Mod-1: LASER

Q1: What does LASER stand for?

A. Light Amplification by Stimulated Emission of Radiation (Correct)

B. Light Amplification by Spontaneous Emission of Rays

C. Light Absorption by Stimulated Energy of Radiation

D. Light Absorption by Spontaneous Energy Rays

Q2: Which of the following is a characteristic of laser light?

A. It is incoherent.

B. It is monochromatic. (Correct)

C. It diverges quickly.

D. It consists of multiple wavelengths.

Q3: What is the role of a metastable state in laser action?

A. It prevents light amplification.

B. It helps achieve population inversion. (Correct)

C. It generates incoherent light.

D. It amplifies sound waves

Q4: What is population inversion?

A. When all electrons are in the ground state.

B. When more electrons are in a higher energy state than a lower one. (Correct)

C. When electrons are equally distributed between energy states.

D. When electrons are destroyed to emit light.

Q5: What is the function of the resonant cavity in a laser?

A. To produce incoherent light.

B. To amplify the sound waves.

C. To trap and reflect photons to amplify light. (Correct)

D. To convert photons into electrons.

Q6: What is the active medium in a laser?

A. The external pump energy source.

B. The material that generates the laser light. (Correct)

C. The outer casing of the laser.

D. The power supply for the laser.

Q7: Which of the following is NOT an application of lasers?

A. LiDAR

B. Barcode Scanners

C. Spectroscopy

D. Generating X-rays (Correct)

Q8: In a helium-neon laser, which gases are used?

A. Helium and Argon

B. Neon and Oxygen

C. Helium and Neon (Correct)

D. Argon and Krypton

Q9: What is coherence in a laser beam?

A. Light waves having the same speed.

B. Light waves being in phase with each other. (Correct)

C. Light waves having different wavelengths.

D. Light waves being perpendicular to each other.

Q10: Which mechanism is responsible for light amplification in a laser?

A. Spontaneous emission

B. Stimulated emission (Correct)

C. Diffraction

D. Refraction

Mod-2: Fibre Optics

Q1: What is the principle behind the operation of optical fibers?

A. Diffraction

B. Total Internal Reflection (Correct)

C. Refraction

D. Dispersion

Q2: What is the critical angle in an optical fiber?

A. The angle of incidence equal to the angle of refraction

B. The angle of incidence at which total internal reflection occurs (Correct)

C. The angle of refraction for maximum light transmission

D. The angle at which light exits the fiber

Q3: What is the acceptance angle in an optical fiber?

A. The angle at which light enters the fiber without escaping (Correct)

B. The angle for total internal reflection

C. The angle for maximum light dispersion

D. The angle at which light is refracted out of the fiber

Q4: What is the purpose of the cladding in an optical fiber?

A. To reflect light into the fiber core (Correct)

B. To allow light to escape

C. To absorb light signals

D. To increase the refractive index

Q5: What is the Numerical Aperture (NA) of an optical fiber?

A. A measure of the fiber's ability to transmit light efficiently

B. The sine of the maximum acceptance angle (Correct)

C. The ratio of core to cladding refractive index

D. The speed of light in the fiber

Q6: Which material is commonly used for the core of optical fibers?

A. Plastic

B. Glass (Correct)

C. Aluminum

D. Copper

Q7: Which type of optical fiber is used for long-distance communication?

A. Step-Index Plastic Fiber

B. Single-Mode Fiber (Correct)

C. Multi-Mode Fiber

D. Gradient-Index Fiber

Q8: What causes light to propagate through the fiber core?

A. Absorption of light

B. Continuous refraction

C. Total internal reflection (Correct)

D. Scattering of light

Attenuation Coefficient

Q9: What is the attenuation coefficient in optical fibers?

A. The ratio of refractive indices of the core and cladding

B. The rate of power loss per unit length of the fiber (Correct)

C. The ability of the fiber to bend light

D. The measure of light dispersion

Q10: Which of the following factors contributes to attenuation in optical fibers?

A. Scattering

B. Absorption

C. Bending losses

D. All of the above (Correct)

Q11: What is Rayleigh scattering in optical fibers?

A. Scattering due to bending of fibers

B. Scattering caused by microscopic variations in material density (Correct)

C. Scattering caused by impurities

D. Scattering due to total internal reflection

Q12: What is the unit of the attenuation coefficient?

A. dB/km (Correct)

B. W/m

C. m/s

D. W/m²

Q13: How can bending losses in optical fibers be minimized?

A. Increasing the core diameter

B. Avoiding sharp bends in the fiber (Correct)

C. Reducing the refractive index

D. Using multi-mode fibers

Q14: What type of absorption occurs due to impurities in the fiber material?

A. Intrinsic absorption

B. Extrinsic absorption (Correct)

C. Thermal absorption

D. Resonance absorption

Q15: What is the approximate range of attenuation for single-mode fibers used in telecommunications?

A. 0.2-0.5 dB/km (Correct)

B. 1-2 dB/km

C. 2-5 dB/km

D. 5-10 dB/km

Mod-3: Interference

Interference in Thin Films

Q1: What causes interference in thin films?

A. Diffraction of light at the edges of the film

B. Reflection of light from the two surfaces of the film (Correct)

C. Scattering of light by the film

D. Refraction of light within the film

Q2: For constructive interference in thin films of uniform thickness in reflected light, the path difference must be:

A. An odd multiple of $\lambda/2$

B. An even multiple of $\lambda/2$ (Correct)

C. Equal to λ

D. Zero

Q3: For destructive interference in thin films of uniform thickness in reflected light, the path difference must be:

A. An odd multiple of λ/2 (Correct)

B. An even multiple of λ/2

C. Equal to λ

D. Zero

Conditions for Maxima and Minima in Wedge-Shaped Films

Q4: In a wedge-shaped film, the thickness of the film varies:

A. Uniformly along its length (Correct)

B. Randomly at different points

C. Is constant throughout

D. Is zero at the edges

Q5: For constructive interference in a wedge-shaped film, the thickness of the film must satisfy the condition:

A. 2nt = mλ (Correct)

B. 2nt = (m + 1/2)λ

C. 2nt = λ

D. t = 0

Q6: For destructive interference in a wedge-shaped film, the thickness of the film must satisfy the condition:

A. $2nt = m\lambda$

B. $2nt = (m + 1/2)\lambda$ (Correct)

C. $2nt = \lambda$

D. $t = 0$

Newton's Rings

Q7: Newton's rings are formed due to:

A. Reflection of light at the surfaces of a thin air film (Correct)

B. Diffraction of light by a circular aperture

C. Dispersion of light through a prism

D. Refraction of light through a lens

Q8: In Newton's rings, the center appears dark when:

A. The lens is transparent

B. The path difference is zero and destructive interference occurs (Correct)

C. The air film is absent

D. The light source is monochromatic

Q9: To determine the wavelength of monochromatic light using Newton's rings, one needs to measure:

A. The diameter of bright and dark fringes (Correct)

B. The thickness of the film

C. The refractive index of the lens

D. The focal length of the lens

Q10: If a liquid is introduced between the lens and glass plate in a Newton's rings setup, what changes?

A. The diameter of rings increases

B. The diameter of rings decreases (Correct)

C. The rings disappear

D. The rings become brighter

Anti-Reflecting Coating

Q11: The purpose of an anti-reflecting coating is to:

A. Increase reflection from a surface

B. Eliminate interference

C. Minimize reflection from a surface (Correct)

D. Enhance diffraction patterns

Q12: For an anti-reflecting coating, the thickness of the coating should be:

A. Equal to the wavelength of light

B. An integral multiple of $\lambda/4$ (Correct)

C. An integral multiple of $\lambda/2$

D. Equal to λ

Q13: The refractive index of the anti-reflecting coating should ideally be:

A. Equal to the refractive index of air

B. Equal to the refractive index of the substrate

C. The geometric mean of the refractive indices of air and the substrate (Correct)

D. Greater than both air and the substrate

Applications and Practical Problems

Q14: The formation of Newton's rings is primarily used to:

A. Measure the focal length of a lens

B. Determine the wavelength of monochromatic light (Correct)

C. Measure the thickness of a lens

D. Analyze the diffraction pattern

Q15: Anti-reflective coatings are widely used in:

   A. Lasers to increase light reflection

   B. Solar panels to improve light absorption (Correct)

   C. Telescopes to decrease diffraction

   D. Eyeglasses to increase glare

Mod-4: Electrodynamics

Gradient, Divergence, and Curl

Q1: What does the gradient of a scalar field represent?

A. A measure of its total value

B. A vector pointing in the direction of the maximum rate of change (Correct)

C. The circulation of the scalar field

D. The divergence of the scalar field

Q2: Which of the following operations is used to calculate the divergence of a vector field?

A. Dot product of ∇ with the vector field (Correct)

B. Cross product of ∇ with the vector field

C. Dot product of the field with itself

D. Curl of the vector field

Q3: What does the curl of a vector field represent?

A. The rate of expansion of the field

B. The rotational tendency of the field (Correct)

C. The divergence of the field

D. The magnitude of the field

Q4: If the divergence of a vector field is zero, what can be said about the field?

A. It is conservative

B. It is solenoidal (Correct)

C. It has no curl

D. It is uniform

Gauss's Law

Q5: Gauss's Law is mathematically expressed as:

A. $\nabla \cdot E = \rho/\varepsilon_0$ (Correct)

B. $\nabla \times E = -\partial B/\partial t$

C. $\nabla \times B = \mu_0 J$

D. $\nabla \cdot B = 0$

Q6: What does Gauss's Law state?

A. Magnetic monopoles exist in nature

B. The net electric flux through a closed surface is proportional to the enclosed charge (Correct)

C. The circulation of the magnetic field is proportional to current

D. Electric fields cannot penetrate conductors

Ampere's Circuital Law

Q7: What does Ampere's Circuital Law describe?

A. The total electric flux through a closed surface

B. The relationship between electric current and the magnetic field it produces (Correct)

C. The conservation of electric charge

D. The behavior of charges in motion

Q8: The integral form of Ampere's Law is:

A. $\oint B \cdot dl = \mu_0 I$ (Correct)

B. $\oint E \cdot dl = -\partial B/\partial t$

C. $\nabla \times B = \mu_0 J$

D. $\nabla \cdot E = \rho/\varepsilon_0$

Faraday's Law

Q9: What does Faraday's Law of Electromagnetic Induction state?

A. A time-varying magnetic field produces an electric field (Correct)

B. A constant electric field generates a magnetic field

C. Electric fields are conserved

D. Magnetic flux remains constant

]

Q10: The integral form of Faraday's Law is:

A. $\oint E \cdot dl = -\partial B / \partial t$ (Correct)

B. $\nabla \times E = 0$

C. $\nabla \times B = \mu_0 J$

D. $\nabla \cdot B = 0$

Divergence Theorem and Stokes' Theorem

Q11: The Divergence Theorem relates:

A. A surface integral to a line integral

B. A volume integral to a surface integral (Correct)

C. A curl to a divergence

D. A gradient to a scalar field

Q12: What does Stokes' Theorem relate?

A. A line integral to a surface integral (Correct)

B. A surface integral to a volume integral

C. Divergence to gradient

D. Magnetic flux to electric flux

Maxwell's Equations

Q13: Which of Maxwell's equations states that magnetic monopoles do not exist?

A. Gauss's law for electricity

B. Gauss's law for magnetism (Correct)

C. Faraday's law

D. Ampere's law

Q14: In point form, which equation represents Ampere's Law with Maxwell's correction?

A. $\nabla \times B = \mu_0(J + \varepsilon_0 \partial E/\partial t)$ (Correct)

B. $\nabla \times E = -\partial B/\partial t$

C. $\nabla \cdot E = \rho/\varepsilon_0$

D. $\nabla \cdot B = 0$

Q15: The significance of Maxwell's equations is that they:

A. Describe the behavior of static charges

B. Provide a unified framework for electricity and magnetism (Correct)

C. Are only valid for Cartesian coordinates

D. Explain the properties of gravitational waves

Mod-5: Quantum Physics

Q1: What does the de Broglie hypothesis state?

A. Matter is made of particles only.

B. Every moving particle has an associated wave nature. (Correct)

C. Waves and particles are independent.

D. Matter waves exist only for photons.

Q2: The de Broglie wavelength for a particle is given by:

A. $\lambda = h/mv$ (Correct)

B. $\lambda = mv/h$

C. $\lambda = h/v$

D. $\lambda = mv^2/h$

Q3: If the velocity of an electron increases, its de Broglie wavelength:

A. Increases

B. Decreases (Correct)

C. Remains constant

D. Becomes infinite

Q4: Which of the following is NOT a property of matter waves?

A. They are not electromagnetic in nature.

B. They are associated with moving particles.

C. They can exist without a particle. (Correct)

D. Their wavelength depends on the momentum of the particle.

Wave Function and Probability Density

Q5: What does the wave function $\psi(x, t)$ represent in quantum mechanics?

A. The physical location of a particle

B. The amplitude of a matter wave (Correct)

C. The exact velocity of a particle

D. The spin of the particle

Q6: The square of the wave function $|\psi|^2$ represents:

A. The energy of the particle

B. The momentum of the particle

C. The probability density of finding the particle at a given point (Correct)

D. The wavelength of the particle

Q7: Which of the following is NOT a valid mathematical condition for a wave function?

A. It must be single-valued.

B. It must be infinite everywhere. (Correct)

C. It must be continuous.

D. Its first derivative must also be continuous.

Schrödinger's Equations

Q8: Schrödinger's time-independent equation is used to describe:

A. A particle in a non-uniform potential field

B. A system in a stationary state (Correct)

C. The time evolution of a quantum system

D. The probability of a particle's velocity

Q9: Schrödinger's time-dependent equation is primarily used to:

A. Calculate the kinetic energy of a particle

B. Describe how the wave function evolves over time (Correct)

C. Find the stationary energy states of a particle

D. Analyze classical systems

Q10: The need for Schrödinger's equations arises because:

A. Newtonian mechanics can explain quantum behavior

B. Classical wave equations cannot describe particles like electrons (Correct)

C. It eliminates the concept of uncertainty

D. It describes the spin of electrons

Energy of a Particle in a Rigid Box

Q11: The energy of a particle in a rigid box is quantized because:

A. The wave function must vanish at the walls of the box (Correct)

B. The particle has infinite energy

C. The box is very small

D. The particle is stationary

Q12: The energy levels of a particle in a 1D rigid box are proportional to:

A. n^2 (Correct)

B. n

C. $\sqrt{n}$

D. 1/n

Q13: If the length of the rigid box is doubled, the energy of the particle will:

A. Increase

B. Decrease (Correct)

C. Remain the same

D. Become zero

Quantum Mechanical Tunneling and Quantum Computing

Q14: Quantum tunneling is a phenomenon where:

A. A particle is absorbed into a barrier

B. A particle passes through a barrier higher than its energy (Correct)

C. A particle loses energy in a barrier

D. A particle stops at the barrier

Q15: In quantum computing, a qubit differs from a classical bit because:

A. It can exist only as 0 or 1

B. It can exist in a superposition of 0 and 1 states (Correct)

C. It operates at a slower speed

D. It has no physical representation

Mod6: Basics of Semiconductor Physics

Direct and Indirect Band Gap Semiconductors

Q1: What is the main difference between direct and indirect band gap semiconductors?

A. The number of electrons

B. The mechanism of photon absorption and emission (Correct)

C. The position of the Fermi level

D. The type of doping

Q2: In a direct band gap semiconductor, the conduction band minimum and valence band maximum:

A. Occur at different momentum values

B. Occur at the same momentum value (Correct)

C. Are not related to momentum

D. Are only determined by doping

Q3: Which of the following is an example of a direct band gap semiconductor?

A. Silicon

B. Germanium

C. Gallium Arsenide (Correct)

D. Diamond

Q4: Indirect band gap semiconductors are more commonly used in:

A. Optical devices

B. Photovoltaic cells (Correct)

C. Lasers

D. LEDs

Electrical Conductivity of Semiconductors

Q5: Electrical conductivity in semiconductors increases with temperature because:

A. The number of free charge carriers increases (Correct)

B. The material becomes a better insulator

C. The band gap increases

D. The mobility of charge carriers decreases

Q6: Intrinsic semiconductors conduct electricity due to:

A. Excess electrons

B. Equal numbers of thermally excited electrons and holes (Correct)

C. Impurities introduced by doping

D. The presence of defects in the lattice

Drift Velocity, Mobility, and Conductivity in Conductors

Q7: Drift velocity is:

A. The average velocity of charge carriers due to an electric field (Correct)

B. The speed of current flow in a conductor

C. The random motion of electrons in the absence of an electric field

D. The velocity of the electric field

Q8: Mobility is defined as:

A. The ability of charge carriers to recombine

B. The ratio of drift velocity to electric field (Correct)

C. The ability of a material to conduct heat

D. The energy of charge carriers

Q9: Electrical conductivity of a material is given by:

A. $\sigma = nq\mu$ (Correct)

B. $\sigma = \mu/E$

C. $\sigma = q/\mu$

D. $\sigma = n/\mu$

Fermi-Dirac Distribution Function

Q10: The Fermi-Dirac distribution function describes:

A. The density of electrons in the conduction band

B. The probability of an energy state being occupied by an electron (Correct)

C. The total number of free electrons in a semiconductor

D. The mobility of electrons in a material

Q11: At absolute zero (0 K), the Fermi-Dirac function predicts that:

A. All energy states are occupied

B. All energy states below the Fermi level are occupied, and all above are empty (Correct)

C. All energy states above the Fermi level are occupied

D. The probability of occupation is 50% for all states

Position of Fermi Level in Intrinsic and Extrinsic Semiconductors

Q12: In an intrinsic semiconductor, the Fermi level lies:

A. Close to the conduction band

B. Close to the valence band

C. In the middle of the band gap (Correct)

D. Outside the band gap

Q13: In an n-type semiconductor, the Fermi level:

A. Lies near the conduction band (Correct)

B. Lies near the valence band

C. Remains unchanged compared to the intrinsic case

D. Lies outside the band gap

Q14: In a p-type semiconductor, the Fermi level:

A. Shifts closer to the conduction band

B. Lies in the middle of the band gap

C. Shifts closer to the valence band (Correct)

D. Lies outside the band gap

Q15: Doping with donor atoms in a semiconductor affects the Fermi level by:

A. Moving it towards the conduction band (Correct)

B. Moving it towards the valence band

C. Keeping it in the middle of the band gap

D. Decreasing the band gap