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# 008101

March 2023

B.TECH. - I SEMESTER

Physics (Waves and Optics) (BSC-101C)

Time : 3 Hours]

[Max. Marks : 75

*Instructions :*

1. *It is compulsory to answer the questions of Part-A. Limit your answers within 20-40 words in this part.*
2. *Answer any four questions from Part-B in detail.*
3. *Different parts of the same question are to be attempted adjacent to each other.*
4. *Boltzmann's constant* $k = 1.38 \times 10^{-23}$ *J/K.*

## PART-A

1. (a) A damped vibrating system starting from rest has initial amplitude of 20 cm which reduces to 2 cm after 100 complete oscillations each of period 2.3 second. Find the logarithmic decrement of the system. (1.5)

(b) Explain energy decay time and write it in terms of amplitude decay time. (1.5)

(c) What is Brewster's effect? (1.5)

(d) A thin film of material whose refractive index is 1.45 is introduced in one of the arms of Michelson Interferometer. It causes a shift of 6.5 fringes. If the wavelength of light used is 5890 Å, calculate the thickness of the film. (1.5)

(e) Find the intensity of a laser beam of 100 mW power and having a diameter of 1.3 m assuming the intensity to be uniform. (1.5)

(f) Using Fermat's principle, prove the laws of refraction. (1.5)

(g) Define nodes and antinodes. (1.5)

(h) What is an evanescent wave? (1.5)

(i) The ratio of population of two energy levels out which upper one corresponds to a metastable state is $1.059 \times 10^{-30}$. Find the wavelength of light emitted at 330 K. (1.5)

(j) What is the difference between an ordinary image and a hologram? (1.5)

## PART-B

2. (a) With the help of a neat diagram, show an experimental arrangement to produce Newton's rings by reflected sodium light. Prove that in reflected light, the diameter of dark rings is proportional to square root of natural numbers. (5)

(b) A diffraction grating is just able to resolve two lines of wavelengths 5500 Å and 5501 Å in the first order. Will it resolve the lines of wavelength 8500 Å and 8501 Å in the second order? (5)

(c) Give the construction and theory of a Plane diffraction grating and explain the formation of spectra by it. (5)

3. (a) Explain the reflection and transmission of transverse waves at a boundary. (8)

(b) What is a driven harmonic oscillator? Set up a differential equation of motion for such an oscillator. Discuss the condition of resonance. (7)

4. (a) What are Fresnel's Equations? Derive them for plane polarized light in a non-magnetic media. (8)

(b) Explain the terms (i) stimulated emission of radiation (ii) pumping. Explain how laser can be produced by He-Ne gas. How is it superior to Ruby laser? (7)

5. (a) What is Impedance matching and why is it required? If two strings of characteristic impedances $Z_1$ and $Z_3$ need to be joined through another string of impedance $Z_2$ for minimum loss, prove that $Z_2 = \sqrt{Z_1 Z_3}$. (10)

(b) Find the ray transfer matrix for refraction at a spherical boundary. (5)

6. (a) Derive the expression for velocity of transverse waves along a stretched string. (5)

(b) What is a mirage? Explain its formation on a hot summer day. Is this mirage a superior mirage or an inferior mirage? (5)

(c) An LCR series combination has R = 10 ohms, L = 1 mH and C = 2 μF. Determine the resonant frequency and the current in the circuit when an alternating voltage of 10 mV operating at resonant frequency is applied to the circuit. (5)

7. Write short notes : (5×3)

(a) Energy of a weakly damped oscillator.

(b) Mach Zehnder Interferometer.

(c) Characteristics of lasers.

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