MANGALORE UNIVERSITY

Department of Physics

MSc Physics

PHH 403: CLASSICAL MECHANICS

[52 hrs]

Course outcome

CO1 Will be able to apply Euler-Lagrange equation to solve problems.

CO2 Will be able to apply knowledge of central forces to solve problems.

CO3 Good knowledge of Motion in a Non-inertial reference frames.

CO4 Good knowledge rigid body dynamics and dynamics of small oscillatory systems.

Unit I System of Particles: Centre of mass, total momentum, angular momentum and kinetic energy of a system of particles, Newton's laws, conservation of linear momentum, angular momentum and energy.Lagrangian Formulation: Constraints and their classification, degree of freedom, generalized co-ordinates, virtual displacement, D'Alembert's principle, Symmetry of space and time: Conservation of linear momentum, angular momentum and energy.

[13 hrs]

Unit IIHamiltonian formalism: Generalized momenta, Hamiltonian function, Physical significance and the Hamilton's equations of motion, Examples of (a) The Hamiltonian of a particle in a central force field, (b) the simple harmonic oscillator. Principle of least action: derivation of equation of motion, variation and end points.

Canonical transformations: Generating functions (four basic types), examples of canonical transformations, the Harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets, properties of Poisson brackets (anti-symmetry, linearity and Jacobi Identity), The Hamilton-Jacobi equation, Solution of linear harmonic oscillator using Hamilton-Jacobi method.

[13 hrs]

Unit III Central Forces**:** Definition and characteristics. Reduction of two particle equations of motion to the equivalent one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion), equations of motion for the orbit, classification of the orbits, conditions for closed orbits, Kepler’s laws of planetary motion. Newton’s law of gravitation.

Scattering in Central Force Field: general description of scattering, cross-section, impact parameter, Rutherford scattering, centre of mass and laboratory co-ordinate systems.

Motion in a Non-inertial reference frames: Motion of a particle in a general non-inertial frame of reference, motion of pseudo forces, equation of motion in a rotating frame of reference, the Coriolis force, deviation due east of a falling body, the Foucault pendulum.

[13 hrs]

Unit IV Rigid body dynamics: Degrees of freedom of a rigid body, angular momentum and kinetic energies of a rigid body, moment of Inertia tensor, principal moment of inertia, Euler angles, Euler's equations of motion for a rigid body, Torque free motion of a rigid body, precession of earth's axis of rotation.

Small oscillations**:** types of equilibriums, Quadratics forms for kinetic and Potential energies of a system in equilibrium, Lagrange's equations of motion, Normal modes and normal frequencies, examples of (i) longitudinal vibrations of two coupled harmonic oscillators, (ii) Normal modes and normal frequencies of a linear, symmetric, tri-atomic molecule.

[13 hrs]

Text Books:

1. Classical Mechanics, H Goldstein , (Addison Wesley, 1980)
2. Classical mechanics, H. Goldstein, C. Poole, J. Safko, (3rd edition, Pearson Educations Inc. 2002).
3. Classical mechanics, K. N. Srinivasa Rao, (University press,2003).
4. Classical mechanics, N. C. Rana and P. S. Joag, (Tata McGraw-Hill,1991).
5. Classical dynamics of particles and systems, J. B. Marion, (Academic press,1970).
6. Introduction to Classical mechanics, R.G.Takwale and P.S.Puranik, (Tata McGraw-Hill 1983).
7. Classical Mechanics, J C Upadhyaya, (Himalaya Publishing House,2005)
8. Classical Mechanics,G. Aruldhas, (Prentice Hall of India,2008)

Reference Books

1 Classical mechanics, L. D. Landau and E. M. Lifshitz, (4th edition, Pergamon press 1985).
2 Lagrangian and Hamiltonian Mechanics, M.G. Calkin, (World Scientific, 1996)
3 Analytical Mechanics, G R Fowles, Holt, Rinehart (1977).
4 Classical Mechanics, Walter Greiner, Springer India (2006).
5 Analytical Mechanics, K A Gamalnath, Narosa, (2011).
6 Classical Mechanics, A K Saxena, CBS Publishers