and one-minute papers that measure students' ability to apply concepts discussed in class. An example would be a multiple choice question answered using an audience response system in which students rapidly compute forces in a few members of a truss using the method of sections.
2) Homework that requires students to interact with the course material and to evaluate their 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 refrigerator being pushed by a man will tip or slide.
3) Periodic quizzes, midterm examinations, and/or projects to 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 whether a refrigerator being pushed by a man will tip or slide. An example project is designing a structure and determining mathematically why the structure does not tip.
4) Final examination or project to evaluate 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 whether a refrigerator being pushed by a man will tip or slide. An example project is designing a structure to hold an established load.

Special Materials Required of Student

Scientific graphical calculator, engineering graph paper/pencil

Minimum Instructional Facilities
Smart classroom with overhead projector/screen

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: Statics. 14th edition. Pearson, 2016.
2) Supplemental: None

Exit Skills
Students having successfully completed this course exit with the following skills, competencies and/or knowledge:
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 and #1 above 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) Perform basic structural analysis of trusses using the methods of joints and sections. Perform basic structural analysis of frames and machines.
7) Calculate the internal forces within beams subjected to various types of loading and supports and draw shear and bending moment diagrams.
8) Determine centroids and centers of gravity of mathematically definable areas and bodies as well as composite areas and bodies made of standard geometric shapes.
9) Determine the area- and mass-moments of inertia and the radii of gyration of mathematically definable areas and bodies, as well as composite areas and bodies made of standard geometric shapes.
10) 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. Identify those situations that cannot be modeled using particles or rigid bodies.
11) Describe and compute the position, velocity, and acceleration (the kinematics) of particles in rectilinear motion.
12) Apply Newton's Second Law to determine the relationship between applied forces and resulting motion (the kinetics) of a particle.

Student Learning Outcomes
Upon successful completion of this course, students will be able to:
1) Use structural analysis to evaluate the internal forces acting on members of trusses, frames, and machines.
2) Analyze composite bodies/areas to determine their centroids and moments of inertia.
3) Apply the kinematics and kinetics of particle motion to explain how and why particles move.