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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: VI**

Branch: Institutional Elective **Duration: 3 hrs.**

Course Code: 22CV6OEMFC **Max Marks: 100**

Course: MECHANICS OF FRP COMPOSITES

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.

		UNIT - I	CO	PO	Marks
1	a.	Define composite materials and discuss in detail the classification and properties of different composite types by highlighting their engineering significance.	CO1	PO1	10
	b.	Compare Laminated, Hybrid, and Sandwich Composites with respect to their structural configuration and material composition. Additionally, state two key advantages associated with each type.	CO1	PO1	10
		OR			
2	a.	Distinguish between micromechanics and macromechanics of composites. Also, state the basic assumptions made while estimating E_{11} and E_{22} using the Rule of Mixtures.	CO1	PO1	10
	b.	Explain the influence of fiber orientation and arrangement on the mechanical behavior of FRP composites. Also, discuss the different types of fiber reinforcements employed in FRP systems.	CO1	PO1	10
		UNIT - II			
3	a.	Evaluate the expressions for longitudinal and transverse Young's moduli of a composite material, highlighting the underlying assumptions used in the derivation.	CO2	PO2	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.	CO2	PO2	06
		OR			
4		Develop the theoretical expressions for the in-plane shear modulus and the ultimate tensile strength of a unidirectional composite lamina. Further, calculate the longitudinal elastic modulus, ultimate tensile strength, and the major and minor	CO2	PO2	20

Poisson’s ratios for a glass/epoxy composite lamina with 70% fiber volume fraction, using the data given below.

Property	Glass	Epoxy
Young’s Modulus	85 GPa	3.4 GPa
(σ)Ult	1550 MPa	72 MPa
ν	0.2	0.3

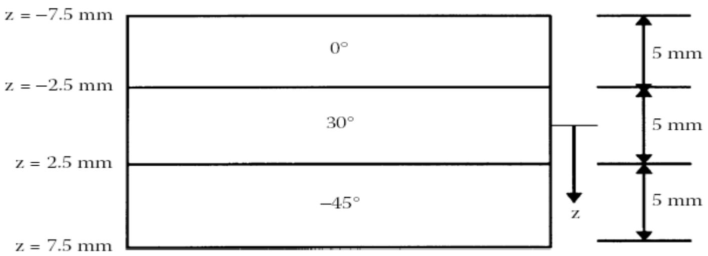
UNIT - III

Q. No.		Question	CO	PO	Marks
5.		Define plane stress and plane strain conditions in the context of material behavior. Derive the constitutive stress-strain relations for an orthotropic material subjected to plane stress. Additionally, list the number of independent elastic constants associated with 3D Anisotropic, Monoclinic, Orthotropic, Transversely Isotropic, and Isotropic material symmetries.	*CO2*	*PO2*	**20**
		OR			
6	a.	For a 60^{o} angle lamina of graphite/epoxy, obtain the transformed reduced stiffness matrix ($[\bar{Q}]$) if E_1 = 181 GPa, E_2 = 10.3 GPa, ν_{12} = 0.28 and G_{12} = 7.17 GPa. Also find Global strains, Local strains and Local stresses, if applied stresses are σx = 2 Mpa, σy = -3 MPa, τxy = 4 MPa.	*CO2*	*PO2*	**12**
	b.	Derive the transformed reduced stiffness matrix for a lamina with arbitrary orientation (derivation of transformation matrix (T) is not required).	*CO2*	*PO2*	**8**

UNIT - IV

Q. No.		Question	CO	PO	Marks
7		Considering that the strain distribution in a laminate depends on mid-plane strains and curvatures, derive the expressions for the extensional stiffness matrix [A], coupling stiffness matrix [B], and bending stiffness matrix [D] for a general *n*-ply composite laminate.	*CO2*	*PO2*	**20**
		OR			
8		Find the three stiffness matrices [A], [B], and [D] for a three-ply [0/30/–45] graphite/epoxy laminate as shown in Figure. Use the properties of unidirectional graphite/epoxy lamina as given below.	*CO2*	*PO2*	**20**

$$[Q]=\begin{bmatrix}181.8 & 2.897 & 0\\ 2.897 & 10.35 & 0\\ 0 & 0 & 7.17\end{bmatrix}(10^{3})Mpa$$



			UNIT - V			
	9	a.	Enumerate the various failure theories applicable to composite materials and explain them with their corresponding mathematical formulation.	***CO2***	***PO2***	**10**
		b.	Explain with examples (i) Laminate code (ii) Balanced laminates (iii) Hybrid laminates (iv) Symmetric and anti-symmetric laminates (v) Cross-ply and angle-ply laminates.	***CO2***	***PO2***	**10**
			OR			
	10	a.	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.	***CO2***	***PO2***	**10**
		b.	What are the different failure theories used in the analysis of composite materials? Describe each theory in detail, including the relevant mathematical expressions or failure criteria.	***CO2***	***PO2***	**10**

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