



GWANDA STATE UNIVERSITY
FACULTY OF ENGINEERING AND ENVIRONMENT
DEPARTMENT OF METALLURGICAL ENGINEERING
ENGINEERING FAILURE ANALYSIS

EMR3202

July/ August 2022 Examinations

This examination consists of 5 pages

Time Allowed: 3 hours
Total Marks: 100
Special Requirements: Graph paper and a scientific calculator
Examiner's Name: Miss K.L Mahamba

INSTRUCTIONS

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

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QUESTION 1

- a. What is failure analysis? [2]
 - ii. Use specific examples to explain its importance in engineering. [5]
- b. What are the 5 factors that influence the level of performance of a part of a component? [5]
- c. Define fatigue and specify the conditions under which it occurs. [3]
- d. Discuss briefly how imperfections affect the operation of a component. [5]

QUESTION 2

- a. Hydrogen is a problem in welded joints. Briefly discuss the sources of hydrogen in a welded joint and how these can be minimized. [10]
- b. The following data applies to extruded and cold rolled nickel alloy (Nimonic 80A) at 750°C.

Given data:

Young's modulus = 140GPa

0.2% proof stress= 450 MPa

Elongation to fracture = 25% (short term tensile strength)

Mean coefficient of thermal expansion (20-750°C) = 15.8×10^{-6}

The stress to cause a plastic creep strain in 3000 hrs is

Stress (MPa)	110	130	160
Strain %	0.1	0.2	0.5

Estimate the coefficient n in a power law representation between stress and strain rate. What would be the total change in length of a bar of 50mm initial length at 20°C, when held at a stress of 150 MPa? [10]

QUESTION 3

Analyse and give a suitable explanation and remedy for the failure – incident shown in Figure 1.

[20]



Figure 1

QUESTION 4

In a Metallurgical Plant setup, a conveyor belt fails due to a taper roller bearing failure. Carry out a failure analysis for the bearing failure and give a detailed account of the failure showing the entire process. The Failure Mode and Effect Analysis method may be used, paying special attention to the failure modes and effects. [20]

QUESTION 5

a. List 5 common types of mechanical failures that are encountered in engineering components and structures. [5]

b. Give a detailed account of the factors that contribute to the fracture of a material. [15]

QUESTION 6

- a.** With the aid of diagrams, explain interfacial defects of a part. **[4]**
- b.** Non-destructive testing methods can be used to detect both surface, subsurface and internal defects. List four non-destructive test methods and indicate for each method listed whether it detects internal, surface, subsurface defects or both. **[8]**
- c.** Describe the principles of magnetic particle inspection (MPI). What are the limitations of MPI compared to radiographic techniques? **[8]**

QUESTION 7

- a.** Using a diagram show how the Fault Tree Analysis is used in a failure analysis process. **[10]**
- b.** Comment on the differences between ductile and brittle fractures. **[6]**
- c.** Explain what the failure of engineering component is? **[4]**

QUESTION 8

- a.** Discuss in detail how you can design against failure, giving examples where possible. **[10]**
- b.** The following are fault analysis techniques in common use. Give a brief explanation of each:
 - i.** Fault Hazard Analysis. **[5]**
 - ii.** Common Cause Failure Analysis. **[5]**

END OF QUESTION PAPER