GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENT OF METALLURGICAL ENGINEERING

MATERIALS TECHNOLOGY

EMR 3204

Part III Second Semester Examination Paper

JUNE 2019

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

INSTRUCTIONS

1. Answer **ANY FOUR QUESTIONS**
2. Each question carries 25 marks
3. Use of calculators is permissible

Additional Requirements
NONE

MARK ALLOCATION

Question 1 to 6	25Marks
Part Questions	As shown in each part question
Total Attainable	100

Question 1

Materials can be classified into different classes based on their properties. Discuss the different classes, their properties and applications. **[25 Marks]**

Question 2

a) Describe the Bohr and Wave mechanical atomic models highlighting the differences between them. **[8 Marks]**

b) Primary bonding between atoms or ions is related to the bonding forces and energies. Explain the relationship between interatomic separation, bonding forces and energy.

[8 Marks]

c) Why are covalently bonded materials generally less dense than ionically or metallically bonded ones. **[6 Marks]**

d) Explain why hydrogen fluoride (HF) has a higher boiling temperature than hydrogen chloride (HCl) ($85.4^{\circ}C$ Vs 19.4), even though HF has a lower molecular weight**.**

[3 Marks]

Question 3

a) Calculate the volume of an FCC unit cell in terms of the atomic radius R **[5 Marks]**

b) Show that the atomic packing factor for the FCC crystal structure is 0.74 **[5 Marks]**

c) Copper has an atomic radius of 0.128 nm, an FCC crystal structure, and an atomic weight of 63.5 g/mol. Compute its theoretical density and compare the answer with its measured density. Measured density of copper is $8.96g/cm^3$ **[5 Marks]**

d) Distinguish between crystal structure and crystal system? **[10 Marks]**

Question 4

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a) Name the three main divisions of composite materials, and cite the distinguishing feature of each. **[6 Marks]**

b) For a polymer-matrix fiber-reinforced composite.

   i. List functions of the matrix phase. **[3 Marks]**

   ii. Compare the desired mechanical characteristics of matrix and fiber phases.
[6 Marks]

c) Carbon Fiber-Reinforced Polymer (CFRP) Composites are high-performance fiber material that are most commonly used reinforcement in advanced (i.e., nonfiberglass) polymer-matrix composites. Explain why is this so? **[10 Marks]**

Question 5

   a) Define metallic, ionic and covalent bonding with examples in each case **[6 Marks]**

   b) Mention and explain four strengthening mechanisms of metals and alloys **[12 Marks]**

   c) Why are metals most ductile and ceramics brittle at room temperature. **[7 Marks]**

Question 6

   a) Explain the terms isomorphous and eutectic **[4 Marks]**
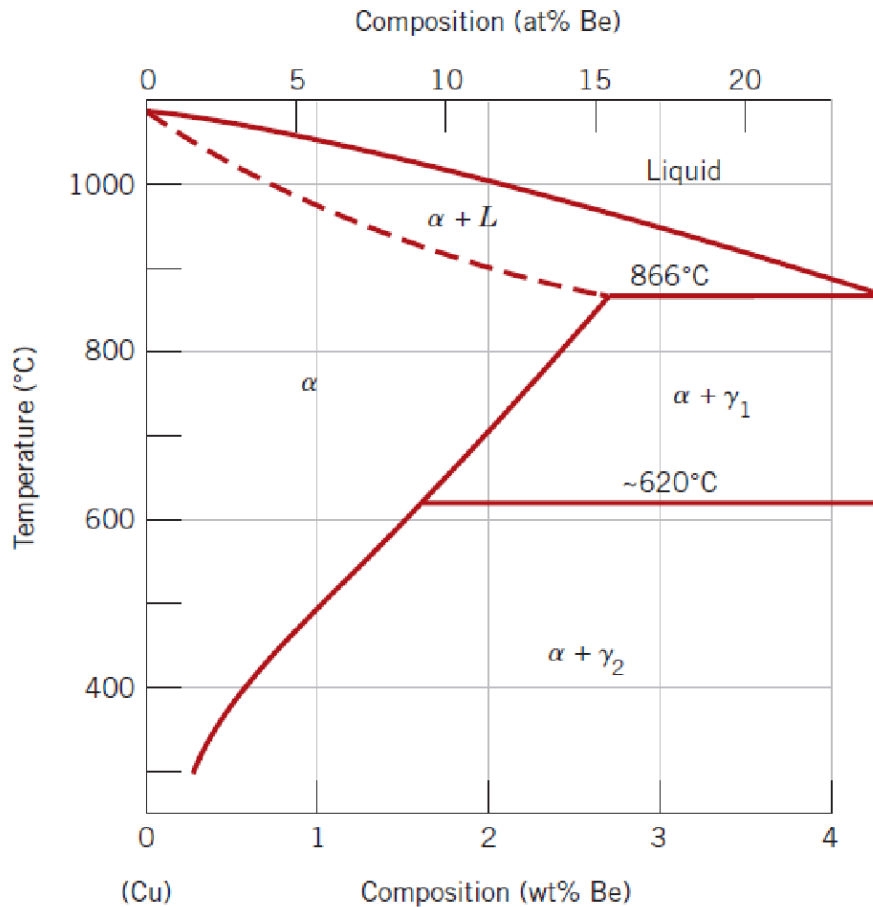
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Figure Q.6

Figure Q.6 shows a portion of the phase diagram for a Copper Beryllium system. Copper-rich copper–beryllium alloys are precipitation hardenable. After consulting the portion of the phase diagram

i.   Specify the range of compositions over which these alloys may be precipitation hardened. **[5 Marks]**

ii. Briefly describe the heat-treatment procedures (in terms of temperatures) that would be used to precipitation harden an alloy having a composition of your choosing, yet lying within the range given for part (a). **[10 Marks]**

b) Differentiate between ceramics and glasses **[6 Marks]**

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END OF QUESTION PAPER

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