**;**

#### MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

**FACULTY OF ENGINEERING, APPLIED SCIENCES AND TECHNOLOGY**

**DEPARTMENT: MINING AND MINERAL PROCESSING ENGINEERING**

**MODULE: MATERIALS SCIENCE**

**CODE: ENGM121**

**SESSIONAL EXAMINATIONS**

**JUNE 2023**

**DURATION: 3 HOURS**

**EXAMINER: Miss F.E CHARANGWA**

## INSTRUCTIONS

1. *Answer* ***compulsory*** *Question 1 and choose any other 3*
2. *Start a new question on a fresh page*
3. *Total attainable marks 100*

***Additional material(s):*** *Calculator*

**Question 1**

1. Define the terms:
2. Unit cell
3. Allotropy
4. Amorphous
5. Metallic bonding
6. Motif **(5Marks**)
7. Distinguish the following terms:
8. Material science and material engineering **(2Marks)**
9. Fatigue and creep **(2Marks)**
10. Bohr atomic model and wave mechanical model **(2Marks)**
11. Electropositive and electronegative elements **(2Marks)**
12. Crystal and lattice **(2Marks)**
13. As atoms or molecules approach each other forces and changes in energy is experienced. Explain the relation between the forces, energy and distance between the atoms. Use a diagram in your explanation. **(6Marks)**
14. Calculate the force of attraction between $Ca^{2+}$ and an $O^{2-}$ ion the centers of which are separated by a distance of 1.25 nm**. (2Marks)**
15. List the 4 factors that affect the properties of a material **(4Marks)**
16. Briefly explain the main differences between ionic, covalent and metallic bonding; giving examples and the help of diagrams on each. **(6Marks**)
17. What type of bonding will be expected for each of the following materials; Bronze, Brass, Rubber, Barium sulphide (BaS) and Aluminium phosphide (AIP)? **(5Marks)**
18. Offer an explanation as to why covalently bonded materials are generally less dense than ionically or metallically bonded ones**. (2Marks)**

**Question 2**

1. Solid materials have been conveniently grouped into three basic classifications. Briefly give an explanation of these material types and representative characteristics of each. **(15Marks)**
2. The beverage companies use different materials for containing their carbonated beverages. It has been noticed that beverages in aluminum and glass containers retain their carbonization (i.e., “fizz”) for several years, whereas those in two-liter plastic bottles “go flat” within a few months. Explain why? **(5Marks)**

**Question 3**

1. Mechanical properties are of concern to a variety of parties (e.g., producers and consumers of materials, research organizations, etc.) that have differing interests. Thus it is imperative that there be some consistency in the manner in which tests of materials are conducted, and in the interpretation of their results. Give a detailed account with diagrams for the standardized tension and Rockwell hardness tests in materials. **(12Marks)**
2. Differentiate engineering stress and engineering strain, giving the Units of each and the equation used to calculate each. **(6Marks)**
3. A piece of copper originally 305 mm (12 in.) long is pulled in tension with a stress of 276 MPa (40,000 psi). If the deformation is entirely elastic, what will be the resultant elongation? Modulus of elasticity (E) for Cu =$ 110×10^{3}$MPa. **(2Marks)**

**Question 4**

1. Define a phase in a material and a phase diagram. **(3Marks)**
2. Write the equation for Gibbs phase rule used in phase diagrams and define each of the terms. **(3Marks)**
3. What are the four Hum-Rothery rules for the solid solubility of one element in another? **(4Marks)**
4. Consider the binary eutectic copper-silver phase diagram below. Make phase analyses of an 88 wt % Ag-12 wt % Cu alloy at the temperatures 1000ºC and 800ºC. In the phase analysis, include:
5. The phases present
6. The chemical compositions of the phases
7. The amounts of each phase and sketch the microstructure **(10Marks)**



**Question 5**

1. Give a detailed account of the Annealing process and the control of the process, pay attention to key words Recovery, Recrystallization and Grain growth **(10Marks)**
2. Describe Solid-solution strengthening and ways in which it affects the properties of materials. **(6Marks)**
3. Give a comparison of hot working and cold working of materials. **(4Marks)**

**\*\*\*\*THE END\*\*\*\***