

**University Of California, Berkeley**  
**Department of Mechanical Engineering**

**ME 170: Engineering Mechanics III (3 units)**

**Elective Course**

*Syllabus*

**CATALOG DESCRIPTION**

This course builds upon material learned in 104, examining the dynamics of particles and rigid bodies moving in three dimensions. Topics include non-fixed axis rotations of rigid bodies, Euler angles and parameters, kinematics of rigid bodies, and the Newton-Euler equations of motion for rigid bodies. The course material will be illustrated with real-world examples such as gyroscopes, spinning tops, vehicles, and satellites. Applications of the material range from vehicle navigation to celestial mechanics, numerical simulations, and animations.

**COURSE PREREQUISITES**

ME 104 or consent of instructor.

**TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL**

Recommended texts: Such texts include, Advanced Engineering Dynamics, by J. H. Ginsberg. Cambridge University Press, 1995. Principles of Dynamics, by D. T. Greenwood. Prentice-Hall, Englewood Cliffs, 1988. Advanced Dynamics, by D. T. Greenwood. Cambridge University Press, 2003.

Class notes are provided by the instructor. These notes are also supplemented with recent archival journal articles and excerpts from the classical literature.

**COURSE OBJECTIVES**

Introduce basic aspects of parameterizing the general motion of a rigid body. These aspects include parameterizations of rotations. Discuss the development and analysis of models using mass particles and rigid bodies drawing from applications in navigation, vehicle dynamics, toys, gyroscopes, celestial mechanics, satellite dynamics and computer animation.

With the help of numerical and analytical methods, to introduce students to the analysis of discrete models for mechanical systems.

**DESIRED COURSE OUTCOMES**

Upon completion of the course, students shall be able to: Understand the kinematical descriptions of rigid body orientations; be able to establish transformations for kinematical quantities expressed in different frames of reference; using the Newton-Euler equations of

## **DESIRED COURSE OUTCOMES (Cont.)**

motion, be able to derive the equations of motion for various systems of particles and rigid bodies; visualize three-dimensional motions of rigid bodies; write special-purpose programs within a procedural programming computer environment, such as MATLAB, to simulate the dynamics of systems of particles and rigid bodies; assess the accuracy and realism of a model for some discrete mechanical systems.

## **TOPICS COVERED**

Dynamics of a single particle in a three-dimensional space; parameterization of rotations, including Euler angles; the Gibbs representation of a rotation and its axis and angle of rotation; angular velocity vectors for compound rotations; kinematics of systems of particles and rigid bodies; kinematics of rolling rigid bodies and sliding rigid bodies; constraint forces and moments in rigid body dynamics; conservative forces and moments in rigid body dynamics; dynamics of a rigid body; application to mechanical systems: for example, gyroscopes, natural and artificial satellites, accelerometers, rolling and sliding rigid bodies, and vehicle dynamics.

## **CLASS/LABORATORY SCHEDULE**

Three hours of lecture per week.

## **CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT**

This course contributes primarily to the students' knowledge of engineering topics and does not provide hands-on design experience. However, aspects of design are discussed in connection with the analysis of the dynamics of various devices.

## **RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES**

- (a) an ability to apply knowledge of mathematics, science, and engineering
- (e) an ability to identify, formulate, and solve engineering problems
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

This course provides valuable training in the modeling and analysis of mechanical engineering systems using systems of particles and/or rigid bodies. It also serves to reinforce and emphasize the connection between fundamental engineering science and practical problem solving.

## **ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES**

Homework assignments on a regular basis. Midterm examinations. Final examination. Semester project.

**PERSON(S) WHO PREPARED THIS DESCRIPTION:** [Oliver O'Reilly](#) Feb 26, 2006