Q. P. Code: 25700

(03 Hours) [Total Marks: 80

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

1. A. Typical laminate made of UD layers is under in-plane loading as given below. Material: T300/5208, fiber volume fraction = 0.7, layer thickness = 0.1 mm, N_x = 300 KN/m, N_y = 250 KN/m, and N_{xy} = 15 KN/m. Laminate considered is $[0_n/90_n]_S$. Find out the minimum value of n that would be necessary if the failure is not to take place in the layers. Use Tsai-Hill Failure Theory. 10

   B. Explain pultrusion process used for manufacturing composite laminates, with a block diagram. 10

2. A. Find out B_{11} for the laminates $[0_2/90_2]_T$ and $[0/90]_{2T}$. It can be seen that both the laminates have same number of plies. Comment on the results. 10

   B. Explain vacuum bagging process and various components involved in it. 10

3. A. Determine the curing residual stress distribution along thickness direction for $[90_n/0_n]_S$ laminate made of T300 Carbon-Epoxy. Δt = –80 °C. Lamina thickness = 0.125 mm. 10

   B. Explain the mechanism of formation of interlaminar stresses near the free edges for a cross-ply laminate under uniaxial tensile loading. 10

4. A. Find out the effective elastic properties ($\bar{E}_x$, $\bar{E}_y$, $\bar{\gamma}_{xy}$, and $\bar{G}_{xy}$) of $[0/90]_s$ laminate made of UD layers of T300/5208 Carbon/Epoxy material. Lamina thickness is 0.1 mm and fiber volume fraction is 0.7. 10

   B. What is shear coupling effect? Write expressions for it. What terms of stiffness / compliance matrix are responsible for it? What is the consequence of shear coupling on the behavior of composite? Give an example of experiencing shear coupling. 10

5. A. 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

   B. What are A, B, and D matrices? Explain their significance in the evaluation of performance of a composite laminate. 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. 10

   B. How the internal and edge delaminations are repaired in a composite laminate? 10

[Turn Over

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)/^{o}K
		α_2	22.5 (μm/m)/^{o}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	$(m^4 + n^4)$	$-m^2n^2$
$\bar{S}_{66}\ (4\bar{Q}_{66})$	$4m^2n^2$	$4m^2n^2$	$-8m^2n^2$	$(m^2 - n^2)^2$
$\bar{S}_{16}\ (2\bar{Q}_{16})$	$2m^3n$	$-2mn^3$	$2(mn^3 - m^3n)$	$(mn^3 - m^3n)$
$\bar{S}_{26}\ (2\bar{Q}_{26})$	$2mn^3$	$-2m^3n$	$2(m^3n - mn^3)$	$(m^3n - mn^3)$
