

## Core II

### Mechanics

#### Course Outcomes

- To Learn the basic concepts of Rigid body dynamics, Radius of Gyration, Moment of Inertia, Non-Inertial Systems
- To Understand the concept of Elasticity, Fluid motion and Types of Vibration
- To understand the concept of Newtonian theory through Gravitation, Central force motion, Kepler's laws, GPS
- To learn the concept of Special theory of Relativity, Michelson- Morley experiment, Lorentz transformation, Relativistic Doppler effect.
- Apply the basic concepts of Mechanics in experiments.

#### Unit I

- **Rotational Dynamics:** Centre of Mass, Motion of CoM, Centre of Mass and Laboratory frames, Angular momentum of a particle and system of particles, Principle of conservation of angular momentum, Rotation about a fixed axis, Moment of Inertia, Perpendicular and Parallel Axis Theorems, Routh Rule, Calculation of moment of inertia for cylindrical and spherical bodies, Kinetic energy of rotation, Euler's Equations of Rigid Body motion, Motion involving both translation and rotation. Moment of Inertia of a Flywheel.
- **Non-Inertial Systems:** Non-inertial frames and fictitious forces, uniformly rotating frame, Laws of Physics in rotating coordinate systems, Centrifugal force, Coriolis force.

#### Unit II

- **Oscillations:**  
Damped oscillation. Equation of motion and solution (cases of oscillatory, critically damped and overdamped) Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Bar Pendulum, Katers Pendulum
- **Elasticity:** Relation between Elastic constants, Twisting torque on a Cylinder or Wire, Bending of beams, External bending moment, Flexural rigidity, Single and double cantilever
- **Fluid Motion:** Kinematics of Moving Fluids: Poiseuilles Equation for Flow of a Liquid through a Capillary Tube, Surface tension, Gravity waves and ripple
- **Viscosity:** Poiseuilles Equation for Flow of a Liquid with corrections.

### **Unit III Gravitation and Central Force Motion**

Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere, Motion of a particle under a central force field, Two-body problem and its reduction to one-body problem and its solution, Differential Equation of motion with central force and its solution, The first Integrals (two), Concept of power Law Potentials, Kepler's Laws of Planetary motion, Satellites. Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS).

### **Unit IV**

**Special Theory of Relativity:** Michelson-Morley Experiment and its out-come, Postulates of Special Theory of Relativity, Lorentz Transformations, Simultaneity and order of events, Lorentz contraction, Time dilation, Relativistic transformation of velocity, Frequency and wave number, Relativistic addition of velocities, Variation of mass with velocity, Massless Particles, Mass- energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics, Transformation of Energy and Momentum.

#### **Text Books:**

- ✓ *Mechanics, D.S. Mathur (S. Chand Publishing )*
- ✓ *Introduction to Special Relativity, R. Resnick (John Wiley)*

#### **Reference Books:**

- ✓ *Introduction to Mechanics Daniel Klapanner and Robert Kolenkow, McgrawHill.*
- Mechanics by K.R Simon*
- ✓ *Mechanics, Berkeley Physics, vol. 1, C.Kittel, W. Knight, etal (Tata McGraw- Hill)*
- ✓ *Physics, Resnick, Halliday and Walker (8/e.2008,Wiley)*
- ✓ *Theoretical Mechanics-M.R. Spiegel (Tata McGrawHill).*
- ✓ *Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands (Pearson)*
- ✓ *Mechanics-M.Das, P.K.Jena and R.N. Mishra (SrikrishnaPublications)*
- ✓ *Classical Mechanics , Gupta Kumar & Sharama,(Pragati Prakashan)*
- ✓ *Classical Mechanics, J.C.Upadhyaya, (Himalaya Publishing Home)*

## LAB : Credit 1

*(Minimum 4 experiments are to be done):*

1. To study surface tension by capillary rise method.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b)  $g$  and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
7. To determine the value of  $g$  using Bar Pendulum.
8. To determine the value of  $g$  using Kater's Pendulum.

### Reference Books:

- ✓ *Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.*
- ✓ *Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.*
- ✓ *A Text book of Practical Physics, I. Prakash and Ramakrishna, 11thEdn, 2011, Kitab Mahal.*