D3ACH2401 **(2 Pages)** **Name.....**
Reg.No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2025
(Regular/Improvement/Supplementary)

CHEMISTRY
FCHE3C09 - ELECTROCHEMISTRY, SOLID STATE CHEMISTRY AND STATISTICAL THERMODYNAMICS

Time: 3 Hours **Maximum Weightage: 30**

Section A: Short answer questions. Answer any *eight* questions. Each carries *one* weightage.

1. Define standard electrode potential. How is it measured with the Standard Hydrogen Electrode?
2. Define electrolytic polarisation. Briefly distinguish between concentration polarisation and electrolytic polarisation.
3. Why is a *5*-fold axis of symmetry not possible in crystals? Give a mathematical explanation in brief.
4. What are Bravais lattices? State the total number and types.
5. Distinguish between Schönflies and Hermann–Mauguin notations.
6. Define screw axes and glide planes as translational symmetry elements with suitable examples.
7. Define Miller indices. How are they obtained for a crystal plane?
8. How is crystal density related to unit cell content? Write the mathematical expression.
9. What are Brillouin zones? Briefly explain their significance in band theory.
10. What is the Hall Effect? Write its expression and mention an application.
11. What are colour centres in crystals? Give examples and their effect on optical properties.
12. Define macrostates and microstates in statistical thermodynamics, giving one example of each.

(8 × 1 = 8 weightage)

Section B: Short essay questions. Answer any *four* questions. Each carries *three* weightage.

13. Describe the working and applications of a reference electrode. Compare the Saturated Calomel Electrode with the Standard Hydrogen Electrode.
14. Discuss the principle of polarography. Derive the expression for half-wave potential and briefly describe its significance in analytical applications.

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15. Describe in detail the various types of imperfections in solids. Explain the origin of non-stoichiometry and its effect on material properties.
16. Explain the phenomenon of superconductivity. Describe the Meissner effect in detail and comment on the basic features of the Cooper pair theory.
17. Compare diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, and ferrimagnetism. Explain the origin of these properties in terms of electronic structure.
18. Derive the Maxwell–Boltzmann distribution law for an assembly of distinguishable particles.
19. Discuss the Einstein model for the heat capacity of solids. Derive the expression for molar heat capacity and explain its limitations compared to experimental observations.

(4 × 3 = 12 weightage)

Section C: Essay questions. Answer any *two* questions. Each carries *five* weightage.

20. Write a comparative account of fuel cells: PEMFC, AFC, PAFC, and direct methanol fuel cells. Discuss electrode reactions, cell voltages, practical advantages, and limitations of each type.
21. Derive the Butler–Volmer equation for electrode kinetics. Discuss the relationship between current density and overvoltage. Explain how this equation is applied to study electrode reactions.
22. Derive the expression for the molecular and molar partition functions and show how they factorise into translational, rotational, vibrational, and electronic parts. Discuss the contribution of each partition function to the thermodynamic properties of a system.
23. Derive the Fermi–Dirac distribution function for electrons in metals and discuss its physical significance. Explain how concepts such as Fermi energy and electronic heat capacity of metals can be derived from this theory.

(2 × 5 = 10 weightage)