



MACHAKOS UNIVERSITY

University Examinations 2020/2021

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

**FIRST YEAR SUPPLEMENTARY/SPECIAL EXAMINATION FOR THE DEGREE OF
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING**

EMM 103: ENGINEERING MATERIALS

DATE: _____

TIME: _____

INSTRUCTIONS

- 1. This paper contains FIVE questions.*
- 2. Question ONE is compulsory and carries 30 marks.*
- 3. Four remaining questions carry 20 marks each.*
- 4. Attempt question ONE and any other TWO.*

QUESTION 1 (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 2 (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 3 (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 4 (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 5 (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 $E = 70 \text{ GPa}$ by volume. The fibres are embedded in a polyester resin ($E = 3.5 \text{ GPa}$). 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)