GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND ENVIRONMENT

DEPARTMENT OF METALLURGICAL ENGINEERING

MATERIALS TECHNOLOGY

EMR3204

July /August 2022 Examinations

This examination consists of 4 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

QUESTION 1

a. In the solidification of a pure metal, what are the two energies involved in the transformation? With the aid of a graph deduce the energy changes associated with the formation of a nucleus during solidification**.** **[10]**

b. Describe any method used to detect defects that arise during solidification apart from visual inspection. **[5]**

c. Briefly explain what strain hardening is and its effect on the mechanical properties of metals and alloys. **[5]**

QUESTION 2

a. Write short notes on the following heat treatment methods:

i. Liquid carburising. **[5]**

ii. Annealing. **[5]**

iii. Normalizing. **[5]**

b. Briefly compare and contrast hot working and cold working metal forming techniques. **[5]**

QUESTION 3

a. Distinguish between crystal structure and crystal system. **[6]**

b. Calculate the volume of an FCC unit cell in terms of the atomic radius R. **[5]**

c. With the aid of an example explain polymorphism. [**4]**

d. Aluminum (A.W. = 26.98 grams) has a FCC lattice cell, with a measured lattice parameter (from x-ray diffraction studies) of a = 4.05 x 10^{-8} cm. Determine its mass density **[5]**

QUESTION 4

a. Discuss the different classes of materials, their properties and applications in engineering. **[15]**

b. Why are most metals ductile and ceramics brittle at room temperature? **[5]**

QUESTION 5

In selecting the best alloy requirements for a given task, it was desired that the mechanical specifications be 150 N/mm2 ultimate tensile strength, 107 N/mm2 yield strength and 7% elongation.

From the casting perspective it was noted that the alloy needed to be that would flow and fill the mould easily and not solidify too quickly as rapid solidification can produce cracks (hot tearing) in the casting.

From the given table of three alloy options, which one would best serve the above requirements based on strength, ductility, corrosion resistance, and castability requirements? Give your full reasons**.** **[20]**

Alloy	Requirement	Alloy A	Alloy B	Alloy C
Performance				
Ultimate Tensile Strength N/mm^2)	150	270	163	171
Tensile Yield Strength (N/mm^2)	107	257	129	77
Ductility (% Elongation)	7	12	7	13
Corrosion Resistance (1= Excellent, 5 = Poor)	2	4	2	1
Castability				
Fluidity (1= Excellent, 5 = Poor)	2	2	1	5
Hot Tear Resistance (1= Excellent, 5 = Poor)	2	3	1	4

QUESTION 6

a. A carbon steel cooled from austenitic region to 723℃ , contains 9.1% ferrite. What is the C content in the steel? **[5]**

b. On the basis of melting temperature, oxidation resistance, yield strength and degree of brittleness, discuss whether it would be advisable to hot work or cold work

i. aluminium alloys. **[5]**

ii. magnesium alloys. **[5]**

c. Why aluminium based alloys are equally important in engineering manufacture as are iron based materials? **[5]**

QUESTION 7

Rolling is a process of reducing the thickness or changing the cross section of a work piece by compressive forces applied through a set of rolls.

a) Draw a diagram to illustrate the flat rolling process. Write brief notes on the movement of rolls and the working piece including forces involved. **[8]**

b) With the aid of a diagram describe the extrusion process. **[6]**

c) Discuss with the aid of a sketch the wire drawing process. **[6]**

END OF QUESTION PAPER