



MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIRST YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 103: ENGINEERING MATERIALS

DATE: 25/3/2021

TIME: 2.00-4.00 PM

INSTRUCTIONS

This paper contains FIVE questions.

Question ONE is compulsory and carries 30 marks.

Four remaining questions carry 20 marks each.

Attempt question ONE and any other TWO.

QUESTION ONE (30 MARKS)

- a) Using appropriate diagrams, describe the slow cooling of a hypoeutectoid alloy from the γ -austenite region. (6 marks)
- b) Calculate the quantities of proeutectoid α -ferrite, pearlite, eutectoid α -ferrite and cementite in 1 kg of a 0.3% C steel at 722°C assuming equilibrium conditions. (4 marks)
- c) List 2 uses of 2XXX (Al-Cu) Al alloys (2 marks)
- d) Name 4 types of bronzes (2 marks)
- e) Titanium has many desirable mechanical properties. Why is it only used in specialized applications? (1 mark)
- f) Highlight 2 advantageous properties of Nickel alloys (2 marks)
- g) Differentiate between thermoplastics, thermosets and elastomers (3 marks)
- h) Name 3 common properties of ceramics (3 marks)
- i) Giving examples, name 4 industries where composites are used (4 marks)
- j) Differentiate between pitting, crevice and intergranular corrosion (3 marks)

QUESTION TWO (20 MARKS)

- a) Using a diagram, describe the production of pig iron in a blast furnace (8 marks)
- b) Explain the following two methods used to harden steels
 - (i) Carburizing (3 marks)
 - (ii) Nitriding (3 marks)
- c) Highlight the 3 types of stainless steels and their uses (6 marks)

QUESTION THREE (20 MARKS)

- a) Using an appropriate diagram, describe the electrolytic reduction of alumina (from the Bayer process) to pure aluminium (6 marks)
- b) Other than the production of aluminium, where else is alumina from the Bayer process used? (3 marks)
- c) Name 3 properties that make brasses important copper alloys (3 marks)
- d) Why is alloying copper with bismuth and antimony disadvantageous? (1 mark)
- e) List 4 classifications of Ti alloys and name an application of each category (4 marks)
- f) Where are nickel-based super alloys used? (3 marks)

QUESTION FOUR (20 MARKS)

- a) Name 4 properties of synthetic polymers that have accelerated their use for engineering purposes (4 marks)
- b) Using sketches, differentiate between isotactic, syndiotactic and atactic morphology in polymers (6 marks)
- c) Describe how crystallinity occurs in polymers (5 marks)
- d) What is corrosion? (1 mark)
- e) Explain 4 ways in which corrosion may be prevented (4 marks)

QUESTION FIVE (20 MARKS)

- a) List the 6 groups of ceramic materials (3 marks)
- b) Name 5 types of common glasses and their uses (5 marks)
- c) Refractories are used to line furnace. What 3 properties makes them ideal for this application? (3 marks)

- d) What is a composite material? (1 mark)
- e) The resulting properties of composites depend on 3 factors. List them (3 marks)
- f) A unidirectional continuous fibre-reinforced composite consists of 45% glass fibre of $E = 70$ GPa by volume. The fibres are embedded in a polyester resin ($E = 3.5$ GPa). Calculate:
- (i) The modulus of elasticity in the longitudinal direction (2 marks)
 - (ii) The load carried by each of the two phases when a load of 12 kN is applied to the composite (3 marks)