



**UNIVERSITI KUALA LUMPUR
Malaysia France Institute**

**FINAL EXAMINATION
SEPTEMBER 2013 SESSION**

SUBJECT CODE : FTB 33103
SUBJECT TITLE : CORROSION
LEVEL : BACHELOR
TIME / DURATION : (2 HOURS)
DATE :

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper **CAREFULLY**.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of **TWO (2)** sections. Section A and B. Answer **ALL** questions in Section A. For Section B, answer **TWO (2)** question only.
6. Answer all questions in English.

THERE ARE 4 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)**INSTRUCTION: Answer ALL questions.****Please use the answer booklet provided.****Question 1**

- (a) Corrosion is defined as the destruction or deterioration of a material because of the reaction with its environment such as air and moisture, mine waters, steam or other gases. Explain briefly the factors listed below that need to be consider in corrosion aspects instead of environment.
- (i) maintenance and operation cost, (3 marks)
 - (ii) contamination of product, (3 marks)
 - (iii) effects on safety and reliability, and (3 marks)
 - (iv) plant shutdowns (3 marks)
- (b) In corrosion, it is suggested that the higher the temperature, the faster a given chemical reaction will proceed. Quantitatively this relationship between the rate a reaction proceeds and its temperature is determined by the Arrhenius Equation. At higher temperatures, the probability that two molecules will collide is higher. This higher collision rate results in a higher kinetic energy, which has an effect on the activation energy of the reaction. The activation energy is the amount of energy required to ensure that a reaction happens. The equation is as below:

$$R = A \exp\left(-\frac{E_a}{kT}\right)$$

where k is the rate coefficient, A is a constant, E_a is the activation energy, R is the universal gas constant, and T is the temperature (in kelvin). R has the value of $8.314 \times 10^{-3} \text{ kJ mol}^{-1}\text{K}^{-1}$.

- (i) Derive the equation in logarithmic form. (2 marks)

(ii) Arrhenius plot is useful in extracting activation energy and pre-exponential factor from experimental kinetic data. Sketch and relate the Arrhenius equation in linear plot.

(6 marks)

Question 2

(a) Define rust.

(4 marks)

(b) Using a schematic diagram below, describe **FOUR (4)** conditions that cause rusting.

(8 marks)

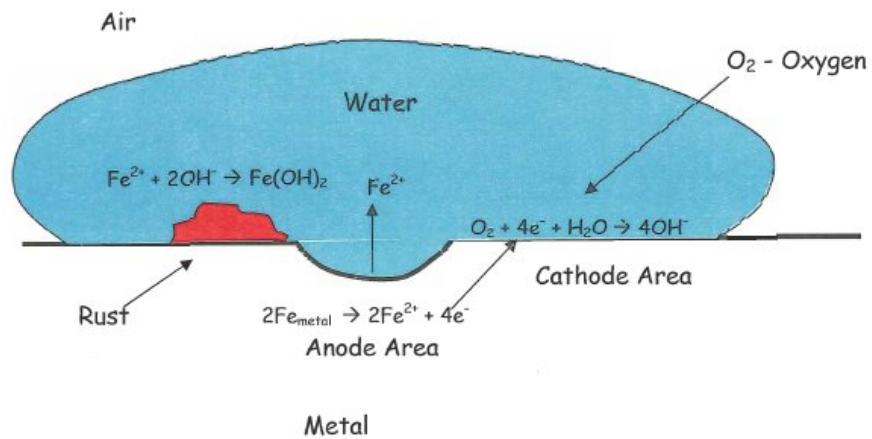


Figure 1.

(c) Suggest the method that can be used to prevent metal car body from rusting?

(10 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer TWO (2) questions only.

Please use the answer booklet provided.

Question 1

(a) Figure 2 shows a schematic diagram of the corrosion mechanism.

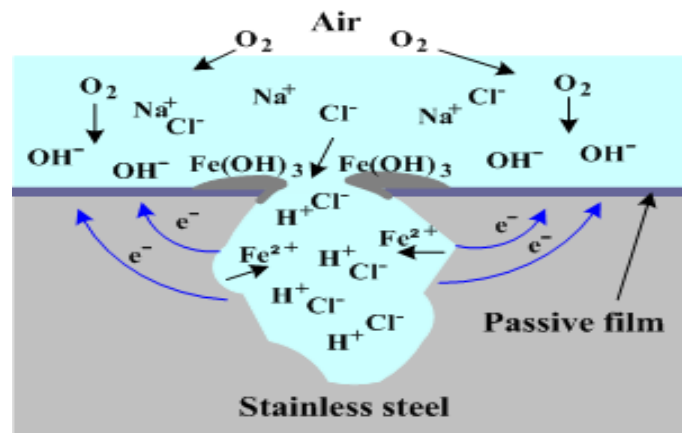


Figure 2

- (i) Identify the type of corrosion according to the schematic diagram shown in Figure 2. (2 marks)
- (ii) List **FOUR (4)** environmental conditions that could promote corrosion shown in Figure 2. (8 marks)
- (iii) Explain how to prevent corrosion shown in Figure 2. (8 marks)
- (b) (i) Define the corrosion inhibitor. (2 marks)
- (ii) Explain corrosion inhibition mechanism. (6 marks)
- (iii) List **FOUR (4)** places where corrosion inhibitor commonly applied? (4 marks)

Question 2

- (a) Define the cathodic protection.
(4 marks)
- (b) Using the suitable schematic diagram, briefly explain the principle of the following techniques.
- (i) Sacrificial anode technique.
(10 marks)
- (ii) Impressed current technique.
(10 marks)
- (c) Describe the advantages and disadvantages of sacrificial anode against impressed current techniques.
(6 marks)

Question 3

- (a) Define Protective Coating.
(2 marks)
- (b) List **FOUR (4)** types of protective coating which used for corrosion control.
(4 marks)
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- (c) Hot dip coating is one of the method used to withstand the corrosion attack. Briefly define and explain the process of this technique.
(8 marks)
- (d) Discuss the advantages and disadvantages of this technique.
(6 marks)
- (e) Compare cathodic and anodic protections in term of applicability, environmental condition, operation cost, and equipment.
(10 marks)

END OF QUESTIONS