RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences

Third Year– Semester I Examination – November/ December 2016

CHE 3207 – ELECTROCHEMISTRY

Answer ALL questions   **Time: Two (2) hours**


Universal Gas Constant (R) = 8.314 J K^{-1} mol^{-1}, Faraday Constant (F) = 96486 C mol^{-1}

The use of a non-programmable calculator is permitted.

1.

i. Explain the term (a) exchange current density and (b) anodic over potential with reference to the reaction, $M^{n+} + ne^- \rightleftharpoons M$

[16 marks]

ii. Draw and label a free energy versus distance plot for the above reaction where (a) the reaction is in equilibrium and (b) metal dissolution takes place

[14 marks]

iii. Determine whether Zn is stable in aqueous solution of HCl with pH 0. The initial concentration of Zn^{2+} is 1×10^{-6} mol dm^{-3}. E^0 (Z^{2+}/Zn) = 0.762 V

[20 marks]

iv. What is meant by cathodic protection? Explain with an appropriate example

[20 marks]

v. Consider that the following reactions that are possible at the metal "iron" under wet conditions.
  a) Assign each reaction to the boundary lines A-C, C-F, F-E, E-D, C-E, C-D, D-B, C-B, and A-B of the pourbaix diagram.
  b) Identify the possible form of iron available in the zones A, B, C, D, E, and F of the pourbaix diagram.

[30 marks]
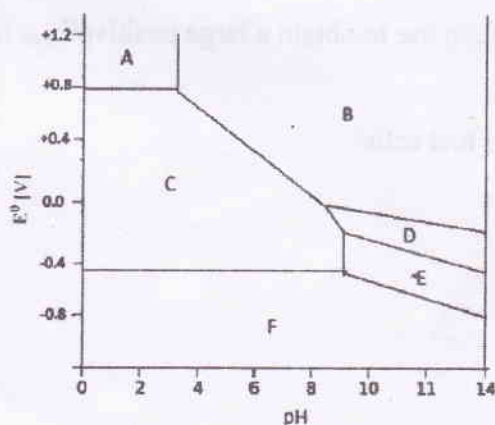
i. $Fe^{2+} + 2e \longrightarrow Fe$ ($E^0 = -0.44$)

ii. $Fe^{3+} + e \longrightarrow Fe^{2+}$ ($E^0 = +0.77$)

iii. $Fe(OH)_2 + 2H^+ + 2e \longrightarrow Fe + 2H_2O$

iv. $Fe_2(OH)_5 + H^+ + e \longrightarrow 2Fe(OH)_2 + H_2O$

v. $2Fe(OH)_3 + H^+ + e \longrightarrow Fe_2(OH)_5 + H_2O$

vi. $Fe(OH)_3 + 3H^+ + e \longrightarrow Fe^{2+} + 3H_2O$

vii. $Fe^{3+} + 3H_2O \longrightarrow Fe(OH)_3 + 3H^+$

viii. $Fe^{2+} + 2H_2O \longrightarrow Fe(OH)_2 + 2H^+$

ix. $Fe_2(OH)_5 + 5H^+ + e \longrightarrow 2Fe^{2+} + 5H_2O$

2. i. Discuss the electrochemistry involved in the extraction of Al from bauxite and the production of Cu by hydrometallurgy. Comment on the major drawbacks in these two methods.

[50 marks]

   ii. Write a short note on "electrocatalysts" involving working principle, properties and applications.

[50 marks]

3.

   i. Discuss, briefly the salient features that one should concern in electro- organic synthesis.

[20 marks]

   ii. Compare and contrast with necessary reactions for the electro and chemical synthesis of adiponitrile, starting from a known organic compound.

[50 marks]

   iii. Explain the mechanism of electrochemical polymerization of aniline and list the factors that influence the polymerization.

[30 marks]

4.

   i. Define the following battery characteristics.
      a) Capacity
      b) Electricity storage density
      c) Cycle life
      d) Energy efficiency

[20 marks]

   ii. "A battery is an energy storage device" Explain with the help of electrochemical reactions in a Ni-Cd battery and explain how it differs from a fuel cell in terms of physical and chemical conditions.

[40 marks]

   iii. Give three strategies a battery designer can use to obtain a large positive E_{cell} for a battery.

[20 marks]

   iv. What are the main benefits of hydrogen fuel cells?

[20 marks]