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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E.
Branch: Institutional Elective
Course Code: 22CV6OEMFC
Course: Mechanics of FRP Composites

Semester: VI
Duration: 3 hrs.
Max Marks: 100

Instructions:1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			CO	*PO*	Marks
		UNIT – I			
1	a)	Define and classify composites. Discuss the benefits of composite laminates over conventional materials.	*CO*1	*PO1*	**10**
	b)	How many independent elastic constants are there for three-dimensional anisotropic, monoclinic, orthotropic, transversely isotropic, and isotropic materials?	*CO*1	*PO1*	**05**
	c)	What are prepregs? Describe its manufacturing process.	*CO*1	*PO1*	**05**
		OR			
2	a)	How does the orientation and arrangement of fibers in a FRP composite affect its mechanical properties? What are the different types of fiber reinforcement used in FRP composites.	*CO*1	*PO1*	**10**
	b)	Differentiate between micro and macro mechanics. What are the basic assumptions in determining E_{11} and E_{22} using rule of mixture.	*CO*1	*PO1*	**10**
		UNIT – II			
3	a)	Evaluate the expressions for ultimate tensile strength and Transverse young's modulus of unidirectional lamina composite materials. Additionally, calculate the longitudinal elastic modulus and ultimate tensile strength for a glass/epoxy lamina with a 70% fiber volume fraction, given that the ultimate tensile strength of the fiber and matrix are 1440 MPa and 70 MPa, respectively, and the Young's moduli of the fiber and matrix are E_f = 82 GPa and E_m = 3.1 GPa, respectively.	*CO*2	*PO1*	**14**
	b)	Find the relationship between the engineering constants of a two dimensional orthotropic material and its compliance matrix.	*CO*2	*PO1*	**06**
		OR			
4	a)	Evaluate the expressions for shear modulus and poisson's ratio for an unidirectional lamina.	*CO*2	*PO1*	**14**

		b)	Find the longitudinal elastic modulus and in-plane shear modulus of a glass/epoxy lamina with a 70% fiber volume fraction. The Young's modulus of the fiber is E_f = 85 GPa, the Young's modulus of the matrix is E_m = 3.4 GPa. Poison's ratios of matrix and fiber are 0.3 and 0.2 respectively.	***CO***2	***PO1***	**06**
			UNIT - III			
	5	a)	Describe the plane stress and plane strain conditions and derive the stress-strain relationship for an angle-ply lamina under plane stress conditions.	***CO*** 2	***PO1***	**12**
		b)	Compute the transformed reduced stiffness matrix for a 45° angle-lamina of graphite/epoxy, given the material properties: E_1 = 181 GPa, E_2 = 10.3 GPa, ν_{12} = 0.28 and G_{12} = 7.17 GPa.	***CO*** 2	***PO1***	**08**
			OR			
	6	a)	Derive the transformation matrix for a lamina with fibers oriented at an arbitrary angle θ.	***CO*** 2	***PO1***	**10**
		b)	Determine the principal stress, principal strain and maximum shear stress and shear strain for a 45° angle lamina of graphite/epoxy, using the properties of unidirectional graphite/epoxy lamina given the material properties: E_1 = 181 GPa, E_2 = 10.3 GPa, ν_{12} = 0.28 and G_{12} = 7.17 GPa.	***CO2***	***PO1***	**10**
			UNIT – IV			
	7		A laminate is constructed from three graphite/epoxy plies, each 3mm thick, oriented at 45°, 60° and 30° from bottom to top. Calculate the extensional stiffness matrix [A], bending stiffness matrix [D] and coupling stiffness matrix [B] for the lamina using the following properties of unidirectional graphite/epoxy lamina as given below. $[Q]=\begin{bmatrix}181.8 & 2.897 & 0\\ 2.897 & 10.35 & 0\\ 0 & 0 & 7.17\end{bmatrix}(10^3)Mpa$	***CO*** 2	***PO1***	**20**
			OR			
	8		Given that the strain in a laminate is a function of mid-plane strains and mid-plane curvatures, derive the extensional stiffness matrix [A], coupling stiffness matrix [B], and bending stiffness matrix [D] for an n-ply laminate (ABD matrix).	***CO*** 2	***PO1***	**20**
			UNIT – V			
	9	a)	Explain the Tsai-Hill and Tsai-Wu failure criteria as applied to 2D orthotropic materials.	***CO*** 2	***PO1***	**10**
		b)	Describe with examples (i) Laminate code (ii) Balanced laminates (iii) Hybrid laminates (iv) Symmetric and anti-symmetric laminates (v) Cross-ply and angle-ply laminates.	***CO*** 1	***PO1***	**10**

			OR			
	10	a)	What are the different failure theories and explain them with the relations.	***CO*** 1	***PO1***	**10**
		b)	A 30^o fibre oriented lamina is subjected to the stresses, σ_x = 12MPa, σ_y = 30MPa and τ_{xy} = 3.5MPa. Check for safety of the lamina by maximum stress theory and Tsai-Hill failure theory by considering the following ultimate permissible stresses, X_T = 250MPa, Y_T = 0.5MPa, X_C = 200MPa, and Y_C = 10MPa and S = 8MPa.	***CO*** 2	***PO1***	**10**

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