



MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE

IN MECHANICAL ENGINEERING

EMM 102: INTRODUCTION TO MATERIAL SCIENCE

DATE: 20/12/2017

TIME: 8.30-10.30 AM

INSTRUCTIONS

This paper consists of *FIVE* questions

Answer question *ONE* (compulsory) and any other *TWO* questions MACHAKOS

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Define the following terms as used in engineering materials
 - i Crystal
 - ii Space lattice
 - iii Unit Cell (6 marks)
- b) With the aid of neat sketches, describe the following crystal structures of metals
 - i Face Centred cubic
 - ii Hexagonal close packed (6 marks)
- c) For a body centred cubic, BCC structure, determine the expression for:
 - i the atomic radius
 - ii the atomic packing factor (6 marks)
- d) i Distinguish between Alloys and allotropes as used in materials, giving an example for each
- ii Using a heating curve, describe the various allotropes of pure iron (8 marks)
- e) i What are miller indices

- ii A plane makes intercepts of 1.5, 2 and 0.5 crystallographic axes of an orthorhombic crystal with $a : b : c = 3 : 2 : 1$. Find the Miller indices of this plane. (4 marks)

QUESTION TWO (20 MARKS)

- a) Describe four mechanical properties of engineering materials (6 marks)
- b) Discuss the effect of **three** factors on the mechanical properties of materials (9 marks)
- c) Explain the working principles of the following methods of non-destructive material tests:
- i Magnetic particle inspection
- ii Ultrasonic test. (5 marks)

QUESTION THREE (20 MARKS)

- a) With the aid of a suitable sketch and the appropriate equations, discuss in detail the blast furnace process of production of iron (12 marks)
- b) i Define the term corrosion
- ii Distinguish between dry and wet corrosion
- c) Discuss three methods of reducing corrosion attack on metals (8 marks)

QUESTION FOUR (20 MARKS)

- a) i What do you understand by the term heat treatment?
- ii Highlight four reasons for carrying out heat treatment
- iii With respect to heat treatment, explain the term critical temperatures
- iv Distinguish between hardening and tempering as heat treatment methods (12 marks)
- b) A cold chisel is to be heat treated for subsequent use in the workshop.
- i With suitable justification, identify and define the various heat treatments desired on this tool
- ii Explain how the heat treatments identified in 4b(i) above are carried out on the chisel (8 marks)

QUESTION FIVE (20 MARKS)

- a) With the aid of a well labeled diagram, describe the stress strain graph obtained for a typical tensile test to destruction of a mild steel specimen (8 marks)

- b) The following observations were made during a tensile test to destruction on a mild steel specimen 40mm diameter and 200mm long: Elongation with 40kN load (within limit of proportionality), change in length=0.0305mm, Yield load=160kN, Maximum load=245kN, length of specimen at fracture=250mm. Diameter at fracture=36.4mm

Determine:

- i Youngs Modulus of elasticity
- ii Yield point stress
- iii Ultimate stress
- iv Percentage elongation
- v percentage reduction in cross section (12 marks)