



PHY 401A/SE 314: Classical Mechanics I

COURSE INSTRUCTOR: SUPRATIK BANERJEE, DEPARTMENT OF PHYSICS, IIT KANPUR
(DEPARTMENTAL CORE COURSE AND SCIENCE ELECTIVE FOR TWO YEAR M. SC., M. SC.- PH. D DUAL DEGREE AND
ADVANCED BS STUDENTS)

ACADEMIC YEAR: 2021-2022; FIRST SEMESTER

INTRODUCTION

This course introduces the analytical approach of classical mechanics. The course will cover a number of topics of Lagrangian and Hamiltonian formulation and Hamilton-Jacobi theory to solve problems of classical physics using these modern approaches. Finally a brief introduction to nonlinear dynamics will be given in order to prepare the background of studying the dynamics of classical complex systems.

PREREQUISITE

None. However, basics of vector algebra, vector calculus, partial differential equations and Newtonian mechanics may be useful.

COURSE CONTENT

- Review of Newtonian mechanics; symmetries and frames of references.
- Calculus of variations, generalized coordinates and momenta, Euler-Lagrange equation from Hamilton's principle.
- Properties of Lagrangian formulation, Noether's theorem
- Lagrangian of free particle, inertial frames
- Solution of equations of motion: one dimensional motion, two body problem, simple harmonic oscillator, Kepler's problem
- Small oscillations and normal modes using Lagrangian formulation, anharmonic oscillators, parametric resonance.
- Secular perturbation theory, Lindstedt-Poincare method.
- Lagrangian formulation of rigid body dynamics, derivation of Euler equations, Euler angles.
- Hamiltonian mechanics, Modified Hamilton's principle.
- Canonical transformations, Poisson brackets.
- Hamilton-Jacobi theory, action-angle variables.
- Fixed point and linear stability analysis, limit cycles, Chaotic attractor, Lyapunov exponents.

COURSE LOAD AND GRADING POLICY

- ⊕ Three lectures and 1 tutorial per week.
- ⊕ Final grade: 2 Quizzes (20%) + Mid-Sem. examination (30%) + End-sem. examination (50%).

REFERENCE

- (i) L. D. Landau & E. M. Lifshitz, Mechanics, ButterworthHeinemann (1976).
- (ii) H. Goldstein, Classical Mechanics, AddisonWesley (1980).
- (iii) J. V. Jose & E. J. Saletan, Classical Dynamics, Cambridge University Press (1998).
- (iv) S. H. Strogatz, Nonlinear Dynamics and Chaos, Westview Press (2001).