

PHYC 671 Classical Mechanics

Course Description

Classical Lagrangian mechanics as applied to particles and rigid body motion. (3 credit hours)
Prerequisite: PHYS 330 or 530 or permission of department chairperson.

Course Objectives

To acquaint the student with the mathematical concepts and techniques necessary for a mature understanding of physical theories and concepts. The application and discussion of these techniques in regard to various problems of classical mechanics. A thorough understanding of advanced classical mechanics with the end result leading to the concepts of relativistic mechanics.

Course Rationale

This mechanics course is an advanced level classical physics course. It is an one-semester, three credit hour course offered for the graduate students. Advanced formulations in this mechanics course serves as the springboard for various branches of modern physics and quantum mechanics. Students find an opportunity to master many mathematical techniques necessary for other advanced level courses. The analytical and problem solving skills are the necessary components for the success in higher studies in physics.

Course Content, Format, Bibliography

Content

Mechanics: Single Particle, Systems of Particles, Lagrangian formulation and simple applications of the Lagrangian formulations.

Variational Principles and Lagrange's Equations: Hamilton's principle, derivation of Lagrange's equations from Hamilton's principle, Extension of Hamilton's principle to nonholonomic systems, Conservation theorems and symmetry properties.

The Central Force Problem: Reduction to the Equivalent one-body problem, The equations of motion, classification of orbits, the Virial theorem, Kipper's Laws, scattering in a central force field.

The Kinematics of Rigid Body Motion: Rigid bodies, rotation of rigid bodies, theory of the top and gyroscope, equations of motion.

Small Oscillations: The eigenvalue equation, frequencies of free vibration and normal modes, free vibrations of a linear triatomic molecule.

Relativistic Mechanics: Relativistic mechanics, Inertial and non-inertial frames of reference, Galilean transformation, Lorentz transformations, relativistic kinematics of collisions and many-particle systems.

The Hamilton Equations of Motion: Legendre transformations and the Hamilton equations of motion.

Hamilton-Jacobi Theory: The Hamilton-Jacobi equation, Hamilton-Jacobi theory, geometrical optics, and wave mechanics.

Lagrangian and Hamiltonian Formulations for Continuous Systems and Fields:

Transition from discrete to a continuous system, Lagrangian formulation for continuous systems,

Hamiltonian formulation, Poisson brackets, relativistic field theory.

Format

These objectives would be attained through lectures and discussions, as well as assigned problems. The course activities would be primarily study and problem solving with extensive reading.

Bibliography

Classical Mechanics, by Herbert Goldstein, second edition, 1992.

Classical Mechanics, by J.B. Marion, Second edition, 1970.