(Pages : 3)

G – 1591

Reg. No. : .....

Name : .....

Sixth Semester B.Sc. Degree Examination, April 2019
Career Related First Degree Programme Under CBCSS
Physics with Computer Applications
Core Course – IX
PC 1641 : SOLID STATE PHYSICS
(2014 Admission Onwards)

Time : 3 Hours

Max. Marks : 80

SECTION – A

Answer **all** questions. **(10×1=10 Marks)**

1. What are Miller indices ?
2. State Debye's T^3 Law.
3. What is Josephson effect ?
4. State Bloch theorem.
5. What is meant by Brillouin Zone ?
6. What is covalent bond ? Give an example.
7. What are the information about the crystals revealed by the X-ray diffraction studies ?
8. Define crystal lattice.
9. What are diamagnetic materials ?
10. Define pair distribution function.

P.T.O.

SECTION – B

Answer **any 8** questions. **(8×2=16 Marks)**

11. What are Bravais lattices ? Name them.
12. Explain Laue method in X-ray diffraction studies.
13. What is the advantage of neutron diffraction over electron diffraction ?
14. Differentiate paramagnetism and ferromagnetism.
15. What is Piezoelectricity ? How does it arise ?
16. Describe diamond structure.
17. Explain various symmetry elements associated with a crystal.
18. What are metallic bond ? Give its properties.
19. Explain critical field.
20. Draw the plot for the four types of polarization at different frequency range.
21. Explain electrical conductivity in free electron theory.
22. How the X-rays are generated ?

SECTION – C

Answer **any six** questions. **(6×4=24 Marks)**

23. Copper has fcc structure and the atomic radius is 0.1278 nm. Calculate the interplanar spacing for (110) and $(\bar{2}12)$ planes.
24. A beam of X-rays of wavelength 0.071 nm is diffracted by (110) plane of rock salt with lattice constant 0.28 nm. Find the glancing angle for the second order diffraction.
25. A paramagnetic material has 10^{28} atoms per m^3. Its susceptibility at 350 K is 2.8×10^{-4}. Calculate the susceptibility at 300 K.
26. A super conducting 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.

27. In an orthorhombic crystal a plane makes intercepts 2.93, 4.47 and 2.35 mm along the three crystallographic axes, the corresponding primitives being 3.05, 6.99 and 4.90 Å. Deduce the Miller indices of the clevage plane.

28. A solid dielectric has electronic polarizability of 10^{-40} Fm^2. If the internal electric field be a Lorentz field, what is the dielectric constant of the material. (Given density = 3×10^{28} atoms/m^3).

29. The magnetic field strength of a piece of metal is 10^6 A/m. Calculate the magnetization and flux density of the material. $\chi = 1.5 \times 10^{-3}$.

30. A current of 10 mA flows through an n-type Ge strip of 1 mm thick and 1 mm wide placed in a magnetic field B. If the Hall Voltage produced inside the strip be 1 mV, what is the value of B ? Given $R_H = 10^{-2}$ m^3/coulomb.

31. A uniform silver wire has a resistivity of 1.54×10^{-8} μm at room temperature. For an electric field along the wire of 1 volt/cm, compute the average drift velocity of the electrons, assuming that there are 5.8×10^{28} conduction electrons/m^3. Also calculate the mobility and the relaxation time of the electron.

SECTION – D

Answer **any two** questions. **(2×15=30 Marks)**

32. Describe the Hall effect. Show that the Hall coefficient is equal to $\frac{1}{ne}$. Give importance of the Hall effect.

33. Derive an expression for the specific heat of solids following the Einstein model. Discuss its agreement with experimental results at various temperature ranges.

34. Describe the Langevin theory diamagnetism.

35. i) Explain Type I and Type II superconductors.
    ii) Briefly discuss BCS theory.

(Pages : 3) **C – 1555**

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SECTION – A

Answer **all** questions, **each** carries **1** mark.

1. Which is the most symmetrical primitive unit cell ? Why ?
2. How a beam of neutrons is used in scattering studies ?
3. Explain collision time and drift velocity in conductors.
4. Explain Fermi surface.
5. What is the expression for heat capacity according to classical theory ?
6. What is a Phonon ?
7. Define Polerisability.
8. Write down different classes of magnetic materials.
9. What is critical field of superconductors ?
10. What is co-ordination number ?

P.T.O.

SECTION – B

Answer **any 8** questions, **each** carries **2** marks.

11. Define unit cell.
12. Explain inversion symmetry.
13. How a metallic bond is formed ?
14. What are the properties unique for metals ?
15. Explain drift velocity and collision time of electrons in a conductor.
16. A crystal with centre of symmetry do not exhibit piezoelectricity. Why ?
17. How band theory modify the assumptions of free electron model ?
18. Superconductors show perfect diamagnetism. Explain.
19. What is the main difference between free electron theory and band theory ?
20. Explain Wiedemann – Franz law.
21. Construct reciprocal lattice vectors from direct lattice vectors a, b and c.
22. Explain Debye T^3 law.

SECTION – C

Answer **any 6** questions, **each** carries **4** marks.

23. Explain Fermi distribution function. How it varies as temperature increases from 0 K. Show the variation graphically.
24. Discuss any two types of bonds between atoms.
25. Discuss how dipolar, ionic and electronic polerisability originated.
26. Explain assumptions made to develop Einstein model. Why it failed to predict heat capacity at lower temperatures ?
27. What is the difference between fcc and bcc structures ?
28. Show that for simple cubic system $d_{100} : d_{110} = 6^{1/2} : 3^{1/2} : 2^{1/2}$.

29. Hall coefficient of a specimen of doped silicon is $3.66\times10^{-4}m^3/C$. Resistivity of the specimen is $8.93\times10^{-3}\Omega m$. Find the mobility and density of charge carriers.

30. NaCl crystal is subjected to an electric field of 1000 V/m which results a polarisation of $4.3\times10^{-8}C/m^2$. Calculate the relative permittivity of NaCl. Permittivity of free space = $\epsilon_0 = 8.85\times10^{-12}$ F/m.

31. Derive expression for drift velocity using classical theory of conductivity.

SECTION – D

Answer **any 2** questions, **each** carries **15** marks.

32. Explain Diamagnetism. Discuss Langevin theory of diamagnetism and deduce expression for magnetic susceptibility.

33. How Miller indices specify crystal planes ? Evaluate inter planer spacing between planes labelled by (hkl). Calculate inter planer distance between (111) planes of a simple cubic crystal with cubic edge a.

34. Explain properties exhibited by materials in superconducting phase. What are type I and type II superconductors ? How BCS theory explain superconductivity ?

35. What are the assumptions proposed in band theory of solids ? Explain band structure using Kronig-Penny model.
