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S. No. of Question Paper : 8573

Unique Paper Code : 42221101

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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 $(A \times B) \times C = (A \cdot C) B - (B \cdot C) A$. 5

(c) Solve the differential equation

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

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.

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

3. (a) What do you understand by the centre of mass of a system of particles ? Show that in the absence of external forces 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 ?
7. (a) Differentiate between inertial and non-inertial frames.
- (b) State Einstein's postulates of special theory of relativity. Derive the Lorentz transformation equations.
- (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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