SYED AMMAL ENGINEERING COLLEGE: RAMANATHAPURAM

Dr.E.M.Abdullah Campus

DEPARTMENT OF PHYSICS

Question Bank

Engineering physics II – PH6251 (R-2013)

UNIT-I – Conducting Materials

PART – A

1. What are the classifications of conducting materials?

2. What are the sources of electrons in metals?

3. Give any three postulates of classical free electron theory.

4. Define drift velocity. How is it different from thermal velocity of an electron?

5. Define the terms relaxation time, collision time and Mean free path of an electron.

6. The mobility of electron in copper is $3x10^{-3}$ m^{2}/Vs. Assuming e = $1.6x10^{-19}$ C. and m_e= 9.1x10-31 kg, calculate the Mean free time.

7. Differentiate between electrical conductivity and thermal conductivity.

8. Mention the drawbacks of classical free electron theory of metals.

9. What are the merits of classical free electron theory of metals.

10. Find the drift velocity of electrons copper wire whose cross sectional area is 1 mm^{2}. When the wire carries a current of 10 A. Assume that each copper atom contributes one electron of the electron gas. Given n = $8.5x10^{28}$ $/m^{3}$

11. A conducting rod contains $8.5x10^{28}$ electrons per m^{3}. Calculate the electrical conductivity at room temperature if the collision time for electron is 2 X 10^{-14} s.

12. State any three assumptions of quantum free electron theory.

13. What are the merits and demerits of quantum free electron theory?

14. Define Fermi level and Fermi energy with its importance.

15. Write down the expression for Fermi-Dirac distribution function and plot it as a function of energy.

16. Calculate the Fermi energy of copper at 0° K if the concentration of electrons is 8.5×10^{28} m^{-3}

17. Define Density of Energy states.

18. Define Lorentz number

19. The thermal conductivity of a metal is 123.92 W/m/k . Find the electrical conductivity and Lorentz number when the metal possess relaxation time 10^{-14} seconds and 300 K.(Density of electrons = 6×10^{28} $/m^3$).

20. The Fermi temperature of a metal is 24600 K. Calculate the Fermi velocity.

PART – B

1. i) Define Electrical conductivity. Derive an expression for electrical conductivity of a metal by using classical free electron theory.

ii) Find the mobility of electrons in copper if there are 9×10^{28} valence electrons/m^3 and the conductivity of copper is 6×10^7 mho/m.

2. i) Define thermal conductivity. Derive an expression for thermal conductivity of a metal.

ii) Calculate the electrical and thermal conductivities for a metal with a relaxation time 10^{-14} second at 300 K. Also calculate Lorentz number using the above result. (density of electrons $=6 \times 10^{28}$ m^{-3}).

3. Deduce mathematical expression for electrical conductivity and thermal conductivity of a conducting material and hence obtain Wiedemann-Franz law.

4. State and prove Wiedmann-Franz law. Why does the Lorentz number determined experimentally does not agree with the value calculated from the classical theory.

5. Derive an expression for the density of states and based on that calculate the carrier concentration in metals.

6. i) Starting with the density of energy states obtain the expression for the Fermi energy of an electron at 0 K and hence obtain the expression for the average energy of an electron.

ii) The Fermi energy of silver is 5.51 eV. What is the average energy of a free electron at 0 K.

7 i) Define mobility. ii)What are Fermi particles or Fermions.

iii)A uniform silver wire has a resistivity of 1.54×10^{-8} ohm/m at room temperature. For an electric field along the wire of 1 Volt/cm, compute the average drift velocity of electron assuming that there is 5.8×10^{28} conduction electrons/m^3. Also calculate the mobility.

8 Write an expression for the Fermi energy distribution function F(E) and discuss its behavior with change in temperature. Plot F(E) versus E for T=0K, and T > 0K.

9 i)Use the Fermi distribution function to obtain the value of F(E) for the level just 0.01eV above the Fermi level at 200 K.

ii) Evaluate the Fermi function of an energy KBT above the Fermi energy .

10 i)The density of silver is 10.5×10^{3} kg/m^{3}. The atomic weight of silver is 107.9. Each silver atom provides one conduction electron. The conductivity of silver at 20°C is 6.8 x107$ohm^{-1}m^{-1}$. Calculate the density of electron and also the mobility of electrons in silver.

ii) Calculate the electrical and thermal conductivities of a metal with the relaxation time of 10^{-14} second at 300 K. The electron density is 6x1026 m^{-3}.

iii)Calculate the Fermi energy and Fermi temperature in a metal. The Fermi velocity of electrons in the metal is 0.86×10^{6} m/s.

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UNIT-II – Semiconducting Materials

PART A

1. Define semiconductor and mention its properties.

2. What is the band gap energy Eg? Give its value for Germanium & Silicon.

3. What are the differences between elemental and compound semiconductors? Give examples.

4. Distinguish between intrinsic and extrinsic semiconductors.

5. Write an expression for electrical conductivity of an intrinsic semiconductor

6. What are the limitations of intrinsic semiconductors?

7. What is meant by doping?

8. What are n-type and p-type semiconductors? Give examples.

9. Give any four differences between n-type and p-type semiconductors.

10. Why compound semiconductors are called direct band gap semiconductors? Give its application.

11. What is meant by donor and acceptor level?

12. i) Define mobility.

ii)Find the resistance of an intrinsic Ge rod 1 cm long,1 mm wide, and 0.5mm thick at 300K.

For Ge, n_i= 2.5 x $10^{19}/m^3$, μe= 0.39 $m^2V^{-1}S^{-1}$ and μh= 0.19 $m^2V^{-1}S^{-1}$ at 300k.

13. Draw the diagram to show the variation of Fermi level with temperature of a p-type semiconductor for high and low doping level.

14. With increase of temperature the conductivity of semiconductor increases while that of metals decreases. Give reasons.

15. Define Fermi level in the case of semiconductors. Mention its position in intrinsic and extrinsic semiconductor at 0 K.

16. For an intrinsic semiconductor with a band gap of 0.7 eV, determine the position of E_F at T=300 k if m_h* = 6 me*.

17. Given an extrinsic semiconductor, how will you find whether it is n-type or p-type.

18. What is Hall Voltage?

19. The Hall Co-efficient of a specimen of doped silicon is found to be 3.66×10^{-4} m^{-3}/c. The resistivity of specimen is 8.93×10^{-3} O m. Find the mobility and density of charge carriers.

20. Mention the applications of Hall Effect.

PART -B

1. Derive an expression for density of electrons in the conduction band, density of holes in the valence band of an intrinsic semiconductor.

2. Derive the intrinsic carrier concentration for intrinsic semiconductor and also calculate the Fermi level and its variation with temperature.

3. i) Derive the Electrical Conductivity of an intrinsic semiconductor.

ii) Discuss the variation of electrical conductivity with temperature.

iii) For an intrinsic GaAs, the room temperature of electrical conductivity is 106 Ohm^{-1}. The electron and hole mobilities are 0.85 and 0.04 m^2/V-s, respectively. Calculate the intrinsic carrier concentration at room temperature.

4. Explain the method of determining the band gap of a semiconductor. Also describe the experimental determination of Band gap.

5. Obtain an expression for the carrier concentration of electrons in the conduction band of n-type semiconductor.

6. Obtain an expression for the carrier concentration of holes in the Valence band of p-type semiconductor.

7. i) With neat sketches, explain how Fermi level varies with impurity concentration and temperature in n-type semiconductor.

ii) With neat sketches, explain how Fermi level varies with impurity concentration and temperature in p-type semiconductor

8. I) Explain the variation of carrier concentration with temperature and impurity in semiconductor.

ii) Explain the variation of electrical conductivity in extrinsic semiconductor.

9. (i) Derive an expression of Hall coefficient and mobility of charge carriers. Describe an experimental setup for the measurement of Hall coefficient.

(ii) The Hall co-efficient of certain silicon was found to be -7.35×10^{-5} $m^3 C^{-1}$ from 100 to 400 k. Determine the nature of the semiconductor. If the conductivity was found to be 200 m^{-1} O^{-1}, calculate the density and mobility of the charge carriers.

10. (i) For an intrinsic semiconductor with gap width Eg = 0.7 eV, calculate the concentration of intrinsic charge carriers at 300 k assuming that $m_e^* = m_h^* = m_0$ (rest mass of electron).

(ii) The resistivity of an intrinsic semiconductor is 4.5 ohm-m at 20°C and 2.0 ohm-m at 32°C. Find the energy band gap in eV.

(iii) A sample of silicon doped with 10^{23} phosphorous atoms/m^3. Find the Hall voltage in a sample with thickness =100 µm, current, I=1mA and magnetic field Bz=0.1 Wb/m^2.(Assume electron mobility µe=0.07 m^2/V.s)

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UNIT -3 - MAGNETIC AND SUPERCONDUCTING MATERIALS

PART – A

1. Classify magnetic materials based on their magnetic moments.

2. What is Bohr Magneton? Write its value.

3. What are paramagnetic materials? Give examples.

4. Define intensity of magnetization and flux density.

5. A magnetic field of 2000 A/m is applied to a material which has a susceptibility of 1000. Calculate the (i) Intensity of Magnetization and (ii) Flux density.

6. Define magnetic susceptibility and permeability.

7. A magnetic field of 1800 ampere/meter produces a magnetic flux of 3x10-5 weber in an iron bar of cross sectional area 0.2 cm2. Calculate permeability.

8. Define retentivity and coercivity.

9. What are soft and hard magnetic materials.

10. Define energy product of a magnetic material.

11. What is antiferromagnetism? Give examples.

12. What is superconductivity?

13. Mention the condition for the material to behave as a superconductor.

14. Define critical temperature and critical field.

15. What is isotope effect?

16. What is meant by persistent current?

17. What are high Tc superconductors? Give examples.

18. What are cooper pairs?

19. Calculate the critical current for a wire of lead having a diameter of 1mm at 4.2 K. Critical temperature for lead is 7.18 K and $H_0 = 6.5 \times 10^4$ A/m.

20. The critical temperature for Hg with isotopic mass 199.5 at 4.184 K. Calculate the critical temperature when its mass changes to 203.4.

PART – B

1. i) State the origin of magnetic moment.

ii) How are magnetic materials classified based on magnetic moments? Compare their properties. Give also their characteristics and examples.

2. Explain ferromagnetic domain theory. Briefly explain different types of energy involved in domain growth.

3. i) Draw the B-H curve (Hysteresis) for a ferromagnetic material and explain the same on the basis of domain theory.

ii) Explain how susceptibility varies with temperature for dia, para, and Ferro magnetic materials in detail.

4. i) Explain soft and hard magnetic materials.

ii) Mention the properties of antiferromagnetism.

5. i) What are ferrites? Explain the structure of ferrites, properties and its applications. ii) Why are Ferrites advantages for use as transformer core?

6. Explain the different properties of superconductors in detail.

7. i) What is Meissner effect. Prove that all superconductors are perfect dia-magnet in superconducting state.

ii) Discuss the important features and the prediction of BCS theory.

8. i) Differentiate the Type I and Type II superconductors

ii) Explain High temperature superconductors in detail.

9. i) Discuss the applications of superconductors in detail.

ii) Superconducting tin has a critical temperature of 3.7 K at zero magnetic field and a critical field of 0.0306 tesla at 0 K. Find the critical field at 2 K.

10. Explain the following in detail

i) AC and DC Josephson Effect ii) SQUID

ii) Cryotron iv) Magnetic Levitation

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UNIT - IV – Dielectric Materials

PART – A

1. What are Dielectrics?

2. Define electric polarization and electric susceptibility.

3. Compare active and passive dielectrics.

4. Define dielectric constant.

5. What are the types of polarization mechanism involved in dielectric material?

6. What are the differences between polar and non polar molecules?

7. Define space charge polarization.

8. Define dielectric loss and dielectric breakdown.

9. Define dielectric strength.

10. What are the requirements of good insulating materials?

11. Calculate the polarization produced in a dielectric medium of dielectric constant 6 and it is subjected to an electric field of 100 V/m. Given $e_0 = 8.85 \times 10^{-12}$ F/m.

12. A capacitor consists of two conducting plates of area 200 cm^2 each separated by a dielectric constant e = 3.7 of thickness 1mm. Find the capacitance and the electric flux density when a potential of 300 V is applied. ($e_0 = 8.85 \times 10^{-12}$ F/m).

13. What are the factors affecting dielectric loss.

14. The dielectric constant of a He gas at NTP is 1.0000684. Calculate the electronic polarizability of He atoms if the gas contains 2.7×10^{25} atoms/m^3 and hence evaluate the radius of the He atoms. Given $e_0 = 8.85 \times 10^{-12}$ F/m.

15. Write the Clausius – Mosotti relation. What is its significance?

16. If a NaCl crystal is subjected to an electric field of 1000V/m and the resulting polarization is 4.3×10^{-8} C/m^2. Calculate the relative permeability of NaCl.

17. State the properties of ferroelectric materials.

18. What is Pyroelectricity?

19. Mention the applications of dielectrics.

PART – B

1. Define the following:

1) Dielectric constant, 2) Polarizability 3) Polarization vector. 4) Electric flux density 5) Electric Succeptibility. Give the necessary equations relating the above quantities.

2. Discuss electronic and ionic polarizations with examples in detail.

3. Explain the different types of polarization mechanisms involved in a dielectric material.

4. Explain the frequency and temperature dependence of all type of polarization in dielectrics.

5. What is meant by local field in a dielectric? And how it is calculated for a cubic structure? Deduce the Clausius – Mosotti relation.

6. i) What is dielectric loss. Derive the expression for dielectric power loss.

ii) The dielectric constant of water is 80. Is water a good dielectric? Is it useful for energy storage in capacitors? Justify your answer.

7. What are the different types of dielectric break down in dielectric medium? Discuss in detail the various types of dielectric breakdown.

8. What is ferroelectricity? Explain the properties of ferro electric material. Give examples and mention the applications.

9. Explain the uses of dielectrics in capacitors and in Transformers.

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UNIT – V ADVANCED ENGINEERING MATERIALS

PART – A

1. Define Metallic glasses.

2. What is meant by glass transition temperature?

3. What do you understand by the term quenching?

4. Mention the merits of metallic glasses as transformer core materials.

5. Mention any four properties of met glasses.

6. Write any four applications of met glasses.

7. What is transformation temperature?

8. What is meant by shape memory effect?

9. What do you understand by Martensite and Austenite phase?

10. What is pseudo elasticity?

11. What is one-way and two-way shape memory alloys?

12. Mention the advantages and disadvantages of shape memory alloys.

13. What are Nano phase materials? Give examples.

14. Mention few techniques for synthesis of Nano phased materials.

15. What is top down and bottom up approach in Nano materials?

16. Give any four non-linear optical properties.

17. What is meant by second harmonic generation?

18. What are bio-materials?

19. What are the types of bio-materials?

20. What are the applications of biomaterials?

PART – B

1. What are metallic glasses? Describe the preparation and properties and applications of metallic glasses.

2. How are metallic glasses prepared? Explain how the melt spinner device can be used to produce met glasses.

3. Explain the properties and application of metallic glasses also mention its types with examples.

4. What are shape memory alloys? Describe the characteristics of SMA and its applications.

5. i) Mention the properties of Ni –Ti alloy.

ii) Explain the applications of SMA

iii) Explain the advantages and disadvantages of SMA.

6. What are Nano materials? Explain the preparation, properties and applications nanomaterials.

7. Describe the method of producing Nano materials using

i) Pulsed laser deposition

ii) Chemical vapor deposition.

8. i) Explain Birefringence

ii) Explain optical Kerr effect.

iii) Explain non-linear materials. Give examples.

9. Explain the origin of non-linear optics? How are second harmonic wave generated.

10. Explain biomaterials, classification and its modern application in field of medicine.
