Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	CORROSION AND PREVENTION
COURSE CODE	:	BDB 40403
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	DECEMBER 2018/JANUARI 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **FIVE (5)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **SEVEN** (7) PAGES

Q1 (a) Discuss the effects of corrosion to social and environmental

(5 marks)

(b) What is Direct and Indirect Corrosion? Give an example for each.

(5 marks)

(c) With a sketch, explain corrosion on steel under drop of water.

(5 marks)

(d) An electrochemical cell is constructed as shown in **Figure Q1 (d).** A strip of Sn and a strip of unknown metal Y are used as electrodes. When the switch is closed, the mass of the Sn electrode increases. Write the half-reactions of anode and cathode. If the standard cell potential E^{o}_{cell} is +0.60 V, what is the standard potential (in volts) for *Y* electrode? Identify your metal *Y*.

(5 marks)

Q2 (a) With an appropriate diagram, explain clearly the difference between activation polarization and concentration polarization.

(5 marks)

(b) Explain how to measure uniform corrosion

(5 marks)

(c) Explain how to control corrosion during design stage

(5 marks)

(d) The concrete roof of swimming pool at Universiti Tun Hussein Onn collapsed. The roof was supported by stainless steel rods. Scene investigation identified that chloride-based disinfectants were used in the pool. The temperature was maintained at ambient and high humidity were observed. Predict what form of corrosion caused the roof to collapse give your suggestion for prevention.

(5 marks)

Q3 (a) A galvanic cell consists of an electrode of magnesium in a 0.05 M solution of $MgSO_4$ and an electrode of copper in a 0.09 M solution of $CuSO_4$ at 25°C. The two electrodes are separated by a porous wall.

(i) Write the anodic and cathodic half-cell reactions for the electrode-electrolyte conditions using E^{o} values in **Table Q3** and identify the value for standard cell potential, E^{o}_{cell}.

(5 marks)

(ii) What is the function of porous wall

(5 marks)

(b) Name electrochemical points (A,B and C) and regions (D and E) in **Figure Q3 (b)**

(5 marks)

(c) Give FOUR (4) methods to control corrosion

(5 marks)

Q4 (a) Explain the application of volatile corrosion inhibitor

(5 marks)

(b) A voltaic cell is created under standard conditions with the cell notation $Cu_{(s)} \mid Cu^{2+}_{(aq)} \parallel Ag^{+}_{(aq)} \mid Ag_{(s)}$

Write the anodic and cathodic half-cell reactions and balanced net-ionic equation for the overall chemical reaction occurring in the cell. Identify the value for standard cell potential, E^{o}_{cell}.

(5 marks)

(c) Give FIVE (5) common atmospheric for classification of atmospheric corrosion.

(5 marks)

(d) Two admiralty brass (71% Cu, 28% Zn, 1% Sn) heat exchanger tubes from a cooler in a refinery unit showed cracks. Results from inspection found both tubes showed cracks extending circumferentially above 180°C on the tension side of the U-bend. Tube 1 showed a relatively smooth surface, whereas Tube 2 showed buildup of corrosion products. Tube 1 showed cracking with minimum branching propagating from inside the tube. By EDX-ray analysis, the presence of copper and zinc ions and some small amounts of chloride, sulfur, silicon and tin were observed. Identify the form of corrosion caused the heat exchanger to fail and suggest your corrosion prevention.

(5marks)

Q5 (a) Give different regimes of framework for treating atmospheric corrosion

(5 marks)

(b) What are the major factors affecting atmospheric corrosion

(5marks)

(c) With an appropriate diagram, briefly explain about anodic protection

(5 marks)

(d) What are the advantages of using impressed current cathodic protection (ICCP) to protect metal from corrosion.

(5 marks)

Q6 (a) Explain how to measure atmospheric corrosion

(5 marks)

(b) Explain the differences between Stress Corrosion Cracking and Hydrogen Embrittlement

(5 marks)

(c) Cylic polarization potential of stainless steel and unknown metal X are shown in **Figure Q6 (c)**. Compare the corrosion properties between these two metals. Which metal has better corrosion resistance?

(5 marks)

(d) A steel screw is attach to a steel body, with time, the area at the bottom of the screw start to corrode. Suggest THREE (3) suitable solutions to prevent this corrosion from happen.

(5 marks)

-END OF QUESTION –

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Table Q3: EMF Series of standard electrode potential at 25 °C

Half-Cell Reaction	E^o (volts)
$F_2 + 2e \longrightarrow 2F^-$	2.87
$Au^+ + e \longrightarrow Au^+$	1.68
$Cl_2 + 2e \longrightarrow 2Cl^-$	1.36
$O_2 + 4H^+ + 4e \longrightarrow 2H_2O$	1.229
$O_2 + 4H^+ (10^{-7}\ M) + 4e \longrightarrow 2H_2O$	0.82
$Ag^+ + e \longrightarrow Ag$	0.799
$Fe^{3+} + e \longrightarrow Fe^{2+}$	0.771
$O_2 + 2H_2O + 4e \longrightarrow 4OH^-$	0.48
$Cu^{2+} + 2e \longrightarrow Cu$	0.337
$2H^+ + 2e \longrightarrow H_2$	0.0000
$Pb^{2+} + 2e \longrightarrow Pb$	-0.126
$Sn^{2+} + 2e \longrightarrow Sn$	-0.14
$Ni^{2+} + 2e \longrightarrow Ni$	-0.25
$Co^{2+} + 2e \longrightarrow Co$	-0.28
$Fe^{2+} + 2e \longrightarrow Fe$	-0.44
$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$	-0.74
$Zn^{2+} + 2e \longrightarrow Zn$	-0.763
$Al^{3+} + 3e \longrightarrow Al$	-1.66
$Mg^{2+} + 2e \longrightarrow Mg$	-2.34
$Na^+ + e \longrightarrow Na$	-2.714
$Ca^{2+} + 2e \longrightarrow Ca$	-2.87
$K^+ + e \longrightarrow K$	-2.925

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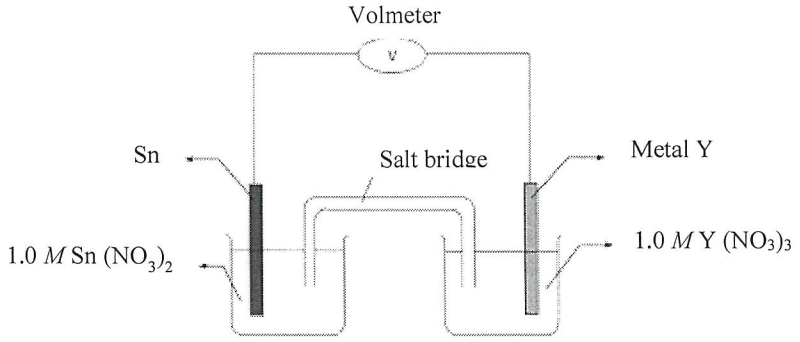

Figure Q1 (d).

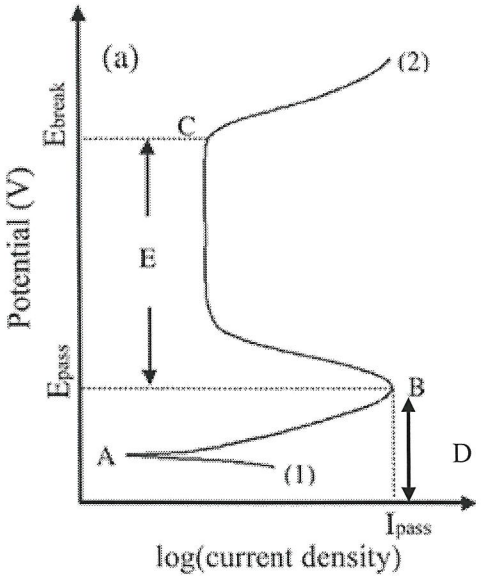

Figure Q3(b)

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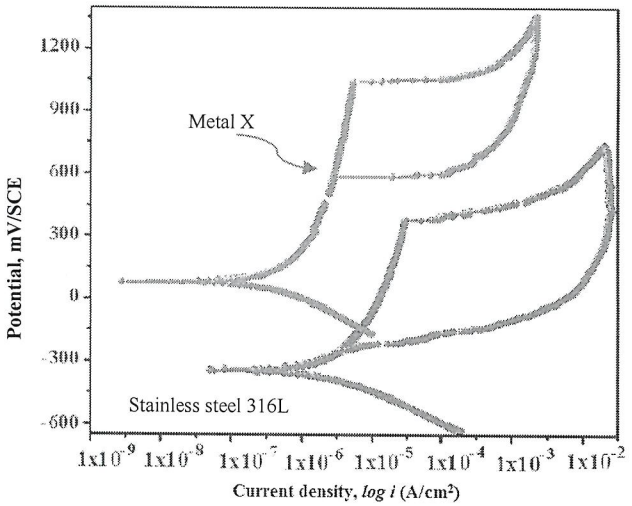

Figure Q6 (c)