GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND ENVIRONMENT

DEPARTMENT OF METALLURGICAL ENGINEERING

ENGINEERING FAILURE ANALYSIS

EMR3202

This examination consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Graph paper and a scientific calculator

Examiners' Names: Miss K.L Mahamba and Dr L Mugwagwa

INSTRUCTIONS

1. Answer any 5 questions

2. Each question carries 20 marks

Question 1

You are an engineer for company X, responsible for a fluidised bed reactor used to dry coal fines. How would you conduct a Failure mode effect analysis of the fluidised bed reactor? **[20]**

Question 2

a. With the aid of examples explain the differences between destructive and non-destructive testing. **[6]**

b. Describe the following types of destructive testing, including diagrams

i. Liquid penetrant testing. **[5]**

ii. Magnetic particle testing. **[5]**

c. With the aid of an example explain what you understand by fatigue failure. **[4]**

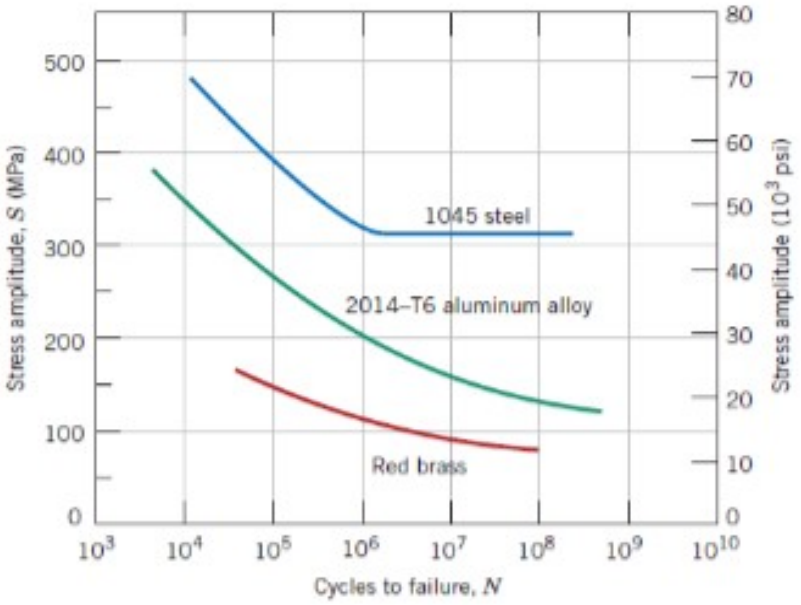
Question 3

a) With the aid of metallurgical examples explain the following commonly used fault analysis techniques:

i. Fault hazard Analysis**.** **[6]**

ii. Common cause failure analysis. **[6]**

b) A 6.4 mm (0.25 in.) diameter cylindrical rod fabricated from a 2014-T6 aluminum alloy is subjected to reversed tension compression load cycling along its axis. If the maximum tensile and compressive loads are 5340 N and -5340 N, respectively, determine its fatigue life. Assume that the stress plotted in Figure below is stress amplitude. **[8]**



Question 4

a. Sharp ductile to brittle transition (DBTT) is observed in BCC and HCC metallic materials. Explain the ductile – brittle transition. **[5]**

b. Hydrogen is a problem in welded joints. Briefly discuss the sources of hydrogen in a welded joint and how these can be minimized**.** **[10]**

c. What are the main factors that influence the level of performance of a part or component? **[5]**

Question 5

A power generating company has asked you as an engineer to use your metallurgical expertise on materials, to check if one of their steam turbines is safe enough to continue its operation. You have checked the main shaft and the blades and found that there is some degree of grain growth along with some voids (porosities) formed within the grains and also at the grain boundaries.

a. What is your conclusion as to whether it is safe to continue the use of the turbine? **[4]**

b. What would be the likely failure mode if the shaft or blades fail? **[4]**

c. Explain the most likely failure mechanism for the potential failure mode? **[5]**

d. Outline and explain the Failure Analysis procedures you would perform in this case. **[7]**

Question 6

b. Discuss how the following factors affect the fracture of an engineering material:

i. Stress concentration. **[5]**

ii. Speed of loading. **[5]**

iii. Temperature. **[5]**

iv. Thermal shocks**.** **[5]**

End of question paper