II. PHY-MN-1A: MECHANICS

(Credits: Theory-03) 45 Lectures

Course Objectives:

This course aims to enable the students to acquire the mathematical knowledge about the vector algebra and ordinary differential equation with their role in applied physics. Key concepts of the general properties of matter, the motion of a particle under central force field, oscillations and non-inertial systems.

Learning Outcomes:

- Understanding about vector algebra and ODEs will be developed.
- 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:

Vectors (4 Lectures): Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

Ordinary Differential Equations (4 Lectures): 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.

General Properties of Matter (12 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. 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. Effect of temperature and pressure on viscosity. Surface tension and surface energy. Angle of contact. Expression for excess pressure. Effect of temperature and pressure on surface tension.

Work and Energy (5 Lectures): Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work and Potential energy. Work done by nonconservative forces. Law of conservation of Energy.

Central Force Motion (8 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 derivation. Satellite in circular orbit and applications. Weightlessness.

Oscillations (7 Lectures): Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations.

Non-Inertial Systems (5 Lectures): Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

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.