

Five-Year integrated M.Sc. Examination 2022-2023
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 number 1 and any three from the rest.

1. Answer any five from the following: 5×3 = 15
 - (a) Calculate the maximum centrifugal acceleration of a mass on the surface of earth due to the rotation of earth about its own axis. Given, radius of earth = 6.4×10^8 cm.
 - (b) At one point in a pipeline the speed of water is 5 m/s and the gauge pressure is 5×10^4 Pa. Find the gauge pressure at a second point in the pipeline, 15 m lower than the first, if the pipe diameter at the second point is twice that at the first.
 - (c) Explain what do you mean by Reynold's number.
 - (d) A hydraulic press contains 300 L of oil. Find the decrease in the volume of the oil when it is subjected to a pressure increase of 1.0×10^7 Pa. The bulk modulus of the oil is 5.0×10^9 Pa.
 - (e) Define Poisson's ratio. Use the relations between elastic constants to find the limits of Poisson's ratio.
 - (f) A particle is showing SHM represented by $\psi(t) = A \cos(\omega t + \phi)$. Show that total energy of the particle is conserved.
 - (g) An object is undergoing SHM with period 1.5 s and amplitude 0.7 m. At $t = 0$ the object is at $x = 0$ and is moving in the negative x-direction. How far is the object from the equilibrium position at $t = 0.5$ s?

2.
 - (a) Explain centrifugal and Coriolis forces due to the rotation of earth about its own axis.
 - (b) Where the maximum and minimum values of these forces are observed on the surface of earth? Explain with diagram.10+5 = 15

3.
 - (a) Derive the two relations in terms of the three coefficients of elasticity and Poisson's ratio.
 - (b) Prove that a shear is equivalent to a compression and an equal extension at right angle to each other.10+5 = 15

4.
 - (a) Derive an expression for the torsional rigidity of a hollow cylinder of internal and external radii R_1 and R_2 , respectively.
 - (b) A square wave voltage is defined as:
 $f(t) = +V_0$ for $0 \leq t \leq T/2$
 $= -V_0$ for $T/2 < t \leq T$
Using Fourier's theorem, show that the above square wave voltage consists of a dc component and several ac components.8+7 = 15

5. (a) Write the equation of motion for a damped harmonic oscillator subject to a damping force which is proportional to the velocity of the oscillator. Draw a diagram and clearly explain all terms.
- (b) Solve the above equation for low damping.
- (c) Draw a sketch of the low damped oscillatory motion.
- (d) Show that the ratio of two successive amplitudes of low damped oscillator is a constant quantity.

$$2+8+2+3 = 15$$