Parul Institute of Engineering and Technology
Parul University
Engineering Physics (303192102)
B.Tech. Semester 2
Assignment 1

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UNIT 4

A. Choose the correct options:

1. Who proposed the concept of stimulated emission, a fundamental principle behind the lasing process?
   (a) Max Planck
   (b)Werner Heisenberg
   (c) Albert Einstein
   (d) de Broglie
2. In the lasing action, the spontaneous emission depends on
   (a) the number of atoms in the excited state
   (b) the intensity of incident light
   (c) both
   (d) the number of atoms in the ground state
3. In a Ruby laser, the activator atom is
   (a) Aluminium
   (b) Oxygen
   (c) Chromium
   (d) Carbon
4. In He: Ne gas laser, the ratio of mixture of Ne gases and He gases is
   (a) 1:1
   (b) 10:1
   (c) 1:10
   (d) 2:1
5. What is the primary semiconductor material used in a semiconductor laser?
   (a) Silicon
   (b) Germanium
   (c) Copper indium gallium selenide (CIGS)
   (d) Gallium Arsenide (GaAs)
6. In a gain medium of a lasing system, only a small fraction of atoms are responsible for light amplification. They are known as:
   (a) Host medium
   (b) Active centres
   (c) Pumping sources

(d) None

7. Which among the following is a pulsed laser?
   (a) He-Ne laser
   (b) Ruby laser
   (c) Both of these lasers
   (d) None of these lasers

9. In the population inversion
   (a) the number of electrons in higher energy state is more than the ground state
   (b) the number of electrons in lower energy state is more than higher energy state
   (c) the number of electrons in higher and lower energy state are same
   (d) none of them

10. In a step index fibre, the refractive index of core
   (a) Changes suddenly at the core-cladding interface
   (b) Changes gradually throughout the core surface
   (c) And cladding remains same
   (d) None of the above

11. Which of the following statement is correct?
   (a) Optical fibres can bend light by diffraction
   (b) Optical fibres cannot bend light
   (c) Optical fibres follow stimulated emission of radiation
   (d) Optical fibres bend the light beam using the principle of total internal reflection

12. In an optical fibre, the intensity of light
   (a) Attenuates linearly with the length of the fibre
   (b) Attenuates exponentially with the length of the fibre
   (c) Attenuates logarithmically with the length of the fibre
   (d) Do not undergo any kind of attenuation

13. When an optical fibre is immersed in water then
   (a) Both θ_A and NA changes
   (b) Both θ_A and NA remains same
   (c) θ_A changes but NA remains same
   (d) NA changes but θ_A remains same

14. The unit of measurement of attenuation in fibre optics is
   (a) dB
   (b) dB/km
   (c) km/dB
   (d) km

15. Which parameter is related to the numerical aperture of an optical fibre?
   (a) Core diameter
   (b) Cladding thickness
   (c) Refractive index of the core and cladding
   (d) Critical angle

16. The maximum angle of incidence at the entrance aperture of the fibre for which the light ray is totally reflected at the core-cladding interface is called
    (a) Critical angle
    (b) Acceptance angle
    (c) Refracted angle
    (d) Reflected angle

B. <u>Answer all the questions:</u>

1. What are the differences between an ordinary and LASER light?
2. Mention 3 important requirements for lasing action.
3. State two conditions needed for confining light within the fibre.
4. Discuss the components of a laser device. What is the significance of an optical resonator in a lasing system?
5. Write four advantages of fibre optics over traditional metal communication lines.
6. Write short notes on:
   a) Population inversion
   b) Metastable states
   c) Coherence length
   d) Stimulated emission
7. Deduce the relation between Einstein's A and B coefficients. State the physical significance of the relations.
8. Explain the construction and working of Ruby Laser with necessary diagrams.
9. a) Explain the working principle of the He-Ne laser with a neat diagram showing its construction and energy level diagrams.
   b) What are the advantages of the He-Ne laser?
10. What is an optical fibre? Discuss the structure/construction of an optical fibre with a suitable diagram.
11. Elucidate total internal reflection and determine the value of the critical angle in terms of refractive indices of two different media. Classify optical fibres based on the modes of propagation and refractive index.
12. (a) Define the numerical aperture and acceptance cone of an optical fibre.
    (b) Deduce the expression of the numerical aperture of an optical fibre.
    (c) Write two significant applications of optical fibres in the present world.
13. The wavelength of emission is 6000 Å and the coefficient of spontaneous emission is 10^6 m/s. Determine the co-efficient of stimulated emission.
14. Sodium d_1 and d_2 lines have wavelength 5890 Å and 5896 Å. Find the coherence length of the sodium vapour lamp.

15. A step-index fibre has a core of refractive index 1.50 and a cladding of refractive index 1.40. If the fibre is used in a water environment, find its NA and Acceptance angle. The refractive index of water is 1.33.
16. An optical fibre power after propagating through a fibre of 1.5 km length is reduced to 25% of its original value. Compute the fibre loss in dB/km.
17. Calculate the (a) cladding index, (b) critical angle, (c) acceptance angle, (d) numerical aperture of a glass-clad fibre made with core glass of refractive index of 1.5 and cladding is doped to give fractional index difference of 0.0005.

UNIT -1

A. Choose the correct options:

1. The energy operator of a moving particle $\hat{E}$ is
   (a) $\hat{E} = i\hbar\frac{\partial}{\partial t}$
   (b) $\hat{E} = \frac{\hbar}{i}\frac{\partial}{\partial t}$
   (c) $\hat{E} = -i\hbar\frac{\partial}{\partial t}$
   (d) $\hat{E} = \hbar^2\frac{\partial}{\partial t}$
2. When the Hamiltonian operator operates on a wave function ψ(r), then the corresponding eigen value is _____
   (a) Potential energy of the system
   (b) Kinetic energy of the system
   (c) Total energy of the system
   (d) None of the above
3. The momentum operator in one dimension (p) is _____
   (a) $\widehat{p_x} = -i\hbar\frac{\partial}{\partial x}$
   (b) $\widehat{p_x} = \frac{\hbar}{i}\frac{\partial}{\partial x}$
   (c) $\widehat{p_x} = -\frac{i}{\hbar}\frac{\partial}{\partial x}$
   (d) $\widehat{p_x} = i\hbar\frac{\partial}{\partial x}$
4. The probability of finding a particle can be given by
   (a) $|\psi|$
   (b) $|\psi|^3$
   (c) $|\psi|^4$
   (d) $|\psi|^2$
5. In a one-dimensional potential box, the potential energy of the particle inside the box is
   (a) Variable
   (b) Undetermined

(c) Zero
(d) Infinite

6. Black-body radiation experimental observations can be explained by the Rayleigh-Jeans formula only for
   (a) Higher Temperature
   (b) Longer wavelength
   (c) High energy
   (d) Shorter wavelength
7. Compton shift depends on which of the following?
   (a) Angle of scattering
   (b) Material type
   (c) Intensity of incident light
   (d) None of the above
8. The intensity of a Black body radiation is not uniform with wavelength.
   (a) True
   (b) False
   (c) Cannot be predicted
   (d) None of the above
9. The Electron microscopes are related to
   (a) Radio waves
   (b) Matter waves
   (c) Electric field
   (d) Electromagnetic waves
10. The Einstein's photoelectric equation is $h\nu = Z + h\nu_0$. Here Z represents the _____. (h is Planck's constant, ν is the frequency of incident radiation, ν_0 is threshold frequency)
    (a) The velocity of ejected electrons
    (b) The intensity of incident light
    (c) The kinetic energy of ejected electrons
    (d) None of the above

B. <u>Answer all the questions:</u>

1. State De Broglie's hypothesis.
2. Define the Photoelectric effect.
3. Define quantum tunneling.
4. Define wave function and its physical significance in brief. What are the conditions for a well-behaved wave function?
5. Explain the Compton Effect in brief.
6. Derive time-dependent Schrodinger's wave equation.
7. Derive the energy and wave function formula for a free particle trapped in a one-dimensional box of width a.

8. Calculate the de-Broglie wavelength associated with an electron of energy 1.5 eV.
9. Calculate the velocity of the ejected photoelectron for the incident photon energy of 5 eV. The threshold energy for the photosensitive metal is given by 3.2 eV.
10. X-rays of the wavelength 0.75Å are scattered from a target at an angle of 45º. Calculate the wavelength of scattered X-rays.
11. An electron is bound in one-dimensional potential well of the width 0.18nm. Find the energy value in eV of the second excited state. Given m = 9.1×10^{-31} kg, h=6.626×10^{-34} J.s
12. Calculate the three lowest energy levels (in eV) for an electron inside a one-dimensional infinite potential well of width 2 Å. Also, determine the corresponding normalized eigenfunctions. Given m = 9.1×10^{-31} kg, h=6.626×10^{-34} J.s
13. Find the probability that a particle in a one-dimensional box of length L can be found between 0.40 L and 0.60 L for the ground state.