Exam.Code:0905
Sub. Code: 6640

2071

B.E. (Bio-Technology) First Semester

Paper-ASPX01: Applied Physics

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 Section. .*

*x-x-x*

Question 1: Attempt any five of the following:- (5x2)

a) 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?

b) Calculate the maximum current in harmonic oscillator consisting of inductance and capacitance when maximum voltage across the capacitor is 0.1 V. The value of the inductance of 0.2 mH and capacitance if 5 μF.

c) What do you understand by equation of motion? Derive differential equation for a mass attached with spring vertically.

d) If 'F' is an irrotational field, show that its line integral is independent of the path between two given points.

e) In the Nicol Prism construction, one of the parallelogram angles is reduced 68 degrees. Explain its importance!

f) Discuss various types of scatterings contributing to the attenuation of the signal propagating through an optical fiber.

g) Explain the mechanism of pumping in a semiconductor laser.

## Section A

**Question 2**

a) Two students were assigned to design an electrical circuit (with L = 30 mH and C = 0.01 μF) with ideal oscillatory motion. One of the students forgot to investigate internal resistance of inductor carefully and choose one with an internal resistance of 100 ohms. What will be the fractional difference in the frequency of oscillations of the circuits designed by two students? 4

b) Write down differential and linear equation of motion for damped motion in horizontal mass spring system with system parameters as spring constant (k) = 30 N/m, mass (m) = 500 g, and resistive component (r) = 75 g/s. Evaluate if the system will be oscillator or not? What will be limiting value of 'r' for the system to be oscillatory? 6

**Question 3**

a) In a mechanical forced oscillator, define and derive the quality factor in terms of the energy stored and dissipated in the system. What will be the value of quality factor at frequency equals to i) natural frequency and ii) double of the natural frequency? 6

b) An electrical series LCR circuit is driven by an external voltage source of constant frequency. Explain how resonance can be achieved by varying inductance. Derive the formulation of the inductance for which voltage across inductor is maximum. 4

**Question 4**

a) Write down the formulation for the reflection and transmission amplitude for the oblique incidence of an electromagnetic wave having E-field oscillations in the plane of incidence. Derive formula for the angle of incidence at which wave will be full transmitted. Discuss its importance in the polarization 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° with the normal to the interface.? 4

## Section B

**Question 5**

a) Explain the construction and working of a Nicol Prism to obtain plane polarized light. Explain the difficulty if Nicol Prism is constructed with the quartz crystals. 4

b) A lab is equipped with a light source (wavelength = 500 nm) of circularly polarized light but an experimental work required to have linearly polarized light. One of the students decided to make use of phase retardation plate (refractive index of E-rays = 1.533 and refractive Index of O-rays= 1.544). What should be thickness of the phase retardation plate? 3

c) What are the polaroids? Explain the working principle of polaroids. Discuss its important applications. 3

P.T.O.

**Question 6**

a) 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 splices with losses 0.5 dB/splice and 1 dB/connector. Calculate the power received at the output of the link. 3

b) Define and formulate the attenuation limit? Discuss its dependence on the refractive index of the core/cladding, wavelength and the spectral width of the incident wave. 3

c) What do you understand by intermodal dispersion. Derive its formulation in terms of the numerical aperture. How does graded indexed fiber reduces intermodal dispersion. 4

**Question 7**

a) Discuss the active medium, pumping and resonator in the He-Ne laser. Explain the various transitions using appropriately labelled energy-level diagram. 4

b) How does a resonator help in an amplified and coherent laser output? Explain it with appropriate diagram. 3

c) Explain the metastable state and the population inversion for a laser. Discuss their importance in lasing action. 3

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