

[This question paper contains 4 printed pages]

**Your Roll No.** : .....

**Sl. No. of Q. Paper** : **203** **I**

Unique Paper Code : 42221101

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

Name of the Paper : Mechanics

Semester : I

**Time : 3 Hours** **Maximum Marks : 75**

**Instructions for Candidates :**

- (a) Write your Roll No. on the top immediately on receipt of this question paper.
- (b) Attempt any **five** questions. Use of non programmable calculator is allowed.

1. (a) If  $A = 2\hat{i} - 3\hat{j} - \hat{k}$  and  $B = \hat{i} + 4\hat{j} - 2\hat{k}$ . Find  $(A+B) \times (A-B)$ . 5

(b) If  $\vec{R} = e^{-t}\hat{i} + \ln(t^2 + 1)\hat{j} + \tan(t)\hat{k}$ . 5

Find  $\left| \frac{d\vec{R}}{dt} \right|$  and  $\left| \frac{d^2\vec{R}}{dt^2} \right|$  at  $t = 0$ .

P.T.O.

(c) Solve the differential equation :

5

$$\frac{dy}{dx} = \frac{2y^4 + x^4}{xy^3}$$

2. (a) What is centre of mass ? Show that in the absence of an external force the velocity of centre of mass remains constant. 5

(b) A vessel at rest explodes breaking into three pieces. Two pieces having equal masses, fly off perpendicular to each other with the same speed of 30 m/sec. The third piece has three times the mass of each piece. What is the direction and magnitude of its velocity immediately after explosion. 5

(c) Show that the force  $\vec{F} = yz\hat{i} + zx\hat{j} + xy\hat{k}$  is a conservative force. 5

3. (a) Define angular momentum  $\vec{j}$  and torque  $\vec{\tau}$ .

Show that  $\vec{\tau} = \frac{d\vec{j}}{dt}$ . 5

(b) A 500 gm mass is whirled round in a circle at the end of a string 40 cm long. The other end of the string is held in hand. If the mass makes 5 rev/sec, what is its angular momentum. If the number of revolutions reduce to 1 rev/sec in 20 seconds, find the torque acting on the mass. 5

(c) Prove law of conservation of mechanical energy for conservative forces. 5

4. (a) State Kepler's laws of planetary motion. 6

(b) Show that the areal for a particle moving under the influence of a central force velocity is constant. 4

(c) What are geostationary satellites? Find the height of a geostationary satellite above the surface of earth. Given, Radius of earth = 6400 km. 5

5. (a) What is simple harmonic motion? Explain with the help of an example. Write down the differential equation of simple harmonic motion and find its solution. 10

(b) Show that for a particle executing simple harmonic motion the average potential energy is equal to half the total energy.

5

6. (a) Derive the relation  $K = \frac{Y}{3(1 - 2\sigma)}$

where  $K$  = Bulk's Modulus,  $Y$  = Young's Modulus and  $\sigma$  = Poisson's ratio. 10

(b) A steel bar 2 m long, 40 mm wide and 20 mm thick is subjected to an axial pull of 160 kN along its length. Find changes in its length, width and thickness. Take Young's Modulus =  $2 \times 10^5 \text{ N/mm}^2$  and Poisson's ratio = 0.3

5

7. (a) Write down Lorentz transformation equations and derive the expression for length contraction. 10

(b) How fast would a rocket have to go relative to an observer on earth for its length to be contracted to 50% of its length when at rest?

5