PHYSICS PAPER–B

(Vibrations, Waves and E.M. Theory-I)

Time : 3 Hours **Max. Marks : 22**

Note : Attempt *five* questions in all, selecting *two* questions from each of the Unit-I and II. Unit-III is compulsory. Use of nonprogrammable scientific calculator is allowed. Logarithmic tables may be asked for, if needed.

Unit–I

1. (a) What is simple harmonic oscillator ? Obtain its differential equation from the expression of its total energy and discuss general solution of the equation. 2½

(b) A particle of mass 0.1 kg is executing SHM. Its P. E. as a function of the displacement at any instant is given by $V = V_0 + 2y + 3y^2$ where V_0 is a constant and y is in meters. Find the position of stable equilibrium, the stiffness of the spring and the frequency of oscillations. 1½

2. (a) Explain analytically how two simple harmonic vibrations at right angles to each other and having same time periods acting simultaneously on a particle can be compounded ? 2½

(b) Show that centre of suspension and centre of oscillation are interchangeable in a compound pendulum. 1½

3. (a) Define logarithmic decrement. Derive a relation for it in case of an electrical oscillator. 2½

(b) The smaller the damping, larger will be the relaxation time and greater the quality factor. Is it so ? Explain. 1½

Unit–II

4. (a) Find Q-factor of an oscillator in terms of reasonance absorption band width. 2½

(b) Show that the band width of resonance absorption curve defines the phase angle range $\tan \phi = \pm 1$. 1½

5. (a) Show that an steady state, the amplitude and phase of driven oscillator adjust themselves such that the average power supplied by the driving force is just equal to that being dissipated against frictional force. 2

(b) Deduce natural undamped frequency and value of quality factor of LCR circuit with $L = 2$ mh, $C = 5\ \mu F$ and $R = 0.2\ \Omega$. 2

6. (a) What is a forced electrical oscillator ? Discuss variation of current amplitude with driving emf frequency in it.

(b) Show that in a resonant LCR circuit, the maximum potential drop across the inductor is equal to Q times the applied emf.

Unit–III

7. Attempt any *six* parts :

(a) What determines the number of modes of a system of coupled oscillators ?

(b) Differentiate between free and forced vibrations.

(c) Show that for a pure LC circuit, quality factor is infinite.

(d) State the condition under which a damped oscillator is overdamped.

(e) What is theoretical limit of time in which amplitude of lightly damped oscillator decays to zero ?

(f) When coupling of oscillators is said to be loose or tight ?

(g) When does driving agency delivers maximum power to the driven oscillator ?

$1 \times 6 = 6$