(03 Hours) [Marks: 80]

N.B.: (1) Attempt any four questions.
(2) Assumption made should be clearly stated.

1.	A.	Write in detail the advantages, limitations, and applications of composite materials.	10
	B.	What is shear coupling effect? What terms of stiffness/compliance matrix are responsible for shear coupling? What is the consequence of shear coupling on the behaviour of composite? Explain with an example.	10
2.	A.	Explain the working principle, applications, strengths, and limitations of the ultrasonic method which uses back scatter phenomenon for the NDE of composite materials.	10
	B.	Explain how the load is transferred from one side of a broken fiber to the matrix and subsequently to the adjacent fibers during tensile loading of a unidirectional composite along the fiber direction. Take the case of $[90/0]_S$ laminate for the purpose of illustration.	10
3.	A.	A 50 mm × 50 mm square lamina with its fibers oriented at 30^o with respect to the + X axis is compressed by 0.05 mm in both the X and Y directions. No shear deformations are allowed. What is the state of stress σ_x, σ_y and τ_{xy} required to produce this bidirectional compression? Material: T300 / 5208, $V_f = 0.7$	10
	B.	Plot the failure envelops on the answer sheet with appropriate proportions, for a typical UD lamina made of T300/5208 composite on stress plane using Maximum Stress and Maximum Strain Failure Theories.	10
4.	A.	Explain any two uniaxial test methods used to find the strength tensor F_{12}.	10
	B.	For a case of symmetric quasi-isotropic laminate $[0/45/-45/90]_S$, derive expressions for A_{11}, A_{12}, and A_{66} in terms of Q_{11}, Q_{12}, Q_{22}, and Q_{66} respectively.	10
5.	A.	Find out *A*, *B* and *D* matrices of $[0_n/90_n]_T$ laminate made of T300/5208 material in terms of *n*. Layer thickness is 0.1 mm and fiber volume fraction is 0.7.	10
	B.	Explain the factors which are required to be considered while selecting an appropriate method for repairing a composite structure.	10
6.	A.	Derive expressions for E_2 and μ_{12} for a specially orthotropic lamina in terms of fiber and matrix elastic properties and volume fractions. Also state the assumptions made.	10
	B.	Write notes on followings: (i) Resin Transfer Moulding (ii) Pultrusion	10

Given data

Properties of Unidirectional 'Graphite / Epoxy' (T300 / 5208) Lamina

V_f	0.7	**Compliance Constants**	
Specific Gravity	1.6	S_{11}	5.525 $(Pa)^{-1} \times 10^{-12}$
E_1	181 GPa	S_{22}	97.09 $(Pa)^{-1} \times 10^{-12}$
E_2	10.3 Gpa	S_{12}	-1.547 $(Pa)^{-1} \times 10^{-12}$
μ_{12}	0.28	S_{66}	139.5 $(Pa)^{-1} \times 10^{-12}$
μ_{21}	0.016	**Strengths (MPa)**	
G_{12}	7.17 GPa	X_t	1500 MPa
Stiffness Constants		X_c	1500 MPa
Q_{11}	181.8 GPa	Y_t	40 MPa
Q_{22}	10.34 GPa	Y_c	246 MPa
Q_{12}	2.897 GPa	S	68 MPa
Q_{66}	7.17 GPa	**Thermal Expansion Coefficients**	
		α_1	0.02 (µm/m)/°K
		α_2	22.5 (µm/m)/°K

Relations for Stiffness and Compliance Transformations

	$S_{11}\ (Q_{11})$	$S_{22}\ (Q_{22})$	$S_{12}\ (Q_{12})$	$S_{66}\ (4Q_{66})$
$\bar{S}_{11}\ (\bar{Q}_{11})$	m^4	n^4	$2m^2n^2$	m^2n^2
$\bar{S}_{22}\ (\bar{Q}_{22})$	n^4	m^4	$2m^2n^2$	m^2n^2
$\bar{S}_{12}\ (\bar{Q}_{12})$	m^2n^2	m^2n^2	(m^4+n^4)	$-m^2n^2$
$\bar{S}_{66}\ (4\bar{Q}_{66})$	$4m^2n^2$	$4m^2n^2$	$-8m^2n^2$	$(m^2-n^2)^2$
$\bar{S}_{16}\ (2\bar{Q}_{16})$	$2m^3n$	$-2mn^3$	$2(mn^3-m^3n)$	(mn^3-m^3n)
$\bar{S}_{26}\ (2\bar{Q}_{26})$	$2mn^3$	$-2m^3n$	$2(m^3n-mn^3)$	(m^3n-mn^3)