Course: Department Specific Elective 1- HPHDS5011T

Semester	V
Paper Number	HPHDS5011T
Paper Title	CLASSICAL DYNAMICS
No. of Credits	06 (Theory – 5, Tutorial-1)
Theory/ Composite	Theory
No. of periods assigned	Th:5 periods/week Tutorial:1 period/week
Name of Faculty member(s)	
Course description/ objective	1. The primary objective of this course is to present an integrated view of the physics of a system of particles and consequently studying its continuum limit, viz. the classical theory of fields. 2. New techniques like the Lagrangian and the Hamiltonian Principle as a way to treat problems in mechanics have been introduced and their utility is discussed. 3. This course aims to present a modern treatment of classical mechanical systems in such a way that the transition to the quantum theory of physics can be made easily. 4. A complete and logically connected theory of electromagnetic fields can only be presented through an inclusion of the special theory of relativity. Thus this has been focussed upon as one of the major areas in this course. 5. An attempt is being made to create a basis in which a student can later go on to look at both the electromagnetic field and the gravitational field as examples of classical field theories. This would hopefully provide a good foundation to understand advanced field theoretic material in the later courses. 6. Finally, the course also aims at enabling a student to incorporate the language of four vectors or tensors allowing them to understand quantitatively compactified versions of field theories, with special emphasis on the electromagnetic field theory.
Syllabus	As enclosed
Textss	As enclosed
Reading/ Reference List	As enclosed
Evaluation	Total – 100 Theory-80, CIA – 20 **Group A : (50 marks)** Three 10 marks qs out of five qs Four 5 mark qs out of six qs **Group B (30 marks)** Two 10 mark qs out of three qs Two five mark qs out of three qs

Syllabus:

HPHDS5011T- CLASSICAL DYNAMICS [Credits :Theory - 6; Lectures : Theory 65, Tutorial :13]

Module A [39 lectures]

Classical Mechanics of Point Particles: Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyro radius and gyro frequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy. [22 Lectures]

Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs. [8 Lectures]

Fluid Dynamics: Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number. [9 Lectures]

Module B [26 lectures]

Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. [26 Lectures]

Reference Books:

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
2.Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Electrodynamics, J.D. Jackson, 3 rdEdn., 1998, Wiley.
4.The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
5.Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
6.Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
7. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
8. Classical Mechanics : An introduction, Dieter Strauch, 2009, Springer.
9. Solved Problems in Classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press
10. Classical Mechanics , John R. Taylor, University Science Books