

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY**MECHANICAL ENGINEERING DEPARTMENT****2024 SEMESTER TWO – FINAL EXAMINATIONS****ME424 – FAILURE ANALYSIS****TUESDAY OCTOBER 22th, 2024****TIME ALLOWED: TWO HOURS****INSTRUCTIONS TO STUDENTS:**

1. Please ensure that you write your NAME and NUMBER on the front page.
2. Kindly respond to all questions directly without including unnecessary information.
3. Mobile phones, additional paper, notes, and textbooks are strictly prohibited.
4. Any form of cheating will result in severe punishment.

Thank you for your cooperation.

MARKING SCHEME: 40**PART I: SHORT ANSWER QUESTIONS****[20 MARKS]**

1. Why are large structures e.g. ships, bridges, and oil rigs) made of steel much more likely to fail in cold winter environments rather than in warm summer climates? *[5 marks]*
2. How can corrosion be prevented? Please list five methods to prevent corrosion. *[5 marks]*
3. What is the bathtub curve and the creep curve in detail? When explaining, please sketch and label the axes and other parts of the curves. *[10 marks]*

PART II: SOLVE THE FOLLOWING PROBLEMS**[20 MARKS]**

1. A large plate is fabricated from a steel alloy that has a plane strain fracture toughness of $55\text{MPa}\sqrt{\text{m}}$. If during service use, the plate is exposed to a tensile stress of 200MPa . Determine the minimum length of surface crack that will lead to fracture. Assume a value of 1.0 for Y . Report your answer in mm. [3 marks]
2. A carbon steel 4130 sheet, with an area of 400 cm^2 , was subjected to a corrosive atmospheric environment. Subsequently, after one-year duration, it exhibited a weight loss of 375 grams as a result of corrosion. What is the corrosion rate in mm/year? [3 marks]
3. A fatigue test was conducted in which the mean stress was 50MPa and the stress amplitude was 225MPa . [6 marks]
 - a) Calculate the maximum and minimum stress levels.
 - b) Calculate the stress ratio.
 - c) Calculate the magnitude of the stress range.
4. Of those metals listed in Table below: [8 marks]
 - a) Which will experience the greatest percent reduction in area? Why?
 - b) Which is the strongest? Why?
 - c) Which is the stiffest? Why?
 - d) Which is the hardest? Why?

Material	Yield Strength MPa	Tensile Strength MPa	Strain at Fracture MPa	Fracture Strength MPa	Elastic Modulus GPa
A	310	340	0.23	265	210
B	100	120	0.40	105	150
C	415	550	0.15	500	310
D	700	850	0.14	720	210
E	Fracture before yielding			650	350