Mechanical

Exam. Code: 0906
Sub. Code: 6242

2054

B.E., Second Semester

ASP-X01: Applied Physics

(Common with EEE, BIO, ECE, CIVIL, MECH)

Time allowed: 3 Hours

Max. Marks: 50

NOTE: *Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Part.*

x-x-x

Question 1 : Attempt any 5 questions 2×5 = 10

(a) A body of mass 2 kg suspended through a vertical spring executes simple harmonic motion of period 6 s. If the oscillations are stopped and the body hangs in equilibrium, find the potential energy stored in the spring. Use g = 10 ms^{-2}.

(b) Discuss, graphically as well, the variation of electrostatic and total energy as a function time and the charge across capacitor for a SHM in ideal LC circuit.

(c) Two externally driven electrical system have quality factors 100 and 500 respectively. What will the ratio of the increase in the charge amplitude as frequency increases from zero to resonance frequency?

(d) Using Wave equation and the Maxwell's equations, prove that electromagnetic waves are of transverse nature.

(e) What is the difference between normal excited state and a metastable state? Explain the importance of metastable state in lasing action.

(f) For a Laurent's half shade device, explain the rationale of choosing a particular thickness for the quartz and glass side.

(g) If the radius of core is doubled, what will the effect on number of possible transmission modes?

Part A

Question 2

(a) For an LCR damped system, write down the equation of motion for under-damping and discuss (graphically) its behaviour. Define and derive the logarithmic decrement and quality factor for this system. 6

(b) A damped harmonic oscillator consists of a block (m = 2 kg), a spring (k = 30 N/m), and a damping force (F = -bv). Initially, it oscillates with an amplitude of 25 cm; because of the damping, the amplitude falls to three-fourths of this initial value at the completion of four oscillations. (a) What is the value of b? (b) How much energy has been "lost" during these four oscillations? 4

Question 3

(a) For an externally driven horizontal mass-spring system, derive formulation for the displacement and discuss variation of its amplitude with the frequency of the external force. 6

(b) For an externally driven LCR circuit, define bandwidth using the power absorption curve and derive its formulation in terms of value of the circuit components. 4

Question 4

(a) Write down the Ampere's law in differential form and discuss its inconsistency for a system with varying current density. How this issue was resolved by Maxwell? Discuss physical significance of the term introduced by Maxwell in the context of the electromagnetic waves. 6

(b) A plane monochromatic electromagnetic wave travels from one medium (refractive index = 1.1) to another (refractive index = 2.2) with electric field oscillating within the plane of incidence. What will be the reflection and transmission coefficients for the system if incident wave makes an angle 60 degrees with the normal to the interface? 4

P.T.O.

Part B

Question 5

(a) Derive the relation between the rate of spontaneous and stimulated emission in terms of the system temperature and the energy gap between the transitions levels. 3

(b) Describe construction and working of a He-Ne laser with emphasis on its active medium, pumping and transition processes involved. 4

(c) What do you understand by threshold condition in the lasing action? What is its dependence on the lifetime of the upper level and the cavity lifetime? 3

Question 6

(a) What do you understand by Optical Activity? Explain the Fresnel's theory used to describe the phenomena of Optical Activity. 4

(b) What are the polaroids? Explain the working principle of polaroids. Give its important application. 3

(c) A lab is equipped with a light source (wavelength = 600 nm) of elliptically polarized light but experimental work is required to have linearly polarized light. One of the students decided to make use of a phase retardation plate (refractive index of E-rays = 1.489 and refractive Index of O-rays = 1.567). What should be the thickness of the phase retardation plate? 3

Question 7

(a) Define numerical aperture and derive its formulation in terms of the refractive indices of core and cladding. Give its physical significance as well. 4

(b) Let's consider laser, with power 1 mW, entering an optical fiber link of length 40 km and attenuation coefficient 0.5 dB/km. In the optical fiber link there are 2 connectors and 4 splice with losses $l_s = 0.5$ dB/splice and $l_c = 1$ dB/connector. Calculate the power received at the output of the link. 3

(c) A fiber link of 40 km (with loss of 0.4 dB/km) have three connectors in its path. Each connector have loss of 1.8 dB. What will be total loss in the fiber link? 3

x-x-x