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: 2020-2021; 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-Largange equation from Hamilton's principle.**
- **Properties of Lagrangian formulation, Noether's theorem**
- **Small oscillations and normal modes using Lagrangian formulation, anharmonic oscillators, parametric resonance.**
- **Secular perturbation theory, Lindtstedt-Poincare method.**
- **Lagrangian formulation of rigid body dynamics, derivation of Euler equations, Euler angles.**
- **Halmiltonian mechanics, integral invariants, symplectic area conservation, 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

- ✙ **One discussion hour (Tuesday 12h-13h) and one tutorial (Wednesday 8h-9h) per week..**
- ✙ **Final grade: 2 Quizzes (20%) + Mid-Sem. examination (30%) + End-sem. examination (50%).**

REFERENCE

(i) J. V. Jose & E. J. Saletan, Classical Dynamics, Cambridge University Press (1998).
(ii) H. Goldstein, Classical Mechanics, AddisonWesley (1 980).
(iii) L. D. Landau & E. M. Lifshitz, Mechanics, ButterworthHeinemann (1976).
(iv) S. H. Strogatz, Nonlinear Dynamics and Chaos, Westview Press (2001).