PHH 454

II Semester M.Sc. Degree Examination, September/October 2022
PHYSICS
Condensed Matter Physics and Electronics

Time : 3 Hours   Max. Marks : 70

Note : *Answer **any four** questions choosing **one each** from Parts **I–V** and Part **V** is **compulsory**.*

PART – I

1. a) Define the crystal lattice. Explain the face centered cubic unit cell.

   b) Show that the interplanar spacing of a cubic centre lattice with Miller indices (hkl) is given by :

   $$d_{hkl} = \frac{a}{(h^2 + k^2 + l^2)^{1/2}}$$

   Calculate the interplanar spacing for planes (321), (210) and (111) in a cubic lattice with a = 5.62 Å.   **(8+7)**

2. a) Explain X-ray scattering by an atom, electron and unit cell.

   b) What is the lattice vibration ? Obtain the dispersion relation for one dimensional diatomic lattice.   **(7+8)**

PART – II

3. a) Describe the behavior of electrons in three dimensional potential well.

   b) Write an expression for Fermi energy and explain it at various temperature. **(8+7)**

4. a) Obtain an expression for Fermi energy in an intrinsic semiconductor.

   b) Write notes on :

   i) Failures of free electron model and

   ii) Electrical conductivity in semiconductor.   **(7+8)**

PART – III

5. a) Discuss the characteristics of LCR circuit and justify why there is phase difference between current and voltage.

   b) $f(t) = \begin{cases} 0 & -T/2 < t < 0 \\ \lambda & 0 < t < T/2 \end{cases}$, find the Fourier series and sketch them.

   c) Explain the characteristics of Uni Junction Transistor (UJT) and its use in the construction of relaxation oscillator. **(4+4+7)**

6. a) Explain the phenomenon of narrowing the channel in a FET. How does this affects the flow of carriers through it ?

   b) Discuss the SCR characteristics and its use in the power control. **(8+7)**

PART – IV

7. a) What are the inverting and non inverting operational amplifiers ? Give a suitable explanation why their outputs are in phase inversion to each other.

   b) Explain the use of operational amplifier as a Comparator and Schmitt trigger. **(7+8)**

8. a) Discuss the voltage regulators as a three terminal and SIMPS Tristate devices.

   b) What is the multivibrator ? Discuss the multivibrator as astable and mention its frequency response output. **(8+7)**

PART – V

9. Answer **any two** questions from following : **(2×5=10)**

   a) Determine the packing efficiency and density of NaCl from the following data's

      i) radius of the Na^+ ion = 0.98 Å,

      ii) radius of the Cl^- ion = 1.81 Å,

      iii) atomic mass of Na = 22.99 amu and

      iv) atomic mass of Cl = 35.45 amu.

   b) The intrinsic carrier density at 300 K in silicon is $1.5×10^{16}/cm^3$. If the electron and hole mobilities are 0.13 and 0.05 $m^2 V^{-1}S^{-1}$ respectively. Calculate the conductivity of

      i) intrinsic silicon and

      ii) silicon containing 1 donor impurity atom per 10^8 silicon atom.

   c) Explain about bipolar transistor differential amplifier.

   d) Explain about the decoders and encoders.

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