

PHYSICS PAPER-B

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

Time Allowed : Three Hours]

[Maximum Marks : 22

- Note :**
- (1) Attempt five questions in all, selecting two questions each from of Unit I and Unit II.
 - (2) Unit III is compulsory.
 - (3) Use of non-programmable scientific calculator is allowed.

Unit-I

1. (a) Show that the total energy of a body executing S.H.M. is directly proportional to the square of the frequency.
(b) If $x = a \cos \omega t + b \sin \omega t$, show that it represents S.H.M. Also find the amplitude of S.H.M. 3, 1½
2. What are damped vibrations ? Derive expression for displacement in case of damped oscillatory motion. Discuss the case of critical damping. 4½
3. (a) What is meant by logarithmic decrement and quality factor of a damped Simple Harmonic oscillator ? Deduce their expressions.
(b) What is the effect of damping on the natural frequency of an oscillator? 3, 1½

Unit-II

4. (a) Drive expression for the velocity of a forced oscillator. Discuss the variation of velocity amplitude with driving force frequency and show its behaviour graphically.

- (b) Show that the maximum displacement amplitude of a forced oscillator having damping constant r and driven by the force $F = F_0 \cos \omega t$ is given by :

$$A_{\max} = \frac{F_0}{\omega' r} \text{ where } \omega' = \sqrt{\frac{s}{m} - \frac{r^2}{4m^2}} \quad 3, 1\frac{1}{2}$$

5. (a) Find expression for the quality factor of a forced oscillator in terms of resonance absorption band width.
- (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 radiowaves to which it will respond. 3, 1½
6. (a) Explain the transfer of energy between two electrical circuits which are inductively coupled. When the coupling is loose or tight ?
- (b) Define normal mode, normal co-ordinates and degrees of freedom of an oscillatory system. 3, 1½

UNIT-III

7. Attempt any six parts :
- (a) The marching troops are asked to break their steps while crossing the bridge. Why ?
- (b) What are forced oscillations ?
- (c) What is stiffness controlled forced oscillator ?
- (d) What are units of damping constant ?
- (e) A mass of 1 kg is attached to a spring of stiffness constant 16 Nm^{-2} . Find its natural frequency.
- (f) What is mechanical impedance of a forced oscillator ?
- (g) What do you mean by inductive coupling ? 4