SET - I

Unique Paper Code	**:**	**42221101**
Name of the Paper	**:**	**Physics-I: Mechanics**
Name of the Course	**:**	**B. Sc. (Prog) CBCS New Course**
Semester	**:**	**I**
Medium	**:**	**English**

Duration: 3 hours **Max Marks: 75**

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All questions carry equal marks. Attempt any **four** questions in all.

1. Prove that *curl grad* $\varphi = 0$.
   Show that $\vec{A} = (6xy + z^3)\hat{\imath} + (3x^2 - z)\hat{\jmath} + (3xz^2 - y)\hat{k}$ is irrotational.
   Solve the differential equation $\cos(x + y)dy = dx$.

2. What are conservative and non-conservative forces? Show that a central force is conservative. Show that a conservative force can be expressed as negative gradient of potential energy. Show that the force acting on a particle whose position at any instant *t* is given by $\boldsymbol{r} = \text{a}\cos\omega t\,\boldsymbol{i} + \text{b}\sin\omega t\,\boldsymbol{j}$ is a conservative force.

3. Prove that a projectile launched on level ground reaches its maximum height midway along its trajectory.
   State Kepler's laws of planetary motion. Show that the inverse square law of gravitation leads to the Kepler's third law of planetary motion.
   Calculate the period of revolution of Neptune round the sun given that the diameter of the orbit is 30 times the diameter of the earth's orbit around the sun, both orbits being assumed to be circular.

4. Obtain an expression for the moment of inertia of a solid cylinder about an axis through its centre and perpendicular to its axis of cylindrical symmetry.
   A ring of mass 0.6 kg and radius 0.1 m and a solid cylinder of mass 0.8 kg and of the same radius are given the same kinetic energy and released simultaneously on a flat horizontal surface such that they begin to roll as soon as released towards a wall which is at the same distance from the ring and the cylinder. Assuming that the rolling friction in both cases is negligible, find out which object reaches the wall first?

5. The equation of motion of a system is given by
   $$\frac{d^2y}{dt^2} + \frac{2}{\tau}\frac{dy}{dt} + \omega_o^2 y = 0$$
   Explain the significance of the various terms of the equation and show that τ has the dimension of time. Solve the equation and discuss the motion of the when $\omega^2\tau^2 > 1$.
   Further, if the relaxation time of a damped harmonic oscillator is 50 second, find the time in which (i) amplitude falls to 1/e times the initial value. (ii) energy of the system falls to 1/e times the initial value. (iii) energy falls to $1/e^4$ of the initial value.

6. Derive relativistic expression for the kinetic energy of a particle. Show that for small velocities the relativistic kinetic energy reduced to the classical kinetic energy.
   What will be the fringe-shift according to the ether theory in the Michelson-Morley experiment, if the effective length of each path is 7 meters and light has 7000 Å wavelength? (The velocity of earth is $3 \times 10^4\ m/sec$)