

N.B. (1) Attempt any six questions.

(2) Note the internal options.

(3) Marks assigned to each question are written against the question.

1. Describe in detail any two electronic band structure methods below:
(a) Cellular method. (b) Augmented plane wave method. (c) Orthogonalized plane wave method. **13**

OR

2. In the Hartree-Fock method,
(a) What is the Hamiltonian and the wave function of the system?
(b) Obtain an expression for the total energy of the system. Interpret every term in it.
(c) Write the Hartree-Fock equations **13**
3. (a) For electrons in a uniform magnetic field, show that the magnetic flux through electron orbits is quantized.
(b) What is the corresponding flux quantization condition for electron orbits in reciprocal (**k**) space.
(c) Hence provide an explanation of the de Haas-van Alfen effect. **12**

OR

4. (a) Compare and contrast the band structures and Fermi surfaces of alkali and noble metals.
(b) Write a short note on cyclotron resonance. **12**
5. Obtain an expression for the potential energy of a 3-dimensional vibrating lattice in harmonic approximation. Identify the dynamical matrix and enumerate some of its properties. **12**

OR

6. (a) Obtain an expression for the phonon density of states in terms of the group velocity v_g .
(b) Explain Brillouin and Raman scattering in optical measurements of phonon spectra. **12**
7. What are the three magnetic vectors and what is the relation between them? Explain the terms susceptibility and permeability. How are magnetic materials classified on the basis of the susceptibility? **12**

OR

8. Explain the phenomenon of hysteresis in magnetic materials. Define the terms saturation magnetization, remanence and coercivity and identify these points on the hysteresis curve. Describe hard and soft magnets with suitable examples. List some of their applications. **12**
9. a) "Perfect diamagnetism and not just perfect conductivity is the sure test for superconductivity." Explain this statement with reference to superconductivity and its characteristic properties. **6**
b) What are Type I and Type II Superconductors? Explain with the help of suitable graphs. Which superconductors are used for designing superconducting magnets? **7**

OR

10. What is Josephson Effect? Describe the DC and AC Josephson effect. Explain any one application based on the Josephson effect. **13**

11. Write in brief about your self-study project. Explain how it is an extended study of the topics in the syllabus. **13**

OR

12. What were the various topics discussed for the in-depth self-study? Discuss any one of them in detail. **13**
