

Five-Year Integrated M.Sc. Examinations 2023

Semester-I

Paper: PH-1-1-1 (Theory)

Subject: 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 five from the rest.

1. Answer any five from the following: 5x4 = 20
 - (a) A nylon rope used by a mountaineer elongates 1.1 m under the weight of a 65 kg climber. If the rope is 45 m in length and 7 mm in diameter, what is Young's modulus for nylon?
 - (b) One litre of glycerine gets reduced in volume by 0.15 cm^3 under a pressure of 5 kg/cm^2 . Calculate its bulk modulus.
 - (c) Consider a rod of circular cross-section of length L and radius R . The volume of the rod is not changed when the rod is stretched in length by an amount ΔL by applying a force. Show that Poisson's ratio for the material of the rod is $\frac{1}{2}$.
 - (d) An object is undergoing SHM with period 0.82 s and amplitude 0.32 m. At $t = 0$ s, the object is at $x = 0.32$ m and is instantaneously at rest. Calculate the time it takes the object to go (i) from $x = 0.32$ m to $x = 0.16$ m and (ii) from $x = 0.16$ m to $x = 0$ m.
 - (e) The displacement of a particle at any instant of time ' t ' is given by $x = 3 \cos \omega t + 4 \sin \omega t$. Investigate whether the motion is simple harmonic or not.
 - (f) A ball of mass 0.52 kg is connected to a horizontal spring. It undergoes SHM and has an acceleration of 4.5 m/s^2 at $x = 0.32$ m. What is the time for one oscillation?
2. Explain the pseudo forces arising due to the rotation of earth about its own axis, assuming the angular velocity to be a constant. 8
3. A light cantilever of length L and circular cross-section of radius R is fixed at one end and loaded at the other end by a weight W . Derive the expression for the downward displacement of the free end of the rod. Given, Young's modulus of the material of the rod is Y . 8
4. Derive an expression for the twisting couple of a solid cylindrical rod of length L and radius R for twisting it by an angle ϕ . Given, torsional rigidity of the material of the rod is η . 8
5. Derive Bernoulli's equation for the streamline motion of a fluid. Explain the physical significance of the equation. 8
6. Write down the equation of motion for the damped oscillation of a system having one degree of freedom (with diagram). Find the solution of the equation for large damping. 8
7. Explain the normal modes and normal coordinates for free oscillation of a system of two coupled pendulums. 8