SIDDARTHA INSTITUTE OF SCIENCE AND TECHNOLOGY :: PUTTUR

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QUESTION BANK (DESCRIPTIVE)

Subject with Code :SEMICONDUCTOR PHYSICS (19HS0851)
Course & Branch: B.Tech – CSE (I SEM), ECE (II-SEM)
Year &Sem: I-B.Tech. **Regulation:** R19

UNIT –I:Electronic Materials.

1 a) What are the salient features of classical free electron theory? Derive an expression for electrical conductivity in a metal? (8M)
b).Mention its drawbacks (4M)

2 a) Describe the electrical conductivity in a metal using quantum free electronic theory. (8M)
b) Write advantages quantum free electron theory over classical free electron theory. (4M)

3 a) Using classical free electron model derive an expression for electrical conductivity in metal. (8M)
b) Find relaxation time of conduction electron in metal if its resistivity is $1.54 \times 10^{-8}\Omega$-m and it has 5.8×10^{28} conduction electron/m^3. Given m= 9.1×10^{-31} kg, e= 1.6×10^{-19} C. (4M)

4 a) Describe the various sources of electrical resistance in metals.(8M)
b) For the metal having 6.5×10^{28} conduction electron/m^3. Find the relaxation time of conduction electrons if the metal has resistivity $1.43 \times 10^{-8}\ \Omega$ m. Given m= 9.1×10^{-31} kg, e= 1.6×10^{-19} C. (4M)

5 a) Write the postulates of classical free electron theory and quantum free electron theory. (8M)
b) Define mean free path? Calculate the mean free path of electron in copper of density 8.5×10^{28} m^{-3} and resistivity $1.6 \times 10^{-8}\ \Omega - m$. Given m= 9.1×10^{-31} kg, e= 1.6×10^{-19} J, T=300K,$K_B=1.38 \times 10^{-23} JK^{-1}$. (4M)

6 a) Classify the solids into conductor, semiconductor and insulators based on band theory. (8M)
b) For the metal having 6.5×10^{28} conduction electron/m^3. Find the relaxation time of conduction electrons if the metal has resistivity $1.43 \times 10^{-8}\ \Omega$ m. Given m= 9.1×10^{-31} kg, e= 1.6×10^{-19} C. (4M)

7 a) Define effective mass and derive the expression for effective mass of an electron in periodic potential field. (8M)

8 b) Evaluate Fermi Function for energy K_BT above Fermi level? (4M)

9 a) Write brief note on Fermi Dirac distribution? (6M)
b) What is the effect of temperature onFermi Dirac distribution function? (6M)

10 a) Obtain the mathematical expression for effective mass of electron in periodic lattice and describe the variation of effective mass with wave vector. (8M)
b) Define Fermi energy level? Find the temperature at which there is 1% probability that a state with energy 0.5 eV is above Fermi energy? (4M)

10. a)Define the terms i)Mean free pathii)Relaxation time iii)Mobility iv) Drift Velocity (8M)

b)Find the mobility of electrons in copper if there are $9x10^{28}$ valence electrons/m^3 and the conductivity of copper is $6x10^7$mho/m? (4M)

UNIT –II:SEMICONDUCTORS.

1. a) What is intrinsic semiconductor and explain the formation extrinsic semiconductors through doping? (6M)
   b) Derive the expression for intrinsic carrier concentration. (6M)
2. a) Explain n-type semiconductor. (6M)
   b) Derive the expression for current generated due to drifting of charge carriers in semiconductorsin the presence of electric field. (6M)
3. a) Obtain the conductivity of intrinsic semiconductor with relevant expressions? (8M)
   b) The following data are given for an intrinsic Ge at 300K. Calculate the conductivity and resistivity of the sample? (n_i= 2.4 $x10^{-19}m^{-3}$, μ_e = 0.39 m^2-$V^{-1}S^{-1}$, μ_p = 0.19 m^2-$V^{-1}S^{-1}$). (4M)
4. a) Distinguishes between intrinsic and extrinsic semiconductors? (8M)
   b) Explain effect of temperature on Fermi energy level of an extrinsic semiconductor? (4M)
5. a) What is Fermi level? Prove that the Fermi level is liesexactly in between conduction band and valance band of intrinsic semiconductor. (6M)
   b) Derive Einstein's relation in semiconductors? (6M)
6. a) Explain the formation of p-n junction. (6M)
   b) Describe the variation of width of depletion layer under forward and reverse bias. (6M)
7. a) Explain P-type semiconductor. (6M)
   b) Derive the expression for current generated due to diffusion of charge carriers in semiconductors in the absence of electric field. (6M)
8. a) Describe the Hall Effect in a semiconductors. (8M)
   b) Write the applications of Hall Effect. (4M)
9. a) What are the characteristics of solar cells? (8M)
   b) Find the diffusion co-efficient of electron in Si at 300 K if μ_e = 0.19 m^2-$V^{-1}S^{-1}$. (4M)
10. a)Describe the construction and working mechanism of LED. (8M)
    b)Determine the wavelength of LED fabricated by the CdS material with band gap of 2.42eV (4M)

UNIT-III
PRICIPLES OF QUANTUM MECHANICS & ELECTROMAGNETIC THEORY

1. a) Derive the expression for de Broglie wavelength for an electron?. (8M)
   b) Calculate the de Broglie wavelength of a neutron whose kinetic energy is two times the rest mass of the electron. Given m_n = 1.67 x 10^{-27} kg, m_e = 9.1x 10^{-31} kg and h = 6.63 x 10^{-34} kg.(4M)
2. a) Define matter waves and explain the properties of matter waves. (8M)
   b) The position of electron in an atom is located within a distance of $0.1A^0$using a microscope. What is the uncertainty in the momentum of the electron located in this way? (4M)
3. a) Derive Schrödinger's time independent wave equation. (8M)

b) Explain the physical significance of wave function. (4M)

4 a) Derive Schrödinger's time dependent wave equation. (8M)

b) An electron is moving under a potential field of 15kv. Calculate the wavelength of electron wave. (4M)

5 a) Describe the behavior of particle in a one dimensional infinite potential well in terms of Eigen values and function. (8M)

b) An electron is confined to a one dimensional potential box of 2 Å length. Calculate the energies corresponding to the second and forth quantum states (in eV). (4M)

6 a) Explain the Faraday's law and Ampere's law through the Maxwell equations. (8M)

b) An electron is bound in a one dimensional infinite well having a width of 1 X 10^{-10}m. Find the energy values in the ground state and the first two excited states. (4M)

7 Write Maxwell's equations in differential and integral form and derive an expression for energy flow by electromagnetic waves? (12M)

8 a) Write the significance of Divergence and Curl of Electromagnetic fields (8M)

b) An electron is bound in a one-dimensional box having size of 4 X 10^{-10}m.What will be its minimum energy and second excited state energy (in eV)?. (4M)

9 a) Explain the propagation of electromagnetic wave in non-conducting media (8M)

b) Calculate the velocity and kinetic energy of an electron of wavelength of 1.66 x 10^{-10}m.(4M)

10 a) Describe Wave & Particle Nature of Matter Waves? (4M)

b) State and Explain Stoke's Theorem and Gauss's Theorem (8M)

UNIT-IV: LASERS AND FIBER OPTICS

1 a) Describe the important characteristic of laser beam? (6M)

b) Explain the difference between spontaneous and stimulated emission of radiation? (6M)

2 a) Derive the relation between the various Einstein's coefficients of absorption and emission of radiation. (8M)

b) Explain population inversion? (4M)

3 a) Describe 1)spontaneous emission 2)stimulated emission 3)stimulated absorption (9M)

b) Calculate the wavelength of emitted radiation from GaAs which has a band gap of 1.44eV (3M)

4 a) Describe the construction and working principle of He-Ne Laser with the help of a neat diagram. (8M)

b) Mention the important components of laser device. (3M)

5 a) Explain the different pumping mechanisms in laser. (7M)

b) Mention the application of laser in different fields. (5M)

6 a) What is the acceptance angle of an optical fibre and derive an expression for it. (8M)

b) An optical fibre has a core refractive index of 1.44 and cladding refractive index of 1.40. Find its numerical aperture and θ_a. (4M)

7 a) What is the numerical aperture of an optical fibre and derive an expression for it. (8M)

b) An optical fibre has a numerical aperture of 0.20 and cladding refractive index of 1.59. Determine the refractive index of core and the acceptance angle for the fibre in water has a refractive index of 1.33. (4M)

8 a) Differentiate step index and graded index fibers. (6M)

b) Write brief note on attenuation in optical fibers. (6M)

9 a)Describe the construction and the working principle of optical fibre. (8M)
b)Mention applications of optical fibres. (4M)

10 a)Describe optical fibre communication system with block diagram. (6M)
b)Mention the application of optical fibre in sensors . (4M)

UNIT-V: PHYSICS OF NANOMATERIALS

1. a) What is nanomaterial? Write the classification of nanomaterials (4M)
   b) Explain the basic principle of nanomaterials. (8M)
2. a) Explain the concept of Quantum Confinement in nano materials. (6M)
   b) Write the applications of nanomaterial in industries and information technology. (6M)
3. a) Explain why surface area to volume ratio very large for nano materials? (8M)
   b) Find the surface area to volume ratio of Sphere using surface area and volume calculation for the given radius is 5 meter? (4M)
4. a) What are the techniques available for synthesizing nanomaterials? (4M)
   b) Explain ball milling technique for synthesis of nanomaterial? (8M)
5. a) Explain Sol-Gel technique for synthesis of nanomaterial? (8M)
   b) Write advantages of sol-gel process? (4M)
6. a) What is Graphene? Write brief note itsproperties. (6M)
   b) Write applications of graphene in various fields (4M)
7. a) What are carbon nanotubes? Mention its structures? (6M)
   b) Write brief note on applications of Carbon nanotubes? (6M)
8. a) What is nanotechnology? Give applications of carbon nanotubes (CNT'S) in various fields (7M)
   b) What are allotropes? Write allotropes of Carbon? (5M)
9. a) Write the physical properties of carbon nanotubes . (6M)
   b)Write the applications of nanomaterial in various fields. (6M)
10. Explain the construction and working principle of Scanning Electron Microscope. (12M)

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