



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF TECHNICAL AND ENGINEERING EDUCATION AND TRAINING

PTE1147 Material Science

Main Examination

November 2024

This examination paper consists of TWO (2) printed pages

Time allowed: 3 hours
Total marks: 100
Special Requirements: A2 Size Bond Paper (Four sheets)
Examiner: Mr. A. Sithole
External Examiner: Dr. Kahanji

INSTRUCTIONS

1. Answer any **FOUR** questions.
2. Sub-division marks are shown in brackets
3. Begin each question on a fresh page and number it.
4. Unless otherwise stated, all dimensions are in millimetres. Dimensions not given are left to your discretion.
5. Credit will be given for accuracy, legibility and neatness.

MARK ALLOCATION

QUESTION	MARKS
1	25 marks
2	25 marks
3	25 marks
4	25 marks
5	25 marks
6	25 marks

Question 1

- a) Briefly explain the following mechanisms by which atoms are bonded in engineering materials.
- i. Metallic bonds [2marks]
 - ii. Covalent bonds [2marks]
 - iii. Ionic bonds [2marks]
- b) Outline the classification of engineering materials [6marks]
- c) With the aid of a labelled diagram show the characteristics of a stress-strain curve for a tensile test on a mild steel piece and explain the various stages as they relate to the behaviour of the test piece during the testing process [13marks]

Question 2

- a) Define the following mechanical properties of materials.
- i. Plasticity [2marks]
 - ii. Ductility [2marks]
 - iii. Malleability [2marks]
- b) What are ceramics? [5marks]
- c) Outline the aspects of polymers and polymerisation with emphasis on categorisation based on mechanical and thermal behaviour [14marks]

Question 3

- a) Give two examples for each of the following properties of materials.
- i. Physical properties [2marks]
 - ii. Electrical properties [2marks]
 - iii. Magnetic properties [2marks]
 - iv. Chemical properties [2marks]
- b) Discuss the crystal structure of materials with specific reference to.
- i. Crystalline materials [5marks]
 - ii. Amorphous materials [2marks]
 - iii. Lattice parameter and crystallographic planes [10marks]

Question 4

- a) Briefly discuss the aspects of material science and engineering [7marks]

- b) Briefly explain the destructive and non-destructive types of material testing methods. [6marks]
- c) Discuss the following categories of polymers based on their mechanical and thermal behaviour.
- i. Thermoplastic polymers [4marks]
 - ii. Thermosetting polymers [4marks]
 - iii. Elastomers [4marks]

Question 5

- a) Briefly explain the following properties of materials.
- i. Linear coefficient of expansion [2marks]
 - ii. Thermal conductivity [2marks]
 - iii. Toughness or tenacity [2marks]
 - iv. Electrical conductivity [2marks]
- b) List five purposes for which engineering materials are tested [5marks]
- c) Explain four mechanisms by which atoms are bonded in engineered materials [12marks]

Question 6

- a) Differentiate linear polymers from branch polymers [4marks]
- b) Briefly discuss the following with reference to levels at which the structure of materials can be examined and described.
- i. Atomic structure [3marks]
 - ii. Nanostructure [3marks]
 - iii. Microstructure [3marks]
 - iv. Macrostructure [3marks]
- c) Explain the following main steel production methods include the following.
- i. The cementation process [3marks]
 - ii. The crucible process [3marks]
 - iii. The open hearth (Acid or Basic) process [3marks]

“ End of Examination Paper ”