



GWANDA STATE UNIVERSITY

**FACULTY OF ENGINEERING AND ENVIRONMENT
DEPARTMENT OF METALLURGICAL ENGINEERING
ENGINEERING FAILURE ANALYSIS**

EMG 3202

JUNE 2025 EXAMINATIONS

This examination consists of 5 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Graph paper and a scientific calculator

INSTRUCTIONS

- 1. Answer any 5 questions**
- 2. Each question carries 20 marks**

Question 1

- a) Define the term “mean stress” [2]
- b) Explain four safety rules that should be followed when conducting a liquid penetrant test. [4]
- c) Why do welds have lower fatigue resistance when compared to the parent material. [4]
- d) Explain two benefits of using FMEA. [4]
- e) You are to assemble a team of five professionals to conduct an FMEA for a blast furnace that processes iron. List the professionals and explain the criteria you will use in choosing the members of the FMEA team. [6]

Question 2

- a) List three measures that can be taken to increase the resistance of welded joints in tanks to fatigue failure. [3]
- b) With the aid of diagrams describe four basic steps on how to conduct a liquid penetrant test. [5]
- c) Fatigue life of a heat exchanger can be improved during the design phase. Explain four ways this can be done. [4]
- d) What is the role of the risk priority number (RPN) in FMEA. [2]
- e) Explain three characteristics of a material that can be detected using visual inspection. [6]

Question 3

- a) State two advantages of acoustic emission testing [2]
- b) Outline how corrosion affect fatigue resistance [4]
- c) Explain the three different types of FMEA [6]
- d) Distinguish between destructive and non-destructive testing [4]
- e) Describe two ways you can prevent thermal fatigue in boilers [4]

Question 4

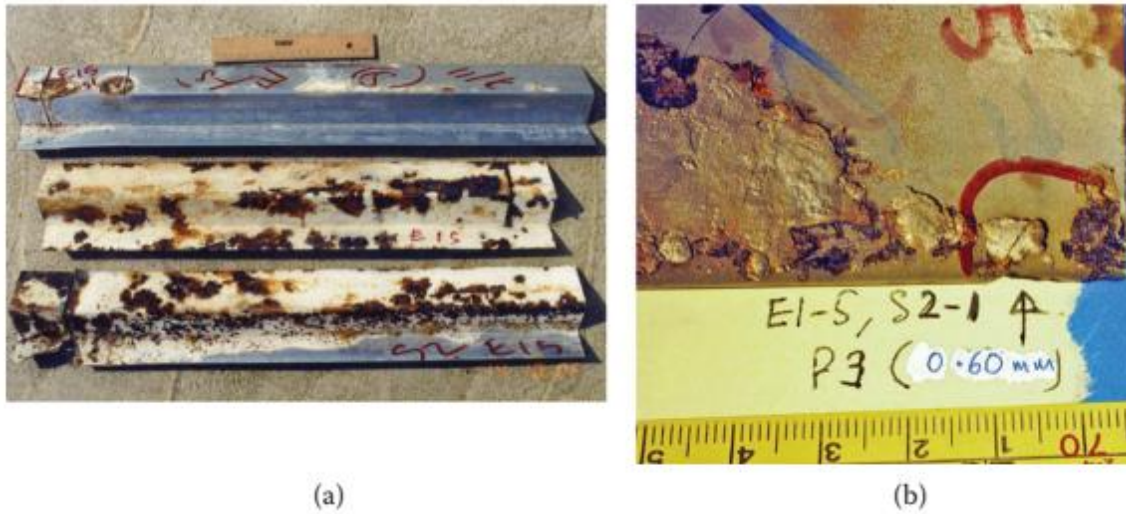


Figure 1 above shows: (a) Corroded Z-spacers from rectified bay E1-5 and (b) localized corrosion and pitting attack on the corroded Z-spacer from bay E1-5.

From the information in Figure 1 above, give full details on how you would carry out:

- a) Site inspection. [5]
- b) Metallurgical examination. [5]
- c) Mechanical examination. [5]
- d) Chemical analysis. [5]

Question 5

- a) The properties of some materials are profoundly influenced by the presence of imperfections (flaws), give an account of how these flaws affect the operation of the part or component. [5]
- b) Using diagrams explain interfacial defects of a part. [5]
- c) Figure 2 below shows a ductile–brittle transition temperature curve

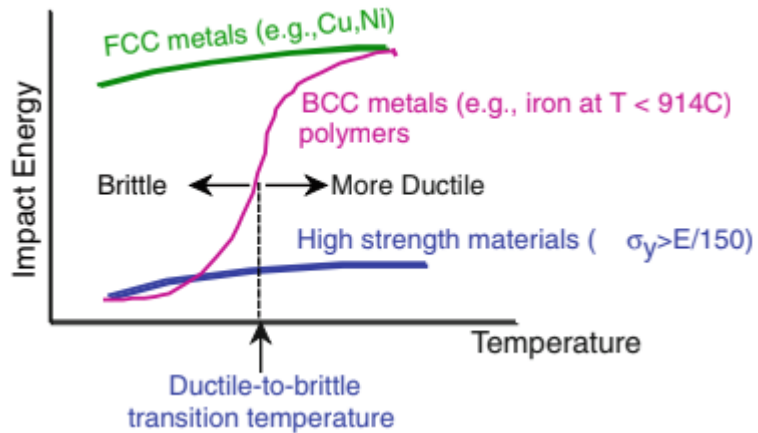


Figure 2: Ductile–brittle transition temperature curve

- d) Explain the ductile-to-brittle phenomenon. [4]
- e) With the aid of examples explain the differences between destructive and non-destructive testing. [6]

Question 6

- a) Briefly explain the following fault analysis techniques
- i. Fault Tree Analysis. [3]
 - ii. Fault Hazard Analysis. [3]
 - iii. Common Cause Failure Analysis. [3]
- b) Describe the Griffith Crack theory. [3]
- c) What are the applications of various welding processes in metallurgical engineering. [8]