

## VIBRATIONS, WAVES AND E.M. THEORY - B

(Re-appear April - 2012)

Time : Three Hours]

[Maximum Marks : 75

Note : Attempt *one* question each from Section A, B, C and D carrying 15 marks each, and *five* questions from Section E consisting of *eight* short answer type questions carrying 3 marks each.

### SECTION : A

- Derive an expression for the total energy of a harmonic oscillator. Show that it is constant and proportional to the square of amplitude. 5
  - Find quality factor of LCR circuit with  $L = 2 \text{ mH}$ ,  $C = 5 \text{ } \mu\text{F}$  and  $R = 0.2 \text{ ohm}$ . 5
  - Derive time period for a Torsional pendulum. 5
- What is meant by Logarithmic decrement and Quality factor of a damped electrical oscillator? 8
  - Show that the fractional changes in frequency of a damped oscillator is  $\frac{1}{8Q^2}$ , where  $Q$  is the quality factor. 7

### Section : B

- Distinguish between Transient and Steady state in an electrical forced oscillator. 10
  - What is Sharpness of Resonance? Explain the effect of damping on sharpness of resonance. 10
- Show that average power supplied by external periodic force is equal to average power dissipated by a forced oscillator. 10

- (b) Prove that the bandwidth of Resonance absorption curve defines the angle range  $\tan \phi = \pm 1$ . 5

**Section : C**

5. (a) Explain transfer of energy between two resistance-free electric circuit which are inductively coupled. When is the coupling loose or tight? 10  
(b) The angular vibrational frequency of HCl molecule is  $0.6 \times 10^5 \text{ sec}^{-1}$ . Calculate amount of work required for stretching it by  $0.5 \text{ \AA}$  from mean position. 5
6. (a) Show that all energy arriving at the boundary in the incident wave leaves the boundary in the reflected and transmitted wave. Define Reflection and Transmission coefficient of energy. 10  
(b) The e.m. waves in an empty space has a maximum electric field of  $1000 \text{ V/m}$ . What is the maximum value of magnetic field? 5

**Section : D**

7. (a) State and derive Poynting theorem. 8  
(b) Define the characteristic impedance of a dielectric its value. 7
8. (a) What is Skin depth? Prove that it is inversely proportional to square root of frequency and conductivity. 8  
(b) Show mathematically that nature of e.m. waves is transverse. 7

**Section : E**

9. Attempt any five parts of the following in short :
- (a) What are the dimensions of stiffness constant and damping constant? 3  
(b) What are Waves packets? 3  
(c) Good conductors are good reflectors. Comment. 3  
(d) Light is mostly characterized by electric field vectors even through it has a magnetic field vector also. Why? 3
- (e) Show that in a conductor the displacement current leads the conduction current by  $\frac{\pi}{2}$ . 5  
(f) Differentiate between In phase and Out of phase mode of vibrations. 3  
(g) Give characteristics of e.m. waves. 3  
(h) What is meant by mechanical impedance of a forced oscillator? 5

5×3=15