University Of California, Berkeley
Department of Mechanical Engineering

ME 175: Intermediate Dynamics (3 units)

Elective Course

Syllabus

CATALOG DESCRIPTION

This course introduces and investigates Lagrange's equations of motion for particles and rigid bodies. The subject matter is particularly relevant to applications comprised of interconnected and constrained discrete mechanical components. The material is illustrated with numerous examples. These range from one-dimensional motion of a single particle to three-dimensional motions of rigid bodies and systems of rigid bodies.

COURSE PREREQUISITES

ME 104 or equivalent.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Recommended texts: Such texts include, but aren't limited to, Analytical Dynamics, by H. Baruh, McGraw-Hill, 1999. Advanced Dynamics, by D. T. Greenwood. Cambridge University Press, 2003. Tensor Calculus by J.L. Synge and A. Schild, University of Toronto Press, 1949 (Reprinted by Dover Publications, New York, 1978).

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 students to the notion of exploiting differential geometry to gain insight into the dynamics of a mechanical system. Familiarize the student with classifications and applications of generalized forces and kinematical constraints. Enable the student to establish Lagrange's equations of motion for a single particle, a system of particles and a single rigid body. Establish equivalence of equations of motion using the Lagrange and Newton-Euler approaches. Discuss the developments of analytical mechanics drawing from applications in navigation, vehicle dynamics, toys, gyroscopes, celestial mechanics, satellite dynamics and computer animation.

DESIRED COURSE OUTCOMES

Upon completion of the course, students shall be able to: Establish and use covariant and contravariant basis vectors for an arbitrary curvilinear coordinate system; establish various forms of Lagrange's equations of motion for a discrete mechanical systems; simulate the dynamics of a mechanical system whose equations of motion are described using Lagrange's equations of motion; understand the relationships and equivalence between Lagrange's equations of motion

DESIRED COURSE OUTCOMES (Cont.)

and the Newton-Euler equations of motion; 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 a discrete mechanical system.

TOPICS COVERED

Curvilinear coordinate systems for a n-dimensional Euclidean space: covariant and contravariant basis vectors and their uses. Integrable and non-integrable constraints in the dynamics of particles and rigid bodies. Parameterizing the rotation of a rigid body using Euler angles. Elements of the kinematics of particles and rigid bodies. Constraint and conservative forces and moments in mechanics. Lagrange's equations of motion for a particle, system of particles and rigid bodies. Elements of the analysis of the dynamics of a mechanical system. 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 and one hour of discussion 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

An ability to apply knowledge of mathematics, science, and engineering. An ability to identify, formulate, and solve engineering problems. The broad education necessary to understand the impact of engineering solutions in a global and societal context. A knowledge of contemporary issues. 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