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S. No. of Question Paper : **8573**

Unique Paper Code : **42221101** **J**

Name of the Paper : **Mechanics**

Name of the Course : **B.Sc. (Prog.)**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

1. (*a*) For the vectors $A = 3i - 2j + k$ and $B = 2i - k$, determine $A \cdot B$ and $(A \times B) \cdot A$. 5

(*b*) Prove $(A \times B) \times C = (A \cdot C)\, B - (B \cdot C) \cdot A$. 5

(*c*) Solve the differential equation

$$(x^2 - y^2)\, dy - 2xy\, dx = 0.$$ 5

2. (*a*) State Kepler's laws of planetary motion. 3

P.T.O.

(*b*) What is a central force ? Give examples of central force. Prove that under the influence of a central force, the motion of a particle is always confined to a plane.

(*c*) A satellite revolves around a planet of mean density 10^4 kg/m^3. If the radius of its orbit is only slightly greater than the radius of the planet, find the time of revolution of the satellite.

[$G = 6.67 \times 10^{-11}$ S.I. units]

3. (*a*) What do you understand by the centre of mass of a system of particles ? Show that in the absence of external force the velocity of the centre of mass remains constant.

(*b*) What is moment of inertia ? State parallel and perpendicular axis theorems.

(*c*) The angular momentum of a rotating body is conserved while its moment of inertia is decreased. Show that its rotational kinetic energy increases.

4. (*a*) State and prove work-energy theorem. 5

(*b*) What are conservative and non-conservative forces ? Show that work done by a conservative force along a closed path is zero. 5

(*c*) Establish the equation of motion of a rocket and obtain the velocity of the rocket at time t taking into account the effect of gravity. 5

5. (*a*) Define kinetic energy of rotation. Develop an expression for kinetic energy involving both translation and rotation. 10

(*b*) A torque of 1 Nm is applied to a wheel of mass 10 kg and radius of gyration 50 cm. What is the resulting translational acceleration ? 5

6. (*a*) What do you understand by simple harmonic motion ? Set up the differential equation of motion for a simple harmonic motion and obtain its solution. Find the expression for time period and angular frequency. 10

P.T.O.

(*b*) At what displacement the kinetic and potential energies are equal ? 5

(*a*) Differentiate between inertial and non-inertial frames. 2

(*b*) State Einstein's postulates of special theory of relativity. Derive the Lorentz transformation equations. 8

(*c*) A rod 1m long is moving along its length with a velocity 0.6c. Calculate its length as it appears to an observer on the earth.

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