L-2/T-1/IPE **Date: 18/09/2025**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2023-2024

Sub: **MME 295** (Engineering Materials-II)

Full Marks: 140 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. **Answer to Question No. 1 is compulsory**. Answer any **TWO** questions from the rest.

1. Stress-strain data for a glass fiber and a polymer are given in the following table. **(23 ⅓)**

Polymer	Strain (%)	0	1	2	4	6	10	15	30	60	100
	Stress (MPa)	0	10	20	30	40	45	48	42	30	10
Glass Fiber	Strain (%)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.85
	Stress (MPa)	0	200	400	600	800	1000	1200	1350	1400	0

Plot the stress-strain curves for both the glass fiber and the selected polymer and determine their key mechanical properties. Then, if you were to create a glass fiber-reinforced polymer composite, calculate the critical volume fraction of fibers needed to achieve effective reinforcement. Using that volume fraction, draw a hypothetical stress-strain curve for the composite.

Provide an explanation of the composite's behavior in the diagram and determine the maximum stress it can withstand for use in structural applications. Finally, demonstrate through calculations how alignment of fibers and the loading direction can influence the strength of the composite.

2. Propose an appropriate manufacturing method for producing a toughened glass sheet intended for use as a train window. Justify your choice and describe the process. Also, explain the specific thermal and chemical strengthening treatment required to achieve the necessary toughness in the final glass product. **(23 ⅓)**

3. Your company plans to launch a new cold beverage and is considering manufacturing the plastic bottles in-house using a thermoplastic polymer. As a project engineer, you must choose the most suitable forming process among extrusion, blow molding, and injection molding. Compare the advantages and limitations of each method, justify your final selection, and provide a clear explanation of the chosen process along with a neat diagram. **(23 ⅓)**

4. Elaborate on the deformation behavior of a semicrystalline polymer, linking the microstructural changes to its stress-strain response. Additionally, evaluate the main factors that affect the mechanical properties of semicrystalline polymers. **(23 ⅓)**

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dray cast / hydro plasm

slip casting

SECTION – B

There are **FIVE** questions in this section. **Answer to Question No. 5 is compulsory.**

Answer any **THREE** questions from the rest.

5. Select a suitable forming process for manufacturing thin-walled ceramic articles with intricate shapes. Provide justification for your selection. Additionally, analyze the key requirements that the raw material must fulfill to ensure successful processing using your selected technique. **(17½)**

6. (a) Engineering ceramics provide better mechanical properties than traditional ceramics. Critically evaluate this statement by discussing the key factors that influence strength and fracture toughness in brittle materials. **(9)**

   (b) What modifications would you incorporate into the processing steps of traditional ceramics to develop high-performance engineering ceramics? Analyze how each modification contributes to enhancing the mechanical performance compared to traditional ceramics. **(8½)**

7. (a) A parallel-plate capacitor is required to store a charge of 2.4×10^{-3} C at a potential difference of 8,000 V. The separation between the plates is fixed at 0.2 mm. Using the provided information, answer the following questions: **(10)**

   (i) Calculate the capacitance of the capacitor required for the given charge and voltage conditions.

   (ii) Determine the required plate area when the dielectric between the plates is vacuum.

   (iii) Now, if $BaTiO_3$ with a dielectric constant of 1800 is used as the dielectric instead of vacuum, calculate the required area of the capacitor plates.

   (iv) How many plates of $BaTiO_3$, each having the same area as calculated in part (iii), are needed to achieve the desired capacitance of 0.05 μF?

   (b) Superconductors are known for their unique ability to exhibit zero electrical resistance below a critical temperature. Elucidate how this distinctive characteristic of a superconducting material functions in a magnetic levitation (maglev) train, focusing on how superconductivity enables both levitation and forward motion. **(7½)**

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8. A ceramics manufacturing company is producing high-performance insulating tiles. During the sintering stage, the processing team has reported issues such as abnormal grain growth, and cracking in the final components. Initial inspection revealed variations in green density and particle shape, and a lack of precise control over the sintering cycle. As a process engineer, you have been asked to evaluate raw materials characteristics and improve the sintering process. Based on your knowledge of ceramic processing, analyze the root causes of the observed problems. Discuss how the factors related to particle characteristics, sintering conditions, and furnace design could be contributing to the defects. Propose justified modifications to the raw material selection and sintering parameters that could prevent these problems and ensure uniform densification and structural integrity in the final product. **(17½)**

9. (a) A research group is developing a multilayer ceramic capacitor and has selected $BaTiO_3$ as the dielectric material because of its high dielectric constant and ferroelectric characteristics. The intended application involves efficient operation at 150°C under varying electric field conditions. Do you support their material choice? Justify your reasoning by discussion the crystal structure (with neat sketches) and polarizability behaviour of $BaTiO_3$ at elevated temperatures. ($\theta_c = 120°C$ for $BaTiO_3$) **(10)**

(b) Describe how MO/SiO_2 ratio formulates crystal structures of silicates. **(7½)**