Nirma University

Institute of Technology

Semester End Examination (IR), December - 2022

B. Tech. in CL / CH / EE / IC / EC / CSE, Semester-VII

2CLOE03 Composite Materials

Roll / Exam No.		Supervisor's initial with date	

Time: 3 Hours Max Marks: 100

Instructions.

1. Attempt all questions.
2. Figures to right indicate full marks.
3. Use section-wise separate answer book.
4. Draw neat sketches wherever necessary.
5. Assume suitable data if necessary and mention the same clearly.

SECTION – I

Q.1 A Define stress and strain for composite materials. **02**

CO4, BL4 B Find the following for a 60° angle lamina of graphite/epoxy. **16**

(i) Transformed reduced compliance matrix
(ii) Transformed reduced stiffness matrix
(iii) Global strains, if applied stresses are σ_x = 4 MPa, σ_y = -6 MPa, τ_{xy} = 8 MPa.
(iv) Local strains
(v) Local stresses
(vi) Principal stresses
(vii) Maximum shear stress

Take E_1 = 181 GPa, E_2 = 10.3 GPa, μ_{12} = 0.28, G_{12} = 7.17 GPa.

(Use following equations:

The compliance matrix elements are $C_{11} = \frac{1}{E_1}$; $C_{12} = -\frac{\mu_{12}}{E_1}$; $C_{22} = \frac{1}{E_2}$; $C_{66} = \frac{1}{G_{12}}$.

The reduced stiffness matrix elements are $Q_{11} = \frac{E_1}{1-\mu_{21}\mu_{12}}$; $Q_{12} = \frac{\mu_{12}E_2}{1-\mu_{21}\mu_{12}}$; $Q_{22} = \frac{E_2}{1-\mu_{21}\mu_{12}}$; $Q_{66} = G_{12}$.

The transformed reduced compliance matrix elements are

$\overline{C_{11}} = C_{11}c^4 + (2C_{12} + C_{66})s^2c^2 + C_{22}s^4$;

$\overline{C_{12}} = C_{12}(s^4 + c^4) + (C_{11} + C_{22} - C_{66})s^2c^2$;

$\overline{C_{22}} = C_{11}s^4 + (2C_{12} + C_{66})s^2c^2 + C_{22}c^4$;

$\overline{C_{16}} = (2C_{11} - 2C_{12} - C_{66})sc^3 - (2C_{22} - 2C_{12} - C_{66})cs^3$;

$\overline{C_{26}} = (2C_{11} - 2C_{12} - C_{66})cs^3 - (2C_{22} - 2C_{12} - C_{66})sc^3$;

$\overline{C_{66}} = 2(2C_{11} + 2C_{22} - 4C_{12} - C_{66})s^2c^2 + C_{66}(s^4 + c^4)$.

The transformed reduced stiffness matrix elements are

$\overline{Q_{11}} = Q_{11}c^4 + 2(Q_{12} + 2Q_{66})s^2c^2 + Q_{22}s^4;$

$\overline{Q_{12}} = Q_{12}(s^4 + c^4) + (Q_{11} + Q_{22} - 4Q_{66})s^2c^2;$

$\overline{Q_{22}} = Q_{11}s^4 + 2(Q_{12} + 2Q_{66})s^2c^2 + Q_{22}c^4;$

$\overline{Q_{16}} = (Q_{11} - Q_{12} - 2Q_{66})sc^3 - (Q_{22} - Q_{12} - 2Q_{66})cs^3;$

$\overline{Q_{26}} = (Q_{11} - Q_{12} - 2Q_{66})cs^3 - (Q_{22} - Q_{12} - 2Q_{66})sc^3;$

$\overline{Q_{66}} = (Q_{11} + Q_{22} - 2Q_{12} - 2Q_{66})s^2c^2 + Q_{66}(s^4 + c^4).$

Q.2 CO3, BL3	A	Describe Tsai-Hill and Tsai-Wu failure theories in brief. Discuss observations made from comparison for the experimental results with all failure theories.	**08**
		OR	
CO4, BL3	A	Find the coefficients of thermal and moisture expansion for the 60° angle lamina of boron/epoxy. Also, determine strains under a temperature change of -100 °C and a moisture absorption of 0.02 kg/kg. Take properties of unidirectional glass/epoxy lamina $\alpha_1 = 6.1 \times 10^{-6}\, m/m/°C, \alpha_2 = 30.3 \times 10^{-6}\, m/m/°C,$ $\beta_1 = 0\ m/m/kg/kg, \beta_2 = 0.6\ m/m/kg/kg.$	**08**
CO4, BL3	B	A glass/epoxy lamina consists of 70% fiber volume fraction. Determine (i) Density of lamina (ii) Mass fractions of the graphite and epoxy (iii) Volume of composite lamina if the mass of the lamina is 5 kg (iv) Volume and mass of glass and epoxy in lamina. Take density of fiber is 2500 kg/m^3 and density of matrix is 1200 kg/m^3.	**08**
Q.3 CO1		Answer the following questions **(Any Four)**	**16**
BL3	[1]	Why fiber is so strong as compared to bulk material? Justify your answer.	
BL3	[2]	Enlist various forms of glass fiber. Explain any one form in details.	
BL3	[3]	Differentiate the properties of PAN, Pitch and Rayon based carbon fibers.	
BL3	[4]	Discuss ceramic fibers. Explain physical properties, advantages and limitations of ceramic fibers.	
BL3	[5]	What are whiskers? Explain the importance of whiskers for manufacturing of composites.	

SECTION – II

Q.4 CO1 BL3		Answer the following questions **(Any Four)**	**20**
BL3	[1]	Explain various physical properties and limitations of HPPE fibers.	
BL3	[2]	Explain various functions of matrix materials.	
BL3	[3]	Explain the various factors affecting selection of matrix materials	
BL4	[4]	Explain any one thermosetting polymeric matrix materials: its composition, properties, advantages and limitations.	
BL4	[5]	Classify various polymer matrix materials. Discuss the effect of temperature on properties of polymer matrix materials.	
Q.5 CO2 BL3		Answer the following questions **(Any Four)**	**20**
BL3	[1]	Discuss the advantages and limitations of metals as matrix materials.	
BL3	[2]	What are fillers? Explain any one type of filler used in polymer matrix composites.	
BL3	[3]	Explain the manufacturing of polymer matrix composite using wet layup method with neat sketch.	
BL3	[4]	Explain the manufacturing of polymer matrix composite using pultrusion process with neat sketch.	
BL3	[5]	Explain various advantages and limitations of resin transfer moulding process.	
Q.6 A CO2 BL3		Answer the following questions	**06**
BL3	[1]	Differentiate between metals and ceramics	
BL3	[2]	What are ceramic matrix composites? Enlist various types of ceramic matrix composites.	
Q.6 B CO2 BL3		Discuss various advantages and limitations of metal matrix composites.	**04**

OR

Q.6 B CO2 BL3		Explain any one method of manufacturing of metal matrix composites.	**04**