



UNIVERSITI  
TEKNOLOGI  
PETRONAS

## FINAL EXAMINATION MAY 2024 SEMESTER

**COURSE** : **AAB4223 - DEGRADATION MECHANISM AND PREVENTION**  
**DATE** : **5 AUGUST 2024 (MONDAY)**  
**TIME** : **9.00 AM - 12.00 NOON (3 HOURS)**

### INSTRUCTIONS TO CANDIDATES

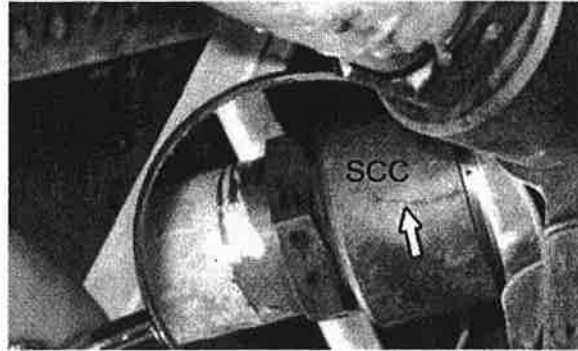
1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. **DO NOT** open this Question Booklet until instructed.

**Note** :

- i. There are **SIX (6)** pages in this Question Booklet including the cover page and appendix.
- ii. **DOUBLE-SIDED** Question Booklet.

1. a. Aluminum alloys used in aircraft construction are particularly prone to stress corrosion cracking (SCC) as shown in **FIGURE Q1**. Propose **THREE (3)** methods to mitigate SCC. Justify your answer.

[12 marks]



**FIGURE Q1: AIRCRAFT COMPONENT**

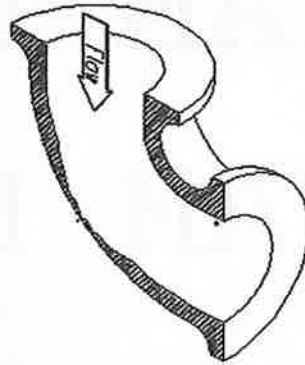
- b. Explain the process of erosion-corrosion in the oil and gas industry and suggest **TWO (2)** effective preventive measures.

[6 marks]

- c. Discuss a common type of corrosion that can impact aluminum alloys in marine environments and suggest a preventive method.

[7 marks]

2. Wear issues are frequently encountered in the oil and gas industry. Elbow steel pipeline, which has been used for many years to transport semi-solid liquids as illustrated in **FIGURE Q2**.

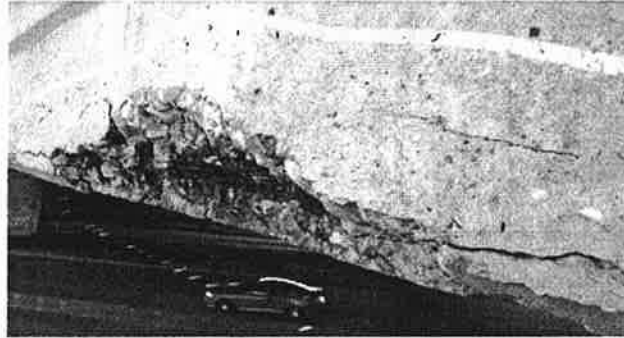


**FIGURE Q2: ELBOW STEEL PIPELINE**

- a. Explain the underlying mechanism associated with this form of erosive wear. [7 marks]
- b. Analyze **THREE (3)** factors that influence the occurrence of erosive wear. [8 marks]
- c. Suggest **THREE (3)** prevention methods to minimize the erosive wear. Justify your answer. [10 marks]

3. a. Describe a possible damage mechanism for the materials below.
- (i) Reinforced concrete in marine environments.  
[3 marks]
  - (ii) Wood in tropical climate.  
[3 marks]
- b. Government agencies are currently encouraging the adoption of biodegradable plastic products through various measures and initiatives to meet the Sustainable Development Goals (SDGs).
- (i) Discuss the environmental factors in Malaysia that affects the degradation of biodegradable plastic food containers.  
[9 marks]
  - (ii) Propose **TWO (2)** chemical names of biodegradable polymers that naturally decompose in soil and water. Justify your answer by explaining the underlying mechanisms.  
[10 marks]

4. Reinforced concrete is crucial in modern construction for its strength and durability, especially in bridges. However, it degrades over time due to corrosion, swelling, and cracking, as shown in **FIGURE Q4**.



**FIGURE Q4: DEGRADED CONCRETE**

- a. Explain **TWO (2)** primary causes for swelling damage in bridge structures.  
[6 marks]
- b. Discuss the carbonation process towards the corrosion damage in the reinforced concrete. Justify the answer.  
[6 marks]
- c. Steel bars embedded in reinforced concrete are subject to corrosion. Explain the underlying mechanism and provide a sketch to support your answer.  
[8 marks]
- d. A 2-meter-long with 0.02-meter diameter steel bar in reinforced concrete was exposed to corrosion for 10 years. Its weight decreased from 3000 grams to 2950 grams. With a steel density of  $7.85 \text{ g/cm}^3$  and an exposed surface area of  $200 \text{ cm}^2$ , calculate the corrosion rate in mm/year.  
[5 marks]

- END OF PAPER -

## FORMULAE

$$CPR = \frac{KW}{\rho AT}$$