Code : 103201

B.Tech 2nd Semester Exam., 2021

(New Course)

PHYSICS

(Waves and Optics and Introduction to Quantum Mechanics)

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

(v) Symbols used (if any) have their usual meanings.

1. Answer any *seven* questions : 2×7=14

(a) Define impedance.

(b) Define acoustic waves.

(c) A point source of light is located 20 cm in front of a convex mirror with focal length 15 cm. Determine the position and character of the image point.

(d) Give examples of two solid-state lasers.

(e) Whether the wave function $\psi = A\sec x$, can be a solution of Schrödinger's equation for all values of x or not. State the reason.

(f) Define Fermi level.

(g) Define intrinsic and extrinsic semiconductors.

(h) What are the merits of Huygen's eyepiece?

(i) Green light of wavelength 5100 Å from a narrow slit is incident on a double slit. If the overall separation of 10 fringes on a screen 200 cm away is 2 cm, find the slit separation.

(j) Define wave particle duality.

2. Derive the equation of motion of a damped harmonic oscillator. Discuss cases of heavy and critical damping. 10+4=14

3. Write short notes on the following : 7×2=14

(a) Total internal reflection

(b) Fresnel equations

(Continued)

4. (a) Show that diameter (D_n) of nth dark ring in Newton's ring is related by the relation

$$D_n = 2\sqrt{n\lambda R}$$

where $n = 1, 2, 3, \ldots$; λ = wavelength of the incident light and R = radius of planoconvex lens. 10

(b) In Newton's ring experiment, the diameter of the 15th ring was found to be 0·59 cm and that of the 5th ring was 0·336 cm. If the radius of the planoconvex lens is 100 cm, calculate the wavelength of light used. 4

5. Establish the relation between Einstein's A and B coefficients. By drawing a neat diagram, discuss construction and working of ruby laser. 4+10=14

6. Write short notes on the following : 7×2=14

(a) Carrier concentration and recombination

(b) Scanning tunnelling microscope

7. What is the physical significance of wave function? A particle is moving in one-dimensional box described by

$$V(x) = \begin{cases} 0, & 0 < x < L \\ \infty, & x \le 0 \text{ and } x \ge L \end{cases}$$

Solve Schrödinger's wave equation and obtain eigenfunction for this particle. 2+12=14

(Turn Over)

8. Derive an expression in Kronig-Penney model and with the help of expression obtained, plot energy *versus* wave number of a one-dimensional lattice.

4+10=14

9. Derive an expression of intensity due to doublet-slit Fraunhofer diffraction and discuss the cases of minima and maxima. What do you mean by missing order in double-slit diffraction?

10+4=14

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$\vec{E} = \vec{E}_{02}\, e^{i(\vec{K}\cdot\vec{r} - \omega t)}$