Reg. No:
Date & Session:

ST.JOSEPH'S UNIVERSITY, BENGALURU -27
B.Sc. (PHYSICS) – I SEMESTER

SEMESTER EXAMINATION: OCTOBER 2022

(Examination conducted in December 2022)

PH 121-MECHANICS AND PROPERTIES OF MATTER

Time: 2 **hours** **Maximum marks: 50**

This question paper has 2 printed pages and 3 parts

PART A

Answer any **FOUR** of the following questions. Each question carries 7 marks. $[4 \times 7 = 28]$

1. For a particle moving in plane polar coordinate system, find the components of velocity and acceleration. [7]

2. (a) State the postulates of Special Theory of Relativity. [2]
   (b) From Lorentz Transformation equations, obtain an expression for the relativistic addition of velocities, if a particle under consideration is moving parallel to the x-axis . [5]

3. (a) State the theorem of perpendicular axis. [2]
   (b) Obtain an expression for the moment of inertia of a rectangular lamina about an axis parallel to one side and passing through the centre of mass and hence obtain its moment of inertia about an axis passing through its centre of mass and perpendicular to its plane. [5]

4. (a) Define the term *neutral axis*. [1]
   (b) Derive an expression for the bending moment of a beam. [6]

5. (a) Write a short note on equation of continuity with reference to fluid dynamics. [2]
   (b) Assuming Stokes formula, obtain an expression for the coefficient of viscosity of a liquid. [5]

6. Show that the excess pressure acting on the curved surface is given by $\Delta P = 2T(\frac{1}{r_1} + \frac{1}{r_2})$ where r_1 and r_2 are the radii of curvature and T is the surface tension of the membrane. [7]

PART B

Solve any **FOUR** of the following problems. Each problem carries 4 marks. $[4 \times 4 = 16]$

7. A particle moves along the curve $x = 2t^2$, $y = t^2 - 4t$, $z = 3t - 5$, where t is the time. Find the component of velocity in the direction of **i**-3**j**+2**k** at t=1.

8. A rocket's initial mass is 300 kg and final mass after exhausting the fuel is 100 kg. If the speed of the exhaust gases is 2 km/s, a) what will be the final velocity of the rocket if it is moving in free space? Assume that the initial velocity of the rocket is negligible. b) If this rocket is starting from the surface of the earth, what should be the rate at which mass should be burned to give the rocket an acceleration of 1 km/s^2?

9. The decay time of a particle in its rest frame is 10^{-6} seconds. If the particle is travelling at a speed of $0.9C$ with respect to the lab frame, what will be the decay time as seen by an observer in the laboratory frame? If the particle travels a distance of 619.422 m before decaying, according to the laboratory observer, what will be the distance travelled by the particle as per an observer moving with the particle? Here C is the speed of light in free space.

10. When a wire 3 m and radius 0.2 mm is stretched by a force of 6 N, the extension is found to be 1mm. Find the Young's modulus and the energy stored in the wire.

11. A satellite is moving around the earth at a distance of 1000 km from the surface of the earth. If the radius of the earth is 6400 km and acceleration due to gravity is 10 m/s^2, what will be the satellite's orbital speed and the period of revolution?

12. In a capillary tube, water rises to a height of 10 cm. In the same tube, mercury is depressed by 3.42 cm. If angle of contact for water is $0°$ and for mercury $135°$ respectively, then calculate the surface tension of mercury. Given:- Surface tension of water is 0.072 N/m, density of mercury is 13600 kg/m^3, density of water is 1000 kg/m^3.

PART C

Answer any **THREE** of the following questions by giving the correct reason or explanation. Each question carries 2 marks. $[3 \times 2 = 6]$

13. (a) Does the direction of acceleration change if the rotation of the particle changes from clockwise to anti-clockwise, radius of rotation remaining a constant?
    (b) From the given two bicycle wheels having same mass and radius but one with spokes and the other in the form of a disc, which will be easier to rotate?
    (c) Poisson's ratio of a material cannot be negative in actual practice. Why?
    (d) Will the orbital speed of earth when it is the closest to sun (perihelion) be the same as when the earth is the farthest from the sun (aphelion)?