

[Time: 2½ Hours]

[Marks: 60]

- N.B. : (1) All questions are compulsory.
(2) Draw neat diagrams wherever necessary.
(3) Figures to the right indicate full marks.
(4) Use of scientific calculator is allowed.

Q.1 (A) Attempt any **one**: (8)

1. Deduce nearly free electron approximation. Evaluate and write conclusions about Band Structure.
2. Transform the Schrödinger equation of an electron moving in the periodic potential $V(\vec{r})$ of a crystal into its reciprocal space representation.

(B) Attempt any **one**: (4)

1. Find $\epsilon(k)$ for a s-band from a single atomic s-level in a fcc lattice with lattice constant a .
2. Write a note on Tight –Binding Method

Q.2 (A) Attempt any **one**: (8)

1. How the motion of electrons takes place in bands? Explain the effective mass of electrons in bands.
2. Describe the cellular method of electronic band structure calculations in detail.

(B) Attempt any **one**: (4)

1. Discuss which equation provides explanation of de Hass-Van Alfen experimental result.
2. Show that the OPW method leads to pseudo potential method.

Turn Over

- Q.3 (A) Attempt any **one**: (8)
1. What is Hall Effect? Discuss AC Hall effect and its application?
 2. Derive the Boltzmann transport equation for the distribution function $f(\vec{r}, \vec{k}, t)$ in an external electric field \vec{E} .
- (B) Attempt any **one**: (4)
1. Describe and explain the thermoelectric Seebeck effect.
 2. What is Lorentz force? Discuss the role of it in Hall Effect.
- Q.4 (A) Attempt any **one**: (8)
1. Show that the external potential $V(\vec{r})$ is uniform function of the electron density $n(\vec{r})$.
 2. Explain the Hartree- Fock theory of free electrons.
- (B) Attempt any **one**: (4)
1. State the basic variational theorem in DFT.
 2. What is correlation energy?
- Q.5 Attempt any **four**: (12)
1. Show that mean drift velocity increases as the square root of applied electric fields.
 2. Show that $\psi_k(\vec{r})$ is periodic in reciprocal lattice.
 3. Describe the band structure of alkali and noble metals.
 4. Discuss the difficulties arises in using Cellular method for band structure calculations.
 5. Explain the concept of magnetoresistance.
 6. Write a note on Wiedmann- Franz law.
 7. What is screening effect in electron - electron interaction?
 8. Write a note of Density function theory.
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