

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING (EEE)

Mid Examination

Course No.: Chem 4121

Course Title: Engineering Chemistry

Winter Semester, A. Y. 2024-2025

Time: 2 hours

Full Marks: 120

There are **4 (four)** questions, answer **all** of them. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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|------|---|----|------------|
| 1 a) | Define quantum number and find whether each of the following sets of quantum numbers is permissible for an electron in an atom. Justify your answer with proper reasons.
(i) $n = 1, l = 1, m = 0, s = +1/2$
(ii) $n = 3, l = 1, m = 2, s = -1/2$
(iii) $n = 2, l = 1, m = 0, s = +1/2$
(iv) $n = 2, l = 0, m = 1, s = 1$ | 7 | CO1
PO1 |
| b) | Explain why four quantum numbers are necessary to describe an electron in an atom. | 8 | CO1
PO1 |
| c) | Derive mathematical expression for the calculation of energy of n^{th} orbit of hydrogen atom.
Find the difference in radius between 3 rd and 5 th orbit of hydrogen atom (in S.I. unit). | 15 | CO2
PO1 |
| 2 a) | Describe the following reactions with example:
Elimination reaction, Polymerization, Isomeric transformation, Redox reaction, and Disproportionation reaction. | 7 | CO1
PO1 |
| b) | State Mendeleev periodic law and Modern periodic law. Find the position of the following elements in the periodic table.
Cu, Ge, Cr, Se, Zn | 8 | CO1
PO1 |
| c) | Explain Hund's principle and ionization energy.
Briefly discuss the factors affecting the ionization energy of elements in the periodic table. | 15 | CO2
PO1 |
| 3 a) | State and explain Kohlrausch's law. | 7 | CO1
PO1 |
| b) | Define the equivalence point in pH curve.
15.0 mL 0.10 M HF is titrated with 0.10 M KOH.
Calculate the pH of the solution
i) When no KOH is added
ii) When 17.0 mL KOH is added. (Given that $K_a = 7.1 \times 10^{-4}$). | 8 | CO2
PO1 |

- c) Describe working principle of a fuel cell and write down the advantages of it. 15 CO2
 Consider a cell constructed of the following two half-reactions. PO1

$$\text{Cd}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cd}(\text{s}); E^{\circ} = -0.40 \text{ V}$$

$$\text{Ag}^{+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Ag}(\text{s}); E^{\circ} = 0.80 \text{ V}$$
- Write down the cell notation for the above cell.
 - Write down the total cell reaction
 - Calculate the cell potential and predict the spontaneity of the cell reaction.
- 4 a) Describe the factors that affect the rate of a chemical reaction. 9 CO1
 PO1
 b) Arrange the following acids in order of increasing acidity and justify: HClO_4 , 6 CO1
 HClO_3 , HClO_2 and HClO . PO1
- c) Deduce the mathematical equation for the rate constant of a first order reaction. 15 CO2
 Prove that half-life of a first order reaction is independent of concentration of PO1
 reactant.
 The decomposition of N_2O_5 to NO_2 and O_2 is first-order with a rate constant of $4.80 \times 10^{-4} \text{ s}^{-1}$ at 45°C .
- If the initial concentration is $1.65 \times 10^{-2} \text{ mol/L}$, what is the concentration after 825 s?
 - How long would it take for the concentration of N_2O_5 to decrease to $1.00 \times 10^{-2} \text{ mol/L}$ from its initial value?