

## PHYC 530 Mechanics

### Course Description

Basic concepts of mechanics, general motion of particles in three dimensions. Simple and damped harmonic motion. Particle dynamics in noninertial frames of reference, central forces. Dynamics of systems of particles. Motion of rigid bodies in three dimensions. Dynamics of oscillation systems. (3 credit hours)

Prerequisite: approval of the department chairperson.

Not open to students who have credit in PHYC 330.

### Course objectives

A course in classical mechanics at the intermediate level, drawing heavily on the calculus and giving strong emphasis to solutions of problems. The course provides an opportunity for the graduate students whose field of concentration is not physics but need mechanics as an elective or required in their field. In addition, the first year physics graduate students who need preparation for the required advanced mechanics (PHYC 671) will take this course as an elective.

### Course Rationale

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### Course Content, Format, and Bibliography

#### *Content*

#### Kinematics

- Speed, velocity, and acceleration

- Transformation of moving axes

- Treatment of vectors

- Circular motion

#### Force and Motion of Particle

- Newton's Laws of Motion: Force and mass

- Position dependent forces, concepts of kinetic and potential energies

- Conservation of energy

- Velocity-dependent forces, vertical fall through a fluid, terminal velocity

### Harmonic Oscillations

Mass on a spring

Pendulum

Energy considerations in harmonic motion

Damped harmonic motion

### General Motion of Particle in Three Dimensions

Potential energy function in three dimensional motion

Projectile motion

Harmonic oscillator in two and three dimensions

Motion of charged particles in electric and magnetic fields

Constrained motion of a particle

### Noninertial Reference Systems

Accelerated coordinate systems and inertial forces

Rotating coordinate systems

Dynamics of a particle in a rotation coordinate system

Effect of Earth's rotation

Motion of a projectile in a rotating cylinder

The Foucault pendulum

### Gravitation and Central Forces

Gravitational force between a uniform sphere and a particle

Kepler's laws

Potential energy in a gravitational field

### Dynamics of Systems of Particles

Center of mass and linear momentum of a system

Angular momentum and kinetic energy of a system

Collisions

Comparison of laboratory and center of mass coordinates

Rocket motion

### Mechanics of Rigid Bodies

Center of mass of a rigid body

Moment of inertia

Physical pendulum

General theorem concerning angular momentum

Impulse and collisions involving rigid bodies

Dynamics of Oscillating Systems

Potential energy and equilibrium

Stable equilibrium

Coupled harmonic oscillator

General theory of vibrating systems

Lagrange's Equations and Hamiltonian Function

Generalized coordinates

Application of Lagrange's Equations

Hamilton's Variation Principle

Hamilton's Equations

*Format*

Homework assignments, quizzes, and examinations

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

*Bibliography*

Fowles, Analytical Mechanics, 7<sup>th</sup> ed., Thomson, ISBN 0534494927

Introduction to Classical Mechanics by A.P. Arya