

M. SC. (CHEMISTRY)
(MSCCHEM)

Term-End Examination

June, 2026

**MCHE-015 : ADVANCED KINETICS AND
ELECTROCHEMISTRY**

Time : 2 Hours

Maximum Marks : 50

Note : *Question No. 1 is compulsory. Attempt
any **four** questions from Question Nos. 2
to 7.*

1. Answer any *five* questions from the
following : 5×2=10

(a) Differentiate between parallel and
consecutive reactions.

- (b) Define quantum yield of photochemical reactions.
 - (c) Briefly explain the mechanism of the Belousov-Zhabotinskii reaction.
 - (d) What is the significance of Taube's experiments in electron transfer reactions.
 - (e) What is the rate-determining step in electrochemical reactions ?
 - (f) Write any *two* factors affecting the rate of corrosion.
 - (g) What is nucleation in electrocrystallisation ?
2. (a) (i) What is the Sabatier principle ? 2
- (ii) Describe the mechanism of the hydrogen-chlorine photochemical reaction. 3
- (b) (i) Define impact parameter and collision cross-section in reaction dynamics. 2
- (ii) Given the rate constants,
 $k_1 = 0.05\text{s}^{-1}$ and $k_2 = 0.1\text{s}^{-1}$ for

two key-steps in an oscillatory reaction, calculate the ratio of intermediate concentrations at steady state if the initial concentration of the reactant $[A] = 0.01 \text{ M}$. 3

3. (a) (i) What are solid-state reactions ? 2
(ii) Explain Wagner's mechanism for solid-state ionic diffusion. 3
(b) (i) Write Tafel equation and name the terms in it. 2
(ii) What is the rate-determining step in multistep electrode reactions ? Explain with the help of an example. 3

Or

- (iii) What is meant by the rate determining step in a multistep electrochemical reaction ? How does it control the overall rate ? 5
4. (a) Explain the process of nucleation and growth in electrodeposition. 3

- (b) An iron sheet loses 0.1 g of metal per dm^2 per day due to corrosion. Calculate the corrosion rate in mm/year. [Given : Density of Fe = 7.87 kg dm^{-3}] 3
- (c) Derive the Butler-Volmer equation and name the terms involved in it. 4
5. (a) What is electrochemical corrosion ? 2
- (b) Derive the rate law for a reversible first order reaction and explain the significance of equilibrium constant in its kinetics. 4
- (c) What are fuel cells ? Explain the working principle of a hydrogen-oxygen fuel cell. 4
6. (a) Compare supercapacitors and lithium-ion batteries in terms of energy density, power density, and life cycle. 5
- (b) Derive the Michaelis-Menten equation for a single intermediate enzyme-catalyzed reaction. What do V_{max} and K_m signify ? 5

7. (a) What is the hydrogen evolution reaction (HER) ? The exchange current density for HER on platinum is $1 \times 10^{-3} \text{ A/cm}^2$, and on nickel it is $1 \times 10^{-5} \text{ A/cm}^2$. Calculate the ratio of reaction rates at a given overpotential assuming same Tafel slope. 2+3
- (b) Describe the electrochemical theory of corrosion and explain how corrosion inhibitors prevent corrosion. 5

Or

Derive the mathematical relationship between corrosion rate and corrosion current using Faraday's law of electrolysis.

× × × × ×