Theory of Metals (7)

1. Define wave particle duality of the matter. Find on expression of Schrödinger wave equations for free particle the.
2. Explain wave function. What are the conditions that should be fulfilled by the wave function? Derive the time independent Schrödinger's equation.
3. Show that energy of an electron that is confined in an infinite potential well is quantized and hence determine the normalized wave function of an electron confined in an infinite potential well. OR,
   Show that the difference in energy between any two consecutive energy levels of a free particle inside infinite potential well is inversely proportional to the square of well length.
4. What is tunneling in quantum mechanics? Explain with the necessary mathematical expression, the nature of wave function in different regions in case of tunneling.
5. Prove that Fermi energy in a metal is independent of temperature and depends only in its electron concentration. OR,
   Prove that the expression of Fermi energy at absolute zero for free electron model is $E_F = 3.65 \times 10^{-19} n^{2/3}$ (in eV), where n be the number of electrons per unit volume.
6. Define number of states and density of state function in quantum mechanics. Show that the relationship between density of state and energy is parabolic.
7. What is Thermionic emission and work function? Derive the Richardson's expression for the Thermionic emission for Schottky effect.
8. Explain thermionic emission, contact potential and the free electron theory.
9. What do you mean by Fermi energy? Explain Fermi Dirac distribution function. Also find the probability that the Fermi level E_F is occupied by an electron.

Free Electron Theory of Conduction in Metals (2)

10. Calculate the lattice constant, face diagonal, body diagonal and packing density of SC, BCC ,FCC crystal unit cell.
11. Illustrating the E-K diagram, explain the significance of effective mass of an electron in solids.
12. What do you mean by the term drift velocity and mobility of an electron? Derive the expression for mean thermal velocity of electron.
13. Define the term electrons drift velocity and mobility. How are they related? Show that the conductivity of electrons with in metallic conductor is product of charge density and mobility.
14. What is diffusion? State and explain Fick's law. Derive Einstein's relation between diffusion coefficient and mobility of electrons.

Conduction in Liquid and Gases (1)

15. Describe ionic conduction in electrolyte and show that ionic conduction in electrolyte depends on temperature.
16. Explain electrical conduction in gases with necessary diagram.
17. What do you mean by electrical breakdown in gaseous medium? Explain with Townsend mechanism.
18. Explain the streamer theory of break down and arc discharge in air at atmospheric pressure.

Dielectric Materials (4)

19. What is polarization? Derive an expression showing relationship between dielectric susceptibility and electronic polarizibility of an atom. OR,
    What is electronic polarization? Derive the mathematical relation showing the relation between electronic polarization and relative permittivity, using Clausius-Massotti equation.
20. Explain polarization in detail. Show that there is no polarization in free space or vacuum.
21. What are different types of polarization in dielectric medium? Explain orientational polarization in detail.
22. Derive the mathematical relation showing the relation between ionic polarization and relation permittivity, using Clausius-Massotti equation.

23. What is the effect of temperature and frequency in polarization in a dielectric material? Explain.
24. Show that dielectric loss per unit volume is function of frequency of the applied field and the loss tangent.
25. What is Corona discharge? Explain different types of breakdown in solid dielectrics.
26. Explain ferroelectricity and piezoelectricity.

Magnetic Materials (3)

27. What is permeability and susceptibility? Explain different types of magnetic material and give two examples of each.
28. What are magnetic domains? Explain domain wall motion in a ferromagnetic material
29. Explain the hysteresis loss and eddy current loss in magnetic materials?
30. Differentiate between hard and soft magnetic materials suggest which type of magnetic material to use for the manufacture of power transformer cores and why?
31. What are ferromagnetic materials? With the help of hysteresis loop, classify hard and soft magnetic material?

Semiconducting Materials (6)

32. Prove that the position of Fermi level is near the middle of band gap in pure silicon semiconductor.
33. What is minority carrier suppression? Prove electron concentration and conduction in n - type semiconductor is defined by impurity donor.
34. Explain the temperature dependence of conductivity in an extrinsic semiconductor.
35. Differentiate between Non-Degenerate and Degenerate semiconductors.
36. With reference to direct and indirect recombination, explain why GaAs became a LED material?
37. Write short notes on a) Compensation doping b) Photogeneration
38. What do you mean by minority carrier life and minority carrier diffusion length in doped semiconductor?
39. What is PN junction? Derive the relation for built in potential and depletion layer of a PN junction.
40. Show that the diode equation for a P-N junction is
$I = I_o [\exp(eV/KT) - 1]$, where I_o is the reverse saturation current and V is the applied voltage.
41. What is reverse saturation current in PN junction semi conductor?
42. What is PN junction? Derive an expression for the width of depletion layer.
43. List out the condition for formation of Ohmic junction between semiconductor and metal.
44. Describe the phenomena of formation of Schottky junction between a metal and a n type semiconductor. What changes occur during forward biasing of such junction?
45. Define diffusion capacitance and depletion layer capacitance.

Semiconductor Materials Procession (5)

46. Why silicon is preferred for semiconducting materials than Germanium? Explain the Floating Zone process of crystal growth with necessary figure.
47. Write short notes on a) Chzochralski process b)photolithography c) Lattice damage and annealing in Ion Implantation.
48. What is diffusion? What are its types? Explain in detail about ion implantation process with neat sketch.
49. What do you mean by epitaxial growth? Explain planner process.
50. Explain the process of IC fabrication.
51. Define the term wafer? Describe chemical vapour deposition and epitaxy in semiconductor fabrication.

Best of Luck