

VIBRATIONS, WAVES AND E.M. THEORY – B

Time Allowed : Three Hours

[Maximum Marks : 75

Note : Attempt *five* questions in all, selecting *one* from each of the Sections A, B, C and D. Section E is compulsory, attempt any *five* parts from it. Use of Non-Programmable calculator is allowed.

Section : A

1. (a) Prove that in case of damped simple harmonic oscillator, the total energy decreases exponentially. 10

- (b) Derive the differential equation for S.H.M. 5
2. (a) What is a compound pendulum? Derive an expression for its time period. 10
 (b) Discuss how inertia and elasticity account for S.H.M. 5
- Section : B**
3. What is forced oscillator? Derive its equation for electrical oscillator and describe its transient and steady state response. 15
4. (a) Find the Q-value of forced oscillator as an amplification factor. 10
 (b) What is the physical significance of the mechanical impedance of forced oscillator? 5
- Section : C**
5. What are normal coordinates, modes and frequencies? Derive the solution of differential equations for normal modes. 15
6. What do you mean by stationary of standing waves in string? Give Mathematical analysis of the formation of stationary waves. 15
- Section : D**
7. What is pointing vector and derive EM wave pointing theorem and equation of continuity. 15
8. Derive electromagnetic wave equation in a medium having finite permeability, permittivity; also discuss the skin depth. 15
- Section : E**
9. Write brief notes on the following terms :
 (a) What is damping? On what factor it depends? (b) Compare undamped and damped oscillations.
 (c) Is energy stored in forced oscillator? (d) Explain the meaning of coupled oscillator.
 (e) Differentiate between in phase and out of phase mode of vibrations.
 (f) Electromagnetic wave in an empty space has a maximum electric field of 1000 Vm^{-1} . What is the maximum value of magnetic field in this space?
 (g) Calculate the pointing vector from a 100 watt lamp at a distance of one meter from it.
 (h) Derive the frequency and quality factor of LCR circuit with $L = 2 \text{ mH}$, $C = 5 \mu\text{F}$ and $R = 02 \text{ ohm}$. $5 \times 3 = 15$