Parvatibai Chowgule College of Arts and Science
Autonomous

B.Sc. Semester End Examination, January 2022

Semester: III

Subject: Physics

Title: Oscillations, Waves and Sound (Elective)

Duration: 2 Hours Max. Marks: 45

Instructions:

1. All questions are compulsory; however, internal choice is available.
2. Figures to the right indicate maximum marks to the question/sub-question.
3. Use of calculator is permitted.
4. Symbols have their usual meaning unless specified.

Q.1 Answer <u>ANY THREE</u> of the following: (9)

a. Given displacement $y = asin\omega t$, show the phase relation between the displacement, velocity and acceleration diagrammatically in one complete vibration.

b. How did Laplace correct Newton's formula for the velocity of a longitudinal wave in a homogenous medium?

c. Discuss sharpness of resonance. Explain the statement *'the quality factor is a measure of the sharpness of resonance in case of a driven oscillator.'*

d. State a few applications of the doppler effect.

Q.2 Answer <u>ANY TWO</u> of the following: (12)

a. What are ultrasonic waves? How ultrasonic waves are produced using the principle of magnetostriction?

b. (i) The potential energy is given by $U = A - \frac{B}{x} + \frac{C}{x^2}$, where A, B and C are positive constants, obtain the position of stable equilibrium and the force constant for small oscillations.

(ii) What is meant by the term logarithmic decrement of a damped harmonic oscillator? Deduce the damping constant between two successive amplitudes with a time interval T between them.

c. Doppler effect in light is symmetric whereas doppler effect in sound is asymmetric. Explain. Support your answer with relevant deduced expressions.

Q.3 Answer <u>ANY TWO</u> of the following: (12)

a. Show that the bifilar suspension executes simple harmonic motion about the vertical axis through its centre of gravity on being displaced in the horizontal plane.

b. Explain how two simple harmonic vibrations of the same frequency acting simultaneously on a particle along the same line can be compounded. Deduce expressions for the resultant amplitude and epoch angle.

c. (i) Define centres of suspension and oscillation of a compound pendulum and show that they are interchangeable. What length of the pendulum has its minimum time period?

(ii) A disc of $10cm$ radius and mass $1kg$ is suspended in a horizontal plane by a vertical wire attached to its centre. If the diameter of the wire is $1mm$ and its length is $1.5m$ and period of torsional vibration of the disc is $5s$, find the rigidity of the material of the wire.

Q.4 Answer <u>ANY ONE</u> of the following two sub-questions: (12)

a. (i) If the damping in the case of a damped harmonic oscillator be very small, obtain expressions for the average total energy of the oscillator and the average rate of energy dissipation.

(ii) Derive an expression for the total energy of a stiffness coupled system of identical pendulums and show that the total energy remains constant. Diagrammatically show how the energy flows back and forth between the pendulums at the beat frequency.

OR

b. (i) A damped harmonic oscillator of quality factor 20 is subjected to a sinusoidal driving force of angular frequency twice the natural angular frequency of the oscillator. If the damping be small, what fraction will the amplitude of the oscillator be of its maximum value and by what angle will it differ in phase from the driving force?

(ii) Deduce an expression for the velocity of transverse waves in a string.

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