MACHAKOS UNIVERSITY

University Examinations for 2020/2021

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 103: ENGINEERING MATERIALS

DATE: 21/6/2021 **TIME: 8:30 – 10:30 AM**

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 (COMPULSORY) (30 MARKS)

a) Imagine that you are a materials engineer working for a steelmaking company and you have been tasked to develop the microstructure of a hypoeutectoid steel alloy with a carbon composition of 0.35 wt% C.

i) Using a well-labelled diagram, discuss the slow cooling of the hypoeutectoid alloy from the γ-austenite region. (6 marks)

ii) Calculate the quantities of pro-eutectoid α-ferrite, pearlite, eutectoid α-ferrite and cementite in 1.3 kg of the alloy at the eutectoid temperature (727°C) assuming equilibrium conditions. (4 marks)

b) Highlight TWO uses of 2XXX (Al-Cu) Al alloys (2 marks)

c) Explain FOUR properties that make brasses important copper alloys (4 marks)

d) Titanium has many desirable mechanical properties. Why is it only used in specialized applications? (1 mark)

e) Explain how crystallinity occurs in polymers (4 marks)

f) Using sketches, differentiate between pitting and crevice corrosion (4 marks)

g) A unidirectional continuous fibre-reinforced composite consists of 35% glass fibre of E = 68 GPa by volume. The fibres are embedded in a polyester resin (E = 3.2 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)

QUESTION TWO (20 MARKS)

a) Using a well-labelled diagram, describe the production of pig iron from iron ore (haematite) in a blast furnace (8 marks)

b) Explain the following heat-treatment procedures used on different steels

(i) Full annealing (3 marks)

(ii) Normalising (3 marks)

(iii) Tempering (3 marks)

c) Name the THREE types of stainless steels and give examples of their uses (3 marks)

QUESTION THREE (20 MARKS)

a) With the help of a well-labelled diagram, describe the electrolytic reduction of alumina to pure aluminium (6 marks)

b) Other than the production of aluminium, where else is alumina from the Bayer process used? (4 marks)

c) Name the FOUR commercially available bronzes and state at least one application of each type (4 marks)

d) There are FOUR types of titanium alloys. Name them and provide examples of their industrial applications (4 marks)

e) State FOUR desirable characteristics of nickel metal (2 marks)

QUESTION FOUR (20 MARKS)

a) Differentiate between thermoplastics, thermosets and elastomers (3 marks)

b) Name FOUR properties of synthetic polymers that have accelerated their use for engineering purposes (4 marks)

c) Explain the role that the FOUR main types of polymer additives play in improving the properties of polymers (4 marks)

d)

i) Define corrosion (2 marks)

ii) State the THREE conditions that must be met for electrochemical corrosion to occur (3 marks)

iii) Explain 4 ways in which corrosion may be prevented (4 marks)

QUESTION FIVE (20 MARKS)

a) Highlight four properties of grey cast irons (4 marks)

b)

(i) Composites are relatively new materials but their special advantages have led to widespread use to an extent that you can find them in nearly all fields of material usage. List FOUR industries where composites are used and provide examples of parts or components made using composites in those industries. (4 marks)

(ii) Explain TWO factors that determine the properties of composites (2 marks)

c) Ceramic materials can be categorised into FIVE groups. Describe these FIVE groups of ceramic materials giving examples and their uses (10 marks)