# SEMESTER-I

## I. PHY-MJ-1: MECHANICS AND PROPERTIES OF MATTER

**(Credit: Theory-04) 60 Lectures**

**Course Objectives:**

This course aims to enable the students to acquire the key concepts of the general properties of matter, the motion of a particle under central force field, oscillations and special theory of relativity.

**Learning Outcomes:**

- Learn about the behaviour of physical bodies around us in daily life.
- Understand the dynamics of planetary motion.
- Build a foundation of various applied field in science and technology.
- Develop the analytical thinking on Mechanics in order to understand the response of the classical systems to external forces.

**Course Content:**

**General Properties of Matter (20 Lectures):** Hooke's law. Stress-strain diagram. Elastic moduli. Poisson's Ratio-expression for Poisson's ratio in terms of elastic constants. Relation between Elastic constants. Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder. Bending moment. Cantilevers, beam supported at the end and loaded at middle and its application to determine Young's modulus. Searle's experiments. Kinematics of Moving Fluids: Viscous fluid, Poiseuille's Equation for Flow of a Liquid through a Capillary Tube with correction, Flow of compressible fluid through a capillary tube, Rankine's methods for measurement of viscosity of gas. Effect of temperature and pressure onviscosity. Surface tension and surface energy. Angle of contact. Expression for excess pressure. Principal of virtual work. Ripples and Gravity waves. Effect of temperature and pressure on surface tension.

**Central Force Motion (10 Lectures):** Motion of a particle under a central force field. Two bodies problem. Conservation of angular momentum. Kepler's Laws of planetary motion and their derivations. Satellite in circular orbit and applications. Weightlessness.

**Oscillations (15 Lectures):** Simple Harmonic Oscillations (SHM). Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Examples of Physical Systems Executing SHM: Simple Pendulum, Compound Pendulum, Torsional Pendulum, LC-Circuit. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance, power dissipation and Quality Factor.

**Special Theory of Relativity (15 Lectures):** Inertial and Non-inertial frames. Centrifugal force and Coriolis force and its applications. Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Lorentz contraction. Time dilation. Simultaneity and order of events. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect.

**Reference Books:**


1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, D. S. Mathur.

3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Feynman Lectures, Vol. I, R.P. Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
5. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.