



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)**

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FIFTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

**BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL
ENGINEERING**

COURSE CODE: MIE 512E

COURSE TITLE: COMPOSITE MATERIALS

SPECIAL/SUPPLEMENTARY EXAMINATIONS

DATE: 7 – 10 - 2022

TIME: 9:00 AM – 11:00 AM

INSTRUCTIONS TO CANDIDATES

1. This paper consists of **FOUR** questions
2. Answer Question **ONE (Compulsory)** and any other **TWO** Questions
3. All symbols have their usual meaning

TIME: 2 Hours

MMUST observes **ZERO** tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over

QUESTION ONE**[30 marks]**

- a) In relation to composite materials, State the rule of mixtures? **[2 marks]**
- b) What is a *cermet* **[1 mark]**
- c) What main factors control the mechanical properties of a fiber reinforced composite material? **[4 marks]**
- d) What are some of the weaknesses of ceramics that might be corrected in fiber-reinforced ceramic matrix composites. **[2 marks]**
- e) Body of boats are usually made using polymer matrix composite materials. Select an appropriate method that can be used to produce *body of a boat* and with an aid of a diagram describe the method. **[8 marks]**
- f) Epoxy prepregs can be cured using Resin Transfer Moulding (RTM). Present the advantages and disadvantages of this process **[6 marks]**
- g) With an aid of a well labelled diagram, describe the filament winding process **[7 marks]**

QUESTION TWO**[20 marks]**

- a) By stating the necessary assumptions, show that the modulus of elasticity in Transverse Loading of a continuous and oriented fiber composite is given by:

$$\frac{1}{E_{ct}} = \frac{V_m}{E_m} + \frac{V_f}{E_f}$$

[5 marks]

- b) With the aid of a well-labeled diagram, briefly describe the auto-clave molding processes. **[10 marks]**
- c) List two disadvantages of metal matrix composites: **[2 marks]**
- d) State three applications of Metal Matrix Composites **[3 marks]**

QUESTION THREE**[20 marks]**

- a) A fiberglass composite consists of a matrix of vinyl ester and reinforcing fibers of E-glass. The volume fraction of E-glass = 30%. The density of the vinyl ester = 0.882 g/cm^3 , and its modulus of elasticity = 3.60 GPa. The density of E-glass = 2.60 g/cm^3 , and its modulus of elasticity = 76.0 GPa. A section of composite 1.00 cm by 25.00 cm by 200.00 cm is fabricated with the E-glass fibers running longitudinal in the 200-cm direction. Assume there are no voids in the composite. Determine the
- (i) mass of vinyl ester in the section, **[5 marks]**
 - (ii) mass of E-glass fibers in the section **[4 marks]**
 - (iii) the density of the composite. **[3 marks]**
 - (iv) the modulus of elasticity in the longitudinal direction of the glass fibers **[3 marks]**
 - (v) the perpendicular direction to the glass fibers. **[3 marks]**
- b) State two advantages of polymer matrix composites **[2 marks]**

QUESTION FOUR**[20 marks]**

- a) A continuous and aligned glass fiber-reinforced composite consists of 35 vol% of glass fibers having a modulus of elasticity of 71 GPa and 65 vol% of a polyester resin that, when hardened, displays a modulus of 3.2 GPa.
- (i) Compute the modulus of elasticity of this composite in the longitudinal direction. **[2 marks]**
 - (ii) If the cross-sectional area is 230 mm^2 and a stress of 45 MPa is applied in this longitudinal direction, compute the magnitude of the load carried by each of the fiber and matrix phases. **[8 marks]**
 - (iii) Determine the strain that is sustained by each phase when the stress in part (b) is applied. **[10 marks]**

