| Course Type | Course Code | Name of Course | L | T | P | Credit |
|---|---|---|---|---|---|---|
| DC | NPHC501 | Classical Mechanics and Special theory of Relativity | 3 | 1 | 0 | 4 |

| Course Objective |
|---|
| Classical mechanics relates more closely to ordinary language than relativity or quantum mechanics. It presents answers to the macroscopic world quite efficiently. On the other hand special theory of relativity contradicts many principles of classical theory and explains motion of particles at high speeds. |
| **Learning Outcomes** |
| By studying classical mechanics one gets the idea about the inadequacy of mechanics while dealing with subatomic particles or particles with speeds comparable to the speed of light. Classical Mechanics also helps the student to prepare for the modern physics courses like Quantum Mechanics. |

| Unit No. | Topics to be Covered | Lecture Hours | Tutorial Hours | Learning Outcome |
|---|---|---|---|---|
| 1. | **Lagrangian Formulation**: Mechanics of a system of particles, constraints and generalized Coordinates and momenta, force and kinetic energy gyroscopic forces, Jacobi integral, Gauge invariance, D'Alembert's principle, Calculus of Variation and Lagrange's equations. Lagrangian formulation of continuous system, variation and end points, Action integrals, Principle of least action, Numerical problems. | 9 | 4 | At the end of the unit student should know the to define generalised coordinates and the Lagrangian approach to solve mechanical problem and its superiority over the Newtonian mechanics. |
| 2. | **Central force:** Equations of motion, orbits: closure and stability of circular orbits, Virial theorem, Kepler problem, Collision and scattering in a central force field | 4 | 1 | Student will learn to apply Lagrangian formulation to solve central force problems. They should know the conditions on orbits of motion to be stable. |
| 3. | **Hamiltonian formulation**: Legendre transformations, Hamilton equations, cyclic coordinates and conservation theorems, Canonical transformations, Poisson theorem, Poisson brackets, Angular momentum, Hamilton-Jacobi theory, Generating functions, Properties. | 7 | 2 | At the end of the unit student should know Hamiltonian formulation of classical mechanics and should be able to apply in different practical cases. |
| 4. | **Rigid body kinematics and Dynamics**: Orthogonal transformations, Euler angles, Coriolis effect, angular momentum and kinetic energy, tensors and dyadic, inertia tensor, Euler equations, applications, heavy symmetrical top. | 7 | 2 | By the end of the course, students should be able to identify the forces and torques occurring in a given problem and be able to set up the equation of motion and solve the problem. They should also be able to identify when conservation of momentum, energy or angular momentum may be used. They should be able to understand the kinematics of a rigid body. |
| 5. | **Small oscillations**: Eigenvalue problem, frequencies of free vibrations and normal modes, forced vibrations, two-coupled oscillations, normal modes and co-ordinates, dissipation | 6 | 2 | At the end of this unit students should be able to generalise the harmonic oscillator problems to the case of small oscillations. Students should be able to appreciate its applications in molecular spectra, acoustics etc. |
| 6. | **Special theory of relativity**: Minkowski world and Lorentz transformations, world lines, Relativistic Mechanics of Mass Points, Lorentz covariance of the new conservation laws, Relativistic analytical mechanics, Relativistic force, Lagrangian and Hamiltonian of a relativistic particle. | 9 | 3 | At the end of this unit students should know the consequences of the modification of classical mechanics for Relativistic speeds. They should learn force, energy momentum relationship and Lagrangian and Hamiltonian formulation of relativity. |
| | **Total** | **42** | **14** | |

**Text Books:**


1. Classical Mechanics, Goldstein, Safkoand Poole; Pearson; 2002.
2. Classical Mechanics: Systems of Particles and Hamiltonian Dynamics; Greiner; Springer-Verlag, 2004.
3. Introduction to Special Relativity; Robert Resnick; John Wiley; 1965.


**Reference Books:**


1. Classical Mechanics; Ranaand Joag; Tata McGraw Hill; 1991.
2. Classical Mechanics; Gupta, Kumar and Sharma; Pragati Prakashan; 2010.
3. Classical Mechanics of Particles and Rigid Bodies; Gupta; John Wiley and Sons; 1988.