Roll No: CS21B1071	Name: B. Nissie Prashamsa

Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram

Mid Semester Examination, May 2022

Course Code: PH 2001 | **Course Title: Waves and Vibrations**
Batch: B. Tech. 2021..... | Category: Core / **Elective**
Date of Examination: 17.05.2022 | Instructor: NAVEEN KUMAR/TAPAS SIL
Duration: 1 hour 30 minutes | Max. Marks: 25

Instructions to students (if any):
- All questions are mandatory
- Students can use scientific calculators but these cannot be exchanged

1. A mass (m) of 4 kg is governed by a spring factor (K) 16 N/m and a dissipative factor (b) 2 N-s/m velocity. If the initial conditions are displacement (x at time (t = 0)) = 0 and velocity (v at time (t = 0 s)) = 2m/s. The equation of motion of the damped oscillator is given as $\frac{d^2x}{dt^2} + \frac{b}{m}\frac{dx}{dt} + Kx = 0$

   Determine the total number of vibrations made before amplitude falls to 1/e value. (2)

2. An object executing a damped oscillation with a frequency of $1Hz$ and its amplitude is halved in $5s$. Write down the equation of motion of the object? (3)

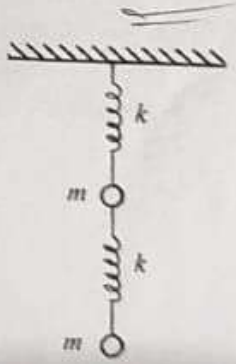
3. A simple spring mass (m) oscillator having natural frequency (ω_0), oscillates under an external force F $\sin(\omega t)$ such that its displacement is expressed below.

$$x = \frac{F/m}{\sqrt{[(\omega_0^2 - \omega^2) + b^2\omega^2/m^2]}}\sin(\omega t - \varphi)$$

Here b is a dissipative factor velocity and K is the spring constant such that $\omega_0^2 = \sqrt{\frac{K}{m}}$

Determine the expression for velocity amplitude for the two cases (i) when external force frequency $\omega \ll \omega_0$ and (ii) when $\omega_0 \ll \omega$. (4)

4. Two equal masses (m) are connected with two identical massless springs of spring constant k as shown in figure. Find out the normal modes of frequencies (angular) for vertical oscillation. (3)



5. Does the function describe a wave? (3)

$\psi(x,t) = \exp[(-4ax^2 - bt^2 + 4\sqrt{ab}xt)]$, Where a and b are constants

6. A plane electromagnetic wave with free space wavelength 600 nm incidents on a metal with refractive index n = 2+ 3i, such that it travels through the metal in z direction. Estimate the distance through which it travels in the metal before it dies. (2)

7. Write down two conditions for obtaining good interference between the two waves. (1)

8. Three waves having spherical, cylindrical and plane phase fronts started at origin with same amplitude and frequency. Write down the mathematical expression for each wave which governs how these propagate through a loss less medium of refractive index n. On the basis of mathematical expression, draw the figure, showing the qualitative change in amplitude of the waves as these propagate. (4)

9. The phase velocity of a surface wave on a liquid of density ρ and surface tension σ is given by, $v_p = \sqrt{\left(\frac{g\lambda}{2\pi}\right) + \frac{2\pi\sigma}{\lambda\rho}}$ where λ is the wave length of the wave and g is the acceleration due to gravity. Find the group velocity (v_g), Also find the λ - value for maximum v_p. (3)