1. Attempt any **five** questions.

(a) The displacement y of a particle executing periodic motion is given by,

$$y = 4\cos^2\left(\frac{1}{2}t\right)\sin(1000\,t)$$

Show that this expression may be a result of the superposition of three independent harmonic motions.

(b) Explain the conditions for obtaining a straight line as a Lissajous figure on an oscilloscope.

(c) A particle of mass 3 moves along the axis attracted toward origin by a force whose magnitude is numerically equal to 12x. The particle is also subjected to a damping force whose magnitude is numerically equal to 12 times the instantaneous speed. If it is initially at rest at x = 10, find the position and the velocity of the particle at any time.

(d) Explain qualitatively the normal coordinates and normal modes of a coupled oscillatory system.

(e) Distinguish between stationary and progressive waves.

(f) Find the quality factor Q for the damped oscillations of an object with a frequency of 1 Hz, and whose amplitude of vibration gets halved in 5 s.

2. (a) A uniform spring of spring constant K and a finite mass 'ms' is loaded with a mass 'M'. If 'ms' is not negligible compared to 'M', show that the period of oscillations of mass spring system is,

$$T = 2\pi\sqrt{\frac{M+\frac{m_s}{3}}{K}}.$$

(b) Two vibrations at right angles to each other are described by the equations x = 10 cos(5πt), y = 10 cos(10πt-π/4). Draw graphically the Lissajous figure of the resulting motion. (10,5)

3. (a) Two collinear simple harmonic motions of nearly equal frequencies and different amplitude are superimposed on each other. Find out resultant equation and explain the formation of beats.

(b) An alternating emf of peak-to-peak value 40 volts is applied across the series combination of an inductor of inductance 100 mH, capacitor of capacitance 1pf and resistance 100 Ω. Determine resonance frequency, quality factor and bandwidth. (10,5)

4. (a) Show that for a forced and damped harmonic oscillator in steady state, the average power is equal to the average power dissipated by system.

(b) Two identical masses of mass 'M' are connected with three identical springs of same spring constant 'K' and placed on a smooth surface as shown in Fig. 1. Find out the normal mode frequencies and corresponding configuration/shapes. (10,5)

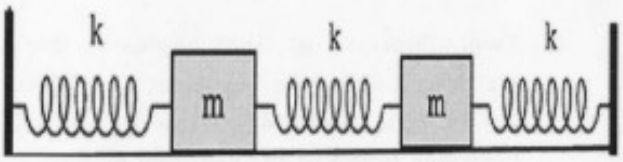

Fig. 1

5. (a) Find the expression for the normal mode of vibration and displacement for a string fixed at both the ends having tension T and mass per unit length μ.

(b) A string of length l = 0.5 m and mass per unit length 0.01 kg/m has a fundamental frequency of 250 Hz. What is the tension in the string? (10,5)