CLASSICAL MECHANICS (PH 3101)

AUTUMN SEMESTER (2021-22)

DEPARTMENT OF PHYSICS

NATIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR

Contact Hours: 3-1-0 (L-T-P)

No. of Credits:4

Course Instructor: Dr. Neha Agnihotri

Evaluation details:

Total evaluation marks: 100

OBJECTIVE

1. To learn and use Newton's laws of motion to solve advanced problems involving the dynamic motion of classical mechanical systems.
2. To introduce differential calculus and other advanced mathematical techniques pertaining to the development of Lagrangian and Hamiltonian formulations of classical mechanics.
3. To solve the dynamical problems using conservation laws.

COURSE CONTENT

UNIT I: (18 Lectures)

Lagrangian Formalism: The Principle of Least Action, Constraints and Generalised Coordinates, Symmetry and Conservation laws. Applications, small oscillations, Hamilton's variational principle. The Hamiltonian Formalism: Hamilton's Equations, Liouville's Theorem, Poisson Brackets, Canonical Transformations, Action-Angle Variables, Adiabatic Invariants, The Hamilton-Jacobi Equation

UNIT II: (18 Lectures)

Two-body problem in central force, Virial theorem, Kepler's problem, scattering in a central force field, Ruthurford formula, Rigid Body Motion: Moment of inertia tensor, angular momentum, Euler's angle, heavy symmetrical top, Euler's equations, non-inertial frames, Coriolis force.

Special theory of relativity: Basic postulate, Lorentz transformation, velocity addition, vectors and tensors, Relativistic angular momentum, Lagrangian Formalism of Relativistic mechanics.

Text Books:

1. H. Goldstein, C. Poole and J. Safko, Classical Mechanics, 3rd edition, Addison & Wesley (2000).
2. W. Greiner, Classical Mechanics, Springer-Verlag (2003).
3. W. Greiner, Classical Mechanics – Point particles and Relativity, Springer (1989)
4. D. Morin, Introduction to Classical Mechanics: With Problems and Solutions, Cambridge University Press (2008).
5. N. C. Rana and P. S. Joag, Classical Mechanics, 25th edition, Mc Graw Hill India (2013).
6. J. R. Taylor, Classical Mechanics, University Science Books (2005).

Reference Books:

1. I.C. Percival and D. Richards, Introduction to Dynamics, Cambridge University Press (1983).
2. J.V. Jose and E.J. Saletan, Classical Dynamics: A Contemporary Approach, Cambridge University Press (1998).
3. E.T. Whittaker, A Treatise on the Analytical Dynamics of Particles and Rigid Bodies, 4th edition, Cambridge University Press (1989).

OUTCOME OF THE COURSE

It is expected that students will learn fundamentals of classical mechanics. Effective learning of this course will enable the students to understand the complicated classical dynamical problems and find possible solutions for these problems.

LECTURE-WISE COURSE PLAN FOR PH-3101

S. No.	Topic	No. of Lectures
1.	Constraints and Generalized co-ordinates	01
2.	Principle of Virtual work and D'Alembert's principle	01
3.	Lagrange's Equations	01
4.	Kinetic Energy in Generalized co-ordinates	01
5.	Conservation laws and symmetry properties	01
6.	Velocity-dependent potential	01
7.	**Tutorial-1**	**03**
8.	Hamilton's Principle	01
9.	Lagrange's Equations from Hamilton's Principle	01
10.	**Tutorial-2**	**01**
11.	Hamilton's Equations of motion	01
12.	Canonical Transformations	01
13.	Poisson Brackets	01
14.	The Principle of least action	01
15.	**Tutorial-3**	**02**
16.	Hamilton-Jacobi Equation	01
17.	Action-Angle variables	01
18.	**Tutorial-4**	**01**
19.	Two-body problem in central force	01
20.	Kepler's laws	01
21.	Scattering in central force field	01
22.	**Tutorial-5**	**01**
23.	The motion of rigid bodies	02
24.	Euler's Equations of motion	01
25.	Coriolis Force	01
26.	**Tutorial-6**	**01**
27.	Special theory of relativity	01
28.	Lorentz transformations	01
29.	Velocity addition	01
30.	**Tutorial-7**	**01**
31.	Relativistic mechanics	01
32.	**Tutorial-8**	**01**