Civil Engineering 240-202: Dynamics

Course Description: 3 cr. U. Kinematics and kinetics of particles and rigid bodies with applications of Newton's second law and the principles of work-energy and impulse momentum. Prereq: Civ Eng 201(P), Math 233(C).

Textbook: Beer and Johnston, *Vector Mechanics for Engineers: Dynamics,* Sixth Edition, 1997.

Prerequisites by Topics:

- Solving simultaneous linear and quadratic equations
- Trigonometry and analytic geometry
- Differentiation and integration in one variable
- Concept of physical dimension
- Vector representation of forces and moments
- Free body diagrams
- Force and moment diagrams
- Moments of inertia of solids

Course Objectives:

Broad Objectives

- Learn a sound methodology to solve engineering problems that is applicable to all future courses and work.
- Appreciate that the governing equations in Dynamics are differential equations.
- Distinguish Statics problems from Dynamics problems and identify inertial effects.

Learning Outcomes

- Understand and postulate modeling assumptions that lead to well-posed equations.
- Establish coordinates, sign conventions, variables, and parameters that quantify physical conditions or states.
- Draw clear and rigorous Free Body Diagrams that accurately describe physical systems, maintaining consistency with assumptions and quantifiers.
- Write equations (in vector form) that govern the behavior physical systems, and check that the equations are well-posed (e.g. #unknowns = #equations; dimensionally and vectorally balanced).
- Determine the solutions using mathematical techniques that are appropriate to their level (e.g. calculus, vector algebra, modest computing).
- Check solutions for dimensional consistency and appropriate order of magnitude.
- Distinguish kinematics principles from kinetics principles.
- Distinguish forces from accelerations.
- Distinguish particles from rigid bodies, and translation from rotation.
- Use balance laws of linear momentum, angular momentum, and energy.
- Determine when certain quantities are or are *not* conserved (e.g. energy, momentum).

Topics Covered:

- Kinematics of Particles
- Kinetics of Particles, including the use of linear and angular momentum
- Principle of Work and Kinetic Energy for Particles
- Principle of Impulse and Momentum for Particles
- Kinematics of Systems of Particles
- Kinetics of Systems of Particles, including the use of linear and angular momentum
- Principle of Work and Kinetic Energy for a System of Particles
- Principle of Impulse and Momentum for a System of Particles
- Kinematics of Rigid Bodies
- Kinetics of Rigid Bodies (Planar)
- Principle of Work and Kinetic Energy for Rigid Bodies (Planar)
- Principle of Impulse and Momentum for Rigid Bodies (Planar)

Class/Laboratory Schedule: Three 50-Minute lectures per week or two 75 minute lectures per week.

Contribution of the Course to Meeting the Professional Component:

Students will master problem-solving skills and methodologies that are essential to all engineering disciplines. Students will learn to recognize dynamic phenomena that occur in the analysis and design of both mechanical systems and non-mechanical systems.

Relationship to Program Objectives:

1b The study of Dynamics is an essential part of a comprehensive foundation in the engineering sciences.

1c Dynamics requires the application of calculus, vector algebra, and other elements of mathematical reasoning.

1d At the heart of Dynamics is precisely the ability to identify, formulate, and solve engineering problems.

2f Training in Dynamics, particularly in developing sound problem-solving methodology, will prepare students for graduate school, to conduct research, and otherwise to discover knowledge throughout life.

Prepared By: Chris Papadopoulos, September 20, 2001

Methods of Assessment:

- Prerequisite Exam
- Course Evaluations by Students
- Graded Examinations
- FE Exam

Resources Commonly Available:

- Instructor
- Teaching Assistant (office hours, potential recitations)
- Free Tutoring
- CAE computing facility
- Demonstrations set up in EMS W165

Desired Student Competencies:

- Numerical solution of equations in one dimension (Newton's Method)
- Differentiation and integration in two or three variables
- Ability to use Internet and common operating systems
- Ability to use the Library
- Ability to present solutions in an orderly format