B.Sc. Eng.ME/1st Sem.

Date: 10 April 2026
Afternoon

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination
Course Number: Chem 4115
Course Title: Physical and Inorganic Chemistry

Winter Semester: 2024-2025
Full Marks: 120
Time: 2 Hours

Please answer according to the order of the questions. Answer all the **4 (FOUR)** questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in the brackets.

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1. a) Discuss the principle of VSEPR theory. Draw the shape of following species and explain the reasons for corresponding geometry. (5+10) CO2, PO1, WK1, WP1
i) SO_2 ii) SF_4 iii) SO_4^{2-} iv) IBr_5 v) XeF_4

b) Consider a cell constructed by the following two half-cells (8+3+4) CO2, PO1, WK1, WP1
Pb^{2+} (aq.) + $2e^-$ = Pb(s) $E^0 = -0.13$ V
Hg^{2+} (aq.) + $2e^-$ = Hg(s) $E^0 = 0.90$ V

i) Draw a cell diagram and write down the cell notation, half-cell reaction, complete cell reaction, and discuss the spontaneity of the cell reaction.
ii) Calculate the cell emf at 25^0C, When the concentrations of Pb^{2+} and Hg^{2+} are 0.100 M and 0.001M, respectively.
iii) Calculate the maximum electrical work of the above cell when 0.05g of Hg is deposited. (Atomic mass of Hg = 200.59).

2. a) Consider the following reaction (9+6) CO2, PO1, WK1, WP1

$$A \rightarrow P$$

Derive integrated rate equations and discuss the relationship between rate constant and half-life, when the reaction is
i) zero order ii) first order and iii) second order

b) Explain Kohlrausch law of independent migration of ions. (4+3+8) CO2, PO1, WK1, WP1

i) The molar conductivities at infinite dilution (Λ_m^0) for sodium acetate, hydrochloric acid, and sodium chloride are 91.0, 425.9, and 126.4 Scm^2mol^{-1} respectively. Calculate the molar conductivity at infinite dilution for acetic acid.
ii) The specific conductivity of 0.00241 M acetic acid is 7.896×10^{-5} Scm^{-1}. Calculate the degree of dissociation and dissociation constant of acetic acid.

3. a) Discuss the working principle of a primary cell. (7) CO1, PO1, WK1, WP1

b) Describe different types of liquid crystals and write down their application. (9+3) CO1, PO1, WK1, WP1

c) Draw the molecular orbital diagram of NO and discuss the following terms: (4+3+2+2) CO1, PO1, WK1, WP1

i) bonding molecular orbital and antibonding molecular orbital.
ii) bond order.
iii) magnetic properties.

4. a) Derive an equation for rate constant of a general reaction A + B→ P according to the collision theory. (7) CO1, PO1, WK1, WP1

b) Discuss the factors favoring for the formation of ionic bond. (8) (CO1, PO1)

c) Discuss different types of organic chemical reactions. (7) CO1, PO1, WK1, WP1

d) Explain that variation of equivalent conductance with concentration change for both weak and strong electrolytes. (8) CO1, PO1, WK1, WP1