7. What is a crystal lattice, unit cell, primitive unit, lattice constant and lattice translational vector? Define with the below figure of the lattice points.   2×5=10

8. Describe Kronig Penney (KP) Model with figure. What is its physical significance? Describe with figure, the presence of allowed and forbidden bands in solids, accordance to the KP model.   2+3+5 =10

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[4]

M.Sc. PHYSICS
SECOND SEMESTER
CONDENSED MATTER PHYSICS
MSP – 203
(Use Separate Answer Scripts for Objective & Descriptive)

Duration : 3 hrs.   **Full Marks : 70**
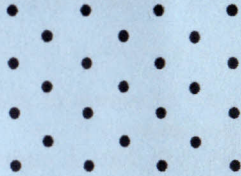
(**PART-A : Objective**)

Time : 20 min.   **Marks : 20**

Choose the correct answer from the following: *1×20=20*

1. A primitive unit cell is
    a. Highest volume unit cell   b. A crystal lattice
    c. A lattice point   d. None of the above

2. Sugar and common salt are examples of
    a. Crystalline and amorphous solids respectively
    b. Amorphous and crystalline solids respectively
    c. Crystalline solids
    d. Amorphous

3. A Brillouin zone in a solid state material is
    a. Allowed electronic energy band in k-space
    b. Forbidden electronic energy band in k-space
    c. Forbidden electronic energy band in real-space
    d. Allowed electronic energy band in real-space

4. Example of a material with covalent bonding is
    a. Sodium chloride   b. Water   c. Silicon wafer   d. Gold

5. According to Drude model, in a metal
    a. Electrons are intact and ions are free to move in the block
    b. Electrons are free to move and ions are intact in the block
    c. Both electrons and ions are intact in the block
    d. Both electrons and ions are free in the block

6. The Bloch theorem provides the notion of
    a. The periodic motion of the electrons in a crystal
    b. The periodic motion of a soliton in a crystal
    c. The free random motion of an electron in a crystal
    d. The free random motion of an soliton in a crystal

7. If electric field applied along X-axis and magnetic field is applied along Y-axis, then the Hall Voltage will be generated in
    a. X-direction   b. Y-direction
    c. Z-direct   d. At an angle $\theta<90°$ between X and Y.

8. With increase in temperature the electrical conductivity of intrinsic semi-conductor
    a. Decreases   b. Increases
    c. Remain same   d. First increase and then decreases

[1]   P.T.O.

9. In an extrinsic N-type semiconductor the Fermi level_____ in the energy band diagram.
   a. Remain in the same position
   b. Moves downwards
   c. Moves upwards
   d. Moves left

10. Curie temperature is the temperature above which
   a. A liquid become gas
   b. A paramagnet become diamagnetic
   c. A ferromagnetic become paramagnet
   d. A gas become liquid

11. Unit of electric polarization is given by
   a. Coulomb
   b. Coulomb/meter
   c. Coulomb/(meter)^2
   d. Coulomb/(meter)^3

12. Imaginary part of dielectric constant (ε_r'') in $\varepsilon_r = \varepsilon_r' - i\,\varepsilon_r''$ represents
   a. absorption
   b. dispersion
   c. intensity
   d. diffraction

13. The process of producing electric dipoles inside the dielectric by an external electric field is
   a. polarization
   b. dipole moment
   c. susceptibility
   d. magnetization

14. Ionic polarizability occurs due to
   a. splitting of ions
   b. passing of magnetic field
   c. displacement of anions and cations
   d. never occur

15. Group velocity of a free electron in terms of momentum (p) and mass (m) is
   a. $V_g = mp$
   b. $V_g = m/p$
   c. $V_g = p/m$
   d. $V_g = p^2/m$

16. Average number of phonons present in a vibrational mode can be represented by
   a. $\bar{n} = \dfrac{1}{e^{\hbar\omega/k_B T}}$
   b. $\bar{n} = \dfrac{1}{e^{\hbar\omega/k_B T} - 1}$
   c. $\bar{n} = \dfrac{1}{e^{\hbar\omega/k_B T} + 1}$
   d. $\bar{n} = \dfrac{1}{e^{(\hbar\omega - E_F)/k_B T} + 1}$

17. In monoatomic lattice, standing wave forms for the frequency (ω)
   a. $\omega > \sqrt{\dfrac{4\beta}{m}}$
   b. $\omega < \sqrt{\dfrac{4\beta}{m}}$
   c. $\omega = \sqrt{\dfrac{4\beta}{m}}$
   d. $\omega = 0$

18. The polarization (P), electric field (E) and dielectric displacement (D) is given by
   a. $E = \varepsilon_0 D + P$
   b. $D = \varepsilon_0 P + E$
   c. $D = \varepsilon_0(P + E)$
   d. $D = \varepsilon_0 E + P$

19. If $f_k = m/m^*$ represents the degree of freedom of an electron, then for free electron
   a. $f_k = 0$
   b. $f_k = 1$
   c. $f_k > 1$
   d. $f_k < 1$

20. In Piezoelectricity, the relation between polarization (P) and applied force (F) is given by
   a. $P \propto F$
   b. $P \propto \dfrac{1}{F}$
   c. $P \propto F^2$
   d. $P \propto F^3$

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[2]

Contd...

[Answer question no.1 & any four (4) from the rest]

1. Answer the following :   5+5=10
   a. Obtain an expression for the frequency of phonons generated by scattering of photons at an angle θ.
   b. If a visible light of wavelength 5000 Å undergoes scattering from a crystal of refractive index 1.5, and if the velocity of sound in the crystal is 5000 ms^{-1}, then calculate the maximum frequency of the phonon generated.

2. A. What is the origine of magnetic behaviour in solid.   2+8=10
   B. Write notes on :
      a. Ferroelectricity
      b. Piezoelectricity
      c. Diamanatism
      d. Paramagnetism

3. Describe Drude model and its significance. From Drude model deduce the expression for electrical conductivity.   5+5=10

4. Answer the following :   6+4=10
   a. Show that the molecular polarizability, $\alpha = \dfrac{3\varepsilon_0}{n}\left(\dfrac{\varepsilon_r - 1}{\varepsilon_r + 2}\right)$, where symbols have their usual meanings.
   b. Consider a CCl_4 molecule, which relative permittivity $\varepsilon_r = 2.24$, density $\rho = 1.60$ gm/cm^3, molecular weight $M_w = 156$. If an electric field of 10^7 V/m is applied to the molecule, then calculate its dipole moment.

5. What is Hall-effect? Explain with figure with proper direction of axes. From Lorentz force deduce the expression for hall coefficient. In the field of semiconductor industry how Hall effect can be a useful physical phenomena.   2+2+4+2 =10

6. What are Millar indices? Identify in figure, the miller indices (110) and (111) in a cubic crystal. Deduce the relation of inter planner spacing.   2+4+4 =10

[3]   P.T.O.