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Your Roll No.....

Sr. No. of Question Paper : 7328 **J**

Unique Paper Code : 42221101 – OC

Name of the Paper : Mechanics

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

Semester : I

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Question No. **1** is compulsory.
4. **All** questions carry equal marks.

1. Answer any **five** of the following :– (5×3=15)

(a) Suppose a particle moves along a curve whose parametric equations is:

$x = 40\,t^2 + 8t;\ y = 2\cos 3t;\ z = 2\sin 3t.$

(h) What is the displacement of a particle executing SHM from its mean position when its kinetic energy is half of its potential energy?

2. (a) Find the area of parallelogram determined by vectors

$\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ and $-3\,\hat{\imath} - 2\,\hat{\jmath} + k$.

What is the sine of the angle between the two vectors?

(b) Solve the following differential equation :

$$\frac{dy}{dx} = -\frac{y}{x} + \frac{1}{x^2}$$

(c) Find the general solution of :

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + y = 0$$

(5,5,5)

3. (a) Find the centre of mass of a thin uniform wire bent in the form of a semi circle of radius R.

(b) State Work-energy theorem.

(c) A rocket ascends from rest in a uniform gravitational field by ejecting exhaust gases with a constant speed u relative to the rocket. Assuming that the rate at which mass is expelled is given by $\frac{dM}{dt} = -\gamma M$, where M is the instantaneous mass of the rocket and γ is a constant, find the velocity of the rocket as a function of time. (5,3,7)

4. (a) A solid sphere of mass 0.1 kg and radius 2.5 cm rolls without slipping with uniform velocity of 0.1 ms^{-1} along a straight line on a horizontal table. Calculate its total energy. 6

(b) State Kepler's laws of planetary motion. Show that for a particle moving in a central force field, the areal velocity is constant.

(c) An earth's satellite makes a circle around earth in 120 minutes. Calculate the height of the satellite above the surface of earth. (5,5,5)

(Given radius of earth is 6400 km and $g = 9.8\ ms^{-2}$)

5. (a) Establish the equation of motion of a damped

harmonic oscillator subjected to a resistive force that is proportional to the first power of its velocity. If the damping is less than critical, show that the motion of the system is oscillatory with its amplitude decaying exponentially with time.

(b) A particle is executing simple harmonic oscillation along a straight line. Its velocities at distance x_1 and x_2 are v_1 and v_2 respectively. Find the time period of oscillations. (12,3)

6. (a) Derive a relation connecting the elastic constants Y, K and σ.

(b) Derive an expression for the couple required to twist one end of a cylindrical wire when its other end is fixed. (8,7)

7. (a) Derive an expression for length contraction (assume that observer is in frame S and rod is kept along x-x′ axis in frame S′).

(b) Two rockets A and B are moving away from the Moon at the respective speeds (w. r. t. Moon) of 0.8 c and 0.9 c. Find the speed of A w. r. t. B.

(c) The proper length of a rod is 5 metres. What would be its length for an observer if it be moving

with velocity 0.8 c relative to him in a direct parallel to its own length? (5,5

8. (a) With what velocity should a rocket move so t every year spent on it corresponds to 4 years earth?

(b) A brass bar 1 cm square in cross-section supported on two knife edges 100 cm apart. load of 1 kg at the centre of the bar depres that point by 2.51 mm. What is Young's modu for this bar?

(c) An earth is revolving around the Sun in circu orbit of radius 1.49×10^{13} cm. If mass of Sun 19.72×10^{34} gm, find the speed of the earth in orbit.

($G = 6.67 \times 10^{-8}$ c. g. s. units) (5,5

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