PHYDSC102T

MECHANICS AND RELATIVITY

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *The objective of this is to review few concepts of mechanics learnt earlier from a more advanced perspective and utilize those to build new concepts. It begins with fundamentals of dynamics and ends with the Special Theory of Relativity. It begins with fundamentals of dynamics and ends with the Special Theory of Relativity.*

Unit 1: Fundamentals of Dynamics

Force and Linear momentum, Principle of conservation of momentum, Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field, Dynamics of a system of particles. Centre of Mass. Impulse.

Work and Energy: Work - Energy Theorem. Conservative and non-conservative forces. Elastic potential energy. Force as gradient of potential energy. Law of conservation of mechanical Energy.

Collisions: Elastic and inelastic collisions in one and two dimensions. Collisions in Centre of Mass and Laboratory frames. **(10 Lectures)**

Unit 2: Rotational Dynamics

Angular momentum of a particle and system of particles. Torque, Principle of conservation of angular momentum. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies.

Elasticity: Hooke's law, Poisson's ratio and its limiting values, Relation connecting Elastic constants. Twisting torque on a Cylinder or Wire. **(8 Lectures)**

Unit 3: Gravitation and Central Force Motion

Law of gravitation, Gravitational potential and potential energy, Potential and field due to spherical shell and solid sphere.

Central force: Definition & Characteristics. Kepler's Laws with derivation. Deduction of Newton's law of gravitation from Keplers law. Satellite in circular orbit (orbital velocity, escape velocity & time period) and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). **(9 Lectures)**

Unit 4: Oscillations

SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic Energy, potential energy, total energy in SHM and their time-average values. Damped oscillation. Forced oscillations, Resonance, sharpness of resonance; power dissipation and Quality Factor.

Non-Inertial Systems: Inertial and Non-inertial frames and fictitious forces. Uniformly rotating

frame. Laws of Physics in rotating coordinate systems: Coriolis Theorem; Centrifugal force. Coriolis force and its applications**.** **(9 Lectures)**

Unit 5: Relativity

Galilean transformations; Galilean invariance; Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation and its experimental verification; Twin Paradox; Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. **(9 Lectures)**

Expected learning outcomes: *Upon completion of this course, the students will be able to learn the concepts of collisions, rotational dynamics, gravitation, oscillations, central forces and the Special Theory of Relativity including Lorentz transformations and its consequences.*

Reference Books:

i. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.

ii. Mechanics, Berkeley Physics, Vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

iii. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

iv. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.

v. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education.

vi. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

vii. A treatise on General Properties of matter, Chatterjee & Sengupta, New Central Book Agency.

viii. Classical Mechanics and properties of Matter, A. B. Gupta, Books and Allied publisher.