

UGANDA MARTYRS UNIVERSITY

FORT PORTAL CAMPUS

FACULTY OF ENGINEERING AND APPLIED SCIENCES

DEPARTMENT OF MECHANICAL ENGINEERING

END OF SEMESTER I YEAR II ACADEMIC YEAR 2023/2024 EXAMINATIONS
DECEMBER, 2023

PROGRAMME (S) (BACHELOR OF MECHANICAL AND MANUFACTURING
ENGINEERING

COURSE NAME: MATERIAL SCIENCE AND ENGINEERING

DATE: 8th DECEMBER, 2023

COURSE CODE: BME2103

TIME: 9:00AM -12:00PM

INSTRUCTIONS TO CANDIDATE

- This Exam contains **Six** questions
- Attempt any **Four** Questions
- All questions carry **25 marks** each
- Begin each question on a fresh page
- Mobile phones are strictly prohibited in the Exam

You should have the following in this Examination

Answer Booklet, Drawing instruments, graph papers and Non-Programmable calculator

Question One

- a) Explain the difference between a casting and an ingot **4 marks**
- b) Discuss the three major causes of gases in castings and ingots and identify measures that can be taken to overcome or avoid them **12 marks**
- c) Discuss the following as applied to elastic deformations in materials **3 marks**
- i. Modulus of elasticity **3 marks**
 - ii. Modulus of rigidity **3 marks**
 - iii. Poisson's ratio

Question Two

- a) Draw a partial solid solubility binary equilibrium diagram and elaborate on all the key features of that diagram. Use the diagram to explain the phase transforms that an alloy of your choice undergoes from liquid state to solid state **15 marks**
- b) The process of solid solution metal strengthening can be achieved by solute atoms that occupy either substitute or interstitial sites. Use sketches to explain how the hardening effect is achieved for each case. **10 marks**

Question Three

- a) Use a characteristic graph to explain the following terms as applied to chemical bonding
- i. Bond length 6 marks
 - ii. Bond strength 2 marks
- b) State, briefly the influence that the type of inter-atomic bond has on the physical properties of a material 3 marks
- c) Describe the nature of bonding within the molecules below; 6 marks
- i. H_2O 4 marks
 - ii. Na_2Cl 4 marks

Question Four

- a) Illustrate with a sketch the structure of an atom with an electron revolving in some orbit and write the expression for the following:
- i. Kinetic energy experienced by the electron 2 marks
 - ii. Potential energy experienced by the electron 2 marks
 - iii. The total energy of the electron 2 marks
- a) With aid of sketches, explain the primary and secondary shrinkage cavities, and elaborate on the measures that can be used to eliminate or minimize them 15 marks

Question Five

- a) Explain why crystal imperfections are studied in engineering and give two examples where crystal imperfections can play a role in enhancing the strength properties of metals 10 marks
- b) Using a sketch, explain how the following types of secondary bonds arises
- i. Van der Waals bonds 7 marks
 - ii. Hydrogen bonds 8 marks

Question Six

- a) Explain the term "nucleation undercooling" and how this phenomenon can be avoided during solidification 5 marks
- b) Use sketches to illustrate the following crystalline structure in metals
- i. BCC 3 marks
 - ii. FCC 3 marks
 - iii. HCP 4 marks
- c) Use sketches and explain the following point defects in crystalline structures
- i. Interstitials 4 marks
 - ii. Substitutional 3 marks
 - iii. Vacancies 3 marks

END