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

Date: 20/10/2023

UNIT 4

1. What is the full form of LASER?
   a) Light amplification by spontaneous emission of radiation
   b) Light amplification by stimulated emission of radiation
   c) Light absorption by stimulated emission of radiation
   d) Light absorption by spontaneous emission of radiation
2. Laser beam is made of
   a) Highly coherent electrons b) Highly coherent photons
   c) Highly coherent phonons d) None of them
3. Multimode step index fiber has _____
   a) Large core diameter & large numerical aperture
   b) Large core diameter and small numerical aperture
   c) Small core diameter and large numerical aperture
   d) Small core diameter & small numerical aperture
4. What is the principle of fibre optical communication?
   a) Frequency modulation b) Population inversion
   c) Total internal reflection d) Doppler Effect
5. The life time of electron in meta stable state is of the order of
   a) 10^{-9} S. b) 10^{-3} S. c) 10^{-8} S. d) 10^{-7} S.
6. An atom or molecule in the ground state of energy E1 can absorb a photon of energy hν and go the higher energy state E2, then the process is known as
   a) Stimulated radiation b) Stimulated absorption
   c) Stimulated emission d) Spontaneous absorption
7. The spontaneous emission produces
   a) Coherent light b) Incoherent light c) White light d) None of the above
8. Ruby laser is a solid state laser, the active medium is
   a) Crystalline substance b) Non crystalline substance
   c) Gaseous substance d) None of the above
9. The He-Ne laser is a kind of neutral atom gas laser in which the wavelength of laser is
   a) 6328A0 b) 6943A0 c) 10600A0 d) None of the above
10. Laser system does not include
    a) Active medium b) Pumping mechanism c) Optical activity d) Optical resonator

1. Discuss various pumping methods used in the Lasers for obtaining population inversion.
2. Differentiate between spontaneous and stimulated emissions
3. What are the main components of a laser system?
4. Explain population inversion, active system and pumping.
5. Write difference between laser light and ordinary light.
6. What is four level Laser? Hence explain theory and working of any four-level laser

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7. Discuss in detail the construction, theory and working of He-Ne laser
8. With the help of suitable diagram, explain the principle, construction and working of Ruby laser.
9. Describe construction of optical fiber with the help of diagram.
10. Explain semiconductor laser. What are the advantages of it?
11. List the applications of laser in different fields.
12. What is the principle of optical fibre? Discuss various applications of optical fibres.
13. Define NA (Numerical Aperture) and Acceptance Angle
14. Classify the optical fibers on the basis of refractive index profile, on the basis ofmodes and on the basis of materials
15. Distinguish between step index and graded index fibre.
16. What do you understand by single mode and Multimode fibre?
17. Find out the numerical aperture and acceptance angle of an optical fibre. [Given, n1 =1.55, n2= 1.50]
18. A fibre cable has an acceptance angle of 30 and a core index of refraction of 1.4. Calculate the refractive index of the cladding
19. Calculate the ratio of i) Einstein Coefficients, ii) Stimulated to spontaneous emissions, for a system at 300K in which radiations of wavelength 1.39μm are emitted.
20. Calculate on the basis of Einstein's theory, the number of photons emitted per second by a He-Ne laser source emitting light of wavelength 6328Ao with an optical power of 10mW.
21. Calculate the numerical aperture, relative RI difference, V- number and number of modes in an optical fibre of core diameter 50μm. Core and cladding Refractive indices 1.41 and 1.40 at λ= 820nm.
22. An optical fibre has clad of RI 1.50 and NA 0.39. Find the RI of core and the acceptance angle.

UNIT 2

1. In semiconductor physics, what does the term "doping" refer to?

A) Adding impurities to modify conductivity
B) Cooling the semiconductor material
C) Increasing the physical size of the semiconductor
D) Removing impurities for purification

2. Which of the following statements is true about P-type semiconductors?

A) They have an excess of electrons
B) They have an excess of protons
C) They have a deficiency of electrons
D) They have a deficiency of protons

3. What is the purpose of a semiconductor diode?

A) To amplify electrical signals
B) To store electrical charge
C) To emit light when biased
D) To control the flow of current in one direction

4. What is the function of the intrinsic semiconductor?

A) It conducts electricity without any impurities
B) It acts as an insulator

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C) It has a fixed conductivity level
D) It is not used in electronic devices

5. Which semiconductor material is commonly used in light-emitting diodes (LEDs)?
   A) Silicon
   B) Germanium
   C) Gallium arsenide
   D) Indium phosphide
6. What is the primary reason for the formation of energy bands in solids?
   A) Electron-electron repulsion
   B) Quantum mechanical effects
   C) Thermal vibrations
   D) External magnetic fields
7. What role do crystal lattices play in the formation of energy bands?
   A) Crystal lattices disrupt band formation
   B) Crystal lattices create energy bands
   C) Crystal lattices are irrelevant to band formation
   D) Crystal lattices only affect metallic properties
8. How does the Pauli Exclusion Principle influence energy band formations?
   A) It encourages band overlap
   B) It restricts the number of electrons in a band
   C) It has no impact on band structures
   D) It increases the speed of electrons in a band
9. Which type of bonding is most associated with the formation of energy bands in solids?
   A) Covalent bonding
   B) Ionic bonding
   C) Metallic bonding
   D) None of the above
10. How does the presence of impurities affect energy band structures in semiconductors?
    A) It has no effect on band structures
    B) It creates additional energy bands
    C) It narrows the band gap
    D) It broadens the conduction band
11. What is the key distinction between direct and indirect semiconductors?
    A) Direct semiconductors have a wider band gap
    B) Indirect semiconductors have a higher density of charge carriers
    C) In direct semiconductors, the minimum energy point in the conduction band aligns with the maximum energy point in the valence band
    D) Indirect semiconductors are only found in elemental semiconductors
12. Which type of semiconductor is more efficient in emitting light?
    A) Direct semiconductor
    B) Indirect semiconductor
    C) Both have similar efficiency
    D) Neither emits light

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13. What is the primary factor influencing whether a semiconductor is direct or indirect?
    A) Atomic number
    B) Crystal structure
    C) Band gap width
    D) Electron affinity
14. What is a semiconductor, and how does it differ from a conductor and an insulator?
15. How do temperature changes impact the conductivity of a semiconductor?
16. Define Effective mass
17. What do you mean by Density of States?
18. Define bandgap.
19. Define Intrinsic and Extrinsic semiconductors.
20. Classify: Conductors, Semiconductors and Insulators
21. Define intrinsic semiconductor.
22. Define: 1. Extended Zone 2. Repeated Zone and 3. Reduced Zone from the E versus K relation.

Descriptive questions

1. Draw E-K diagram and explain briefly.
2. Derive an expression for the Density of States (DOS) in a metal.
3. Difference between Direct and Indirect semiconductors.
4. Derive an expression for the effective mass (m*) of an electron.
5. Calculate the Carrier concentration at 0K and deduce the equation of the fermi energy (E_F). [**Hint** : $\int Z(E)dE \times F(E)$]
6. Derive an expression for the carrier concentration of the holes in intrinsic semiconductor.
7. Prove that in an intrinsic semiconductor, fermi level lies exactly at the middle of the band gap.
8. Derive an expression for the carrier concentration in n-type semiconductor.
9. What are the characteristics of the semiconductors?
10. Calculate the intrinsic concentration of charge carriers at 300 K given that m *e =0.12mo, m *h =0.28mo and the value of brand gap = 0.67 eV.
11. The intrinsic carrier density is 1.5×10^{16} m^{-3}. If the mobility of electron and hole are 0.13 and 0.05 m2 V–1 s–1, calculate the conductivity.
12. The Intrinsic carrier density at room temperature in Ge is 2.37×10^{19} m^{-3} if the electron and hole mobilities are 0.38 and 0.18 m2 V^{-1} s^{-1} respectively, calculate the resistivity.
13. In a P-type germanium, $n_i = 2.1 \times 10^{19}$ m^{-3} density of boran 4.5×10^{23} atoms /m^3. The electron and hole mobility are 0.4 and 0.2 m^2 v^{-1} s^{-1} respectively. What is its conductivity before and after addition of boron atoms.
14. An N-type semiconductor has hall coefficient = 4.16×10^{-4} m^3 C^{-1}. The conductivity is 108 $^{-1}$ m^{-1}. Calculate its charge carrier density 'n_e' and electron mobility at room temperature.
15. Explain formation, biasing, V-I characteristics, and applications of PN junction diode.