VIBRATIONS AND WAVES - I
Paper - A, Semester – II

Time Allowed : Three Hours] **[Maximum Marks : 70**

Note : (1) Candidates are required to attempt *two* questions each from Section A and B. Section C is compulsory. All questions carry equal marks.
(2) Use of non programmable calculator is allowed.

Section : A

1. What is a compound pendulum ? Derive an expression for its time period. What is the condition for time period to be minimum ? 8

2. (a) Disucss the composition of two SHMs perpendicular to each other periods are in the ratio 1 : 2. 5
   (b) The displacement of a simple harmonic oscillator is given by $x = a \sin(\omega t + \phi)$ if the oscillator started at time $t = 0$ from a position x and with a velocity v_0 show that : $\tan\phi = \frac{\omega x_0}{v_0}$ and $a = \sqrt{x_0^2 + \frac{v_0^2}{\omega^2}}$. 3

3. (a) Prove that the average kinetic energy of harmonic oscillator is equal to its average potential energy and each to half the total energy. 5
   (b) A particle of mass 1m moved in a potential energy will be given by $u = 2x^2 + 4x = 4$. Find :
   (i) the force constant (ii) the frequency of oscillation. 3

4. (a) Define logarithmic decrement of a damped oscillator. Deduce the expression for it. 4
   (b) Show that the ratio of the energy lost per cycle to the energy stored in a damped oscillator is $2\pi\backslash Q$, where Q is he quality factor. 4

Section : B

5. Write down the equation of motion of forced oscillator being driven by an alternating force $F = F_0 \cos \omega t$. Explain the transient and steady state behaviour of forced oscillator. 8

6. (a) Derive an expression for the average power supplied by the driving force and the average power dissipated by the damping force or a forced oscillator. Show that they are equal. 5
   (b) Find the frequency of a circuit containing inductance of 5×10^{-2} H and a capacitance of 5×10^{-10} F. Find the wavelength of the radio wave to which it will respond. 3

7. (a) Show that in the resonant LCR circuit, the maximum potential drop across an inductor occurs at a frequency: $\frac{\omega_0}{\sqrt{\left(1 - \frac{1}{2Q^2}\right)}}$
   (b) Show that the band width of the resonance absorption curve defines the phase angle $\tan\phi = \pm 1$. 3

8. (a) What is sharpness of Resonance curve ? Explain the effect of damping on sharpness of resonance.
   (b) A r.m.s. voltage of 200 volts is applied to a series LCR circuit, having R = 100 ohm, L = 10 mH and C = 1μF. Calculate :
   (i) the natural frequency (ii) current resonance
   (iii) Q-value of the circuit at resonance. 3

Section : C

9. Write a brief not on the following :

(i) Expain how the interaction of inertia and elasticity produces SHM.
(ii) Distinguish between free and forced oscillations.
(iii) What is the physical signifiance of the mechanical impedance of forced oscillator ?
(iv) What is absorption resoance curve ? Define absorption band width.
(v) Is energy stored in forced oscillator ? Explain.
(vi) Are all periodic motion simple harmonic ? Is the reversae true ?
(vii) Define quality factor of a damped oscillator.
(viii) Examine whether the discharge of capacitor of 1 μF is oscillatory or not ? 1×8=8