

Roll No. 1510442072

(011/17-I)

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B. Sc. EXAMINATION

(Fifth Semester)

PHYSICS

PH-501

Quantum and Laser Physics

Time : Three Hours Maximum Marks : 40

Note : Attempt Five questions in all the five Sections. Section I Q. No. 1 is compulsory. Attempt any one question out of the two questions set from each of the Sections from Section II to V.

Section I

1. (a) For an X-ray of wavelength 5\AA , the compton wavelength is 0.02\AA . What is compton-shift in the direction 60° to the direction of incidence ? 2

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- (b) Define penetration depth. 2
- (c) Define temporal and spatial coherences in light. 2
- (d) Draw energy level diagram of a He-Ne laser. 2

Section II

2. (a) What do you understand by wave-particle dualism ? Explain double slit and Germer experiment to verify it. 5

(b) An electron has a speed $1.05 \times 10^4 \text{ ms}^{-1}$ within the accuracy of 0.01%. Calculate the uncertainty in the position of the electron. 3

(a) Develop one-dimensional time-independent Schrödinger wave equation for a non-relativistic particle. 5

(b) What will be the de-Broglie wavelength of an electron having kinetic energy of 500 eV ? 3

Section III

4. (a) Write down Schrödinger's wave equation for a free particle in a one-dimensional box. Solve it to get eigen functions and show that the eigen values are discrete. 5
(b) A particle is in motion along a line between $x = 0$ and $x = a$ with zero potential energy and at point $0 \geq x \geq a$ the potential energy is infinity. The wave function for the particle in the n th state is given by :

$$\psi_n = A \sin(n\pi x/a)$$

Find the expression for the normalized wave function. 3

5. (a) What do you understand by tunnelling through a barrier ? A particle travelling with energy E along x -axis has a potential barrier defined as :

$$V(x) = 0 \text{ for } 0 > x > a$$

$$= V_0 \text{ for } 0 > x > a$$

Derive the expression for the Reflection and transmission coefficient of the particle. 5

(b) What is the concept of Boundary condition in Quantum mechanics ? 3

Section IV

6. (a) Discuss in detail the concepts of directionality, monochromaticity, intensity and coherence of laser. 4

(b) Show that frequency spread of a spectral line is of the order of the inverse of the collision time. 4

7. (a) Derive Fuchbauer-Labenburg formula from kinetics of optical absorption to reach the saturation of the medium for lasing action. 4

(b) Explain laser pumping. Why is it used for ? Discuss various methods used for laser pumping. 4

Section V

8. Discuss with suitable diagram the principle, construction and working of a He-Ne laser. 8
9. (a) Discuss the main features and conditions of lasing action of a semiconductor laser. 4
(b) How laser find applications in the fields of industries and medicines ? 4

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