

# Five-Year Integrated M.Sc. Examination 2024

## Semester-I

### Paper: PH-1-1-1

#### (Mechanics, Waves and Oscillations)

Time: Three Hours

Full Marks: 60

Questions are of value as indicated in the margin.

**Answer Question No. 1 and any four from the rest.**

1. Answer **any five** from the following: 5x4 = 20
  - (a) Write down the general expression for centrifugal force on an object of mass  $m$  situated at any position on the surface of earth with position vector  $\vec{r}$  due to the rotation of earth about its own axis. Where will be the maximum centrifugal acceleration on the object? Calculate its value. Given,  $r = 6.4 \times 10^8$  cm (radius of earth).
  - (b) Draw a diagram and explain the concept of effective weight of a body of mass  $m$  at a distance  $r$  from the center of the earth having a latitude  $\lambda$  due to the rotation of earth about its own axis (considering centrifugal force).
  - (c) Sunflower oil is packed in a pouch of volume  $720 \text{ cm}^3$ . The oil is compressed by increasing the pressure to  $5.0 \times 10^6$  Pa and the volume decreased by  $5 \text{ cm}^3$ . Calculate (i) the bulk modulus of the liquid and (ii) the compressibility of the liquid.
  - (d) A body of mass 2 kg is attached to an ideal spring resting horizontally. It is found that the spring vibrates with a frequency of 10 Hz. Calculate (i) the time period of motion, (ii) the angular frequency and (iii) the force constant of the spring.
  - (e) A particle vibrates with SHM of amplitude 5 cm and a period of 6 s. How long does it take to move from one end of its path to a position 2.5 cm from the equilibrium position on the same side.
  - (f) Find the amount of work done in twisting a steel wire of radius 1 mm and length 25 cm through an angle of  $45^\circ$ . Given, modulus of rigidity of steel =  $8 \times 10^{11}$  CGS unit.
2. Derive the two relations in terms of the three coefficients of elasticity and Poisson's ratio. 10
3. Define internal bending moment of a beam and find an expression for it. 10

4. A particle is subjected to two SHMs at right angles to each other, having the same frequency. Show that the resultant locus of the particle is an ellipse. Hence, find the locus when the two motions are (i) in phase and (ii) out of phase.

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5. Explain how the coefficients of the Fourier series of a periodic function are evaluated.

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6. Establish Bernoulli's equation for an incompressible fluid, when the flow is streamline and irrotational and the external force is gravitational force.

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