Sanjay Ghodawat University, Kolhapur

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2019-20

EXM/P/09/01

Year and Program: 2019-20 and T.Y.B.Tech | **School of Technology** | **Department of Aeronautical Engineering**

Course Code: AET307A | **Course Title: Composite Materials and Structure** | **Semester – V**

Day and Date Tuesday 26/11/19 | **End Semester Examination (ESE)** | **Time: 3 Hours** 10.30am to 1.30pm | **Max Marks: 100**

Instructions:
1) All questions are compulsory.
2) Assume suitable data wherever necessary.
3) Figures to the right indicate full marks.

Q.1	**Attempt the Following**	Marks	Bloom's Level	CO
a)	Explain Fiber Reinforced Polymer Composite. State its advantages and disadvantages.	07	L_2	CO1
	OR			
a)	A lamina consists of 65% fiber volume fraction. Properties of lamina are ρ_f = 3000 kg/m^3, ρ_m = 1100 kg/m^3. Using these properties, determine: 1. Density of lamina, 2. Mass fractions of the fiber and matrix, 3. Volume of composite lamina if the mass of the lamina is 4kg, 4. Volume of fibers and matrix.	07	L_3	CO1
b)	Find compliance matrix and reduced stiffness matrix when the properties of a lamina are E_1 = 190 GPa, E_2 = 10.3 GPa, ν_{12} = 0.28, G_{12} = 7.17 GPa.	08	L_3	CO1
	OR			
b)	A ply of 60^0 fiber orientation is in planar state of stress. Check if the lamina will fail using Tsai-Wu theory. Use the following data: F_{1t} = 1950MPa, F_{2t} = 27MPa, F_{1c} = 1480MPa, F_{2c} = 200MPa, F_{6u} = 79MPa, σ_1 = 920MPa, σ_2 = 110MPa, τ_6 = -66MPa.	08	L_3	CO1

Q.2 **Attempt the Following**

a) Consider a symmetric laminate made up of three-plies. Each has thickness of 5 mm. Calculate: 1. All five flexural constants, 2. Find [κ] if M_y = 1Nm. 07 L_3 CO2

$$[D^*] = \begin{bmatrix} 2.032\times10^{-5} & -3.526\times10^{-6} & 0 \\ -3.526\times10^{-6} & 2.136\times10^{-4} & 0 \\ 0 & 0 & 4.959\times10^{-4} \end{bmatrix} \frac{1}{Pa\text{-}m^3}$$

OR

a) For a three-ply laminate $[0/\overline{90}]_s$ with a thickness of 5 mm per ply: 1. Draw the laminate from laminate code, 2. Stiffness matrix [A] 07 L_3 CO2

$$[\bar{Q}]_{90} = \begin{bmatrix} 10.35 & 2.897 & 0 \\ 2.897 & 181.8 & 0 \\ 0 & 0 & 7.17 \end{bmatrix} (10^9)\ Pa$$

$$[\bar{Q}]_{0} = \begin{bmatrix} 181.8 & 2.897 & 0 \\ 2.897 & 10.35 & 0 \\ 0 & 0 & 7.17 \end{bmatrix} (10^9)\ Pa$$

b) Consider a laminate $[45/0]_s$. Apply Tsai-Wu theory to calculate the strength ratio for ply with $\theta = 0^0$. 08 L_3 CO2

For laminate: F_{1t} = 1500 MPa, F_{1c} = 1500 MPa, F_{2t} = 40 MPa, F_{2c} = 246 MPa, F_6 = 68 MPa

For 0^0, σ_1 = 97.26 Pa, σ_2 = 1.313 Pa, τ_6 = 0 Pa

OR

b) For a lamina of 60°, calculate 1. Coefficient of thermal expansion, 2. Coefficient of moisture absorption, 3. Strains under temperature change of –100°C and moisture absorption of 0.02 kg/kg. Ignore mechanical strains. 08 L_3 CO2

$\alpha_1 = 8.6\times10^{-6}$ m/m/°C, $\beta_1 = 0$ m/m/kg/kg,

$\alpha_2 = 22.1\times10^{-6}$ m/m/°C $\beta_2 = 0.6$ m/m/kg/kg

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Q.3	**Solve any Two**				
	a)	Explain glass fiber reinforcements in detail.	08	L_2	CO1
	b)	Explain strength ratio in detail. Name the four types of failure theories.	08	L_2	CO1
	c)	Answer the following: 1. Give four assumptions used in Classic Laminate Plate Theory 2. What are different types of laminates?	08	L_2	CO2
	d)	Write in detail about hygrothermal stresses.	08	L_2	CO2
Q.4	**Solve any Two**				
	a)	Write in detail about Moiré methods with diagram.	09	L_2	CO3
	b)	Use Moiré strain analysis to find strain when: 1. $p = 3$ mm, $\theta = 60^0$ and $\varphi = 80^0$ 2. $p = 5$ mm, $\theta = 80^0$ and $\varphi = 120^0$	09	L_3	CO3
	c)	Consider a specimen coated with brittle ceramic coating completely. Specimen properties: E = 1 GPa, $\nu = 0.3$ and $\sigma_1 = 15$ N/m^2. Coating properties: E = 0.5 GPa and $\nu = 0.2$. Calculate σ_1 and σ_2 for coating when specimen stress $\sigma_2^s = 0$ and when specimen stress $\sigma_2^s = 20$ N/m^2	09	L_3	CO3
Q.5	**Solve any Two**				
	a)	A steel bar of E_s = 210GPa and an aluminium bar of E_a = 70GPa are bonded together to form a composite bar. Determine the maximum stress in aluminium only when the bar is bent about a horizonal axis with M = 60Nm. Use y = -9 mm. Steel is the 8 x 8 mm small portion surrounded by aluminium bars on three sides as shown in figure 1.	09	L_3	CO4

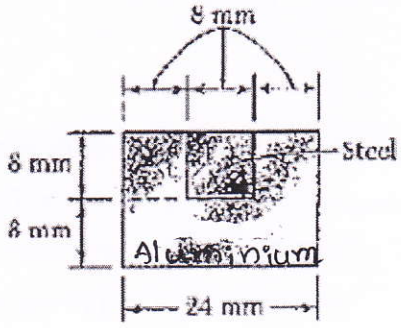


Fig. 1

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b) A beam is made of three planks, 20 by 100mm in cross section, nailed together as shown in figure 2. Knowing the spacing between nails is 25mm and vertical shear in beam is V = 500N, determine shearing force in each nail. 09 L_3 CO4

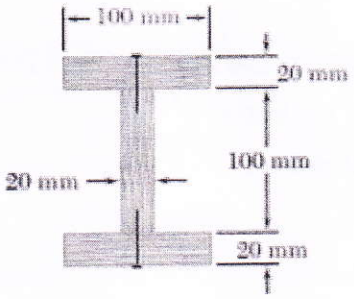


Fig. 2

c) Explain in detail foam core materials used in a sandwich composite. 09 L_2 CO4

Q.6 **Solve any Three**

a) Name the parameters that influence the behaviour of brittle coating. 06 L_2 CO3

b) Answer the following: 06 L_2 CO3

i. What are advantages of brittle coating?

ii. What are disadvantages of brittle coating?

c) i. What is sandwich composite? 06 L_2 CO4

ii. Draw a sandwich composite.

iii. What are the advantages of sandwich composite?

d) Explain the following failure modes of sandwich panels with diagrams: 06 L_2 CO4

i. Skin wrinkling

ii. Intra cell buckling

iii. Local compression

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