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Question Paper Code : 40062

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Sixth/Seventh Semester

Aeronautical Engineering

AE 8603 — COMPOSITE MATERIALS AND STRUCTURES

(Common to : Aerospace Engineering)

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the need for the composite materials in engineering applications?

2. What is the role of reinforcement in load-transfer mechanism of a composite?

3. List the different elastic constants used to define an orthotropic material.

4. Distinguish between neutral axis and arbitrary axis of a laminate.

5. Give one sample lay-up sequence for (a) symmetric cross-ply (b) unsymmetric angle-ply of a laminate made of eight layers.

6. Explain the need for quasi-isotropic laminate.

7. List the types of open mould processes.

8. Differentiate between autoclave and non-autoclave methods.

9. List the advantages of sandwich panels compared to metal and fibre reinforced composite panels.

10. In sandwich construction, the core is relatively less stiff compared to the facing layers. Why?

PART B — (5 × 13 = 65 marks)

11. (a) Derive the strain-stress relation for a composite material. Using the same establish the stress-stress strain relation for transversely isotropic material. Specify clearly number of independent elastic constants needed in each case to establish the stress-strain relation. (13)

Or

(b) (i) Derive an expression for longitudinal tensile strength, minimum fiber volume fraction and critical fiber volume fraction of a unidirectional lamina using mechanics of material approach. (7)

(ii) A E-Glass Fibre polymer composite sheet has the following data:

For Glass Fibre : Young's modulus 68.9 GPa; Density = 2540 kg/m^3 Length of fibre = 25 mm; Diameter = 2.5 mm.

For Polyester matrix: Young's modulus = 3.45 GPa, Density = 1100 kg/m^3. Calculate the tensile modulus, shear modulus and Poisson's ratio. (6)

12. (a) For a Graphite/Epoxy unidirectional lamina, find the following, (i) Compliance matrix, (ii) Minor Poisson's ratio, (iii) Reduced stiffness matrix, if the applied stresses are σ_1 = 2 MPa, σ_2 = –3 MPa, and ζ_{12} = 2 MPa. Assume

E_1 = 181 GPa; E_2 = 10.3 GPa; G_{12} = 7.17 GPa and γ_{12} = 0.28 (13)

Or

(b) Derive the relations to analyze failure of a composite laminate using Tsai-Wu failure theory. (13)

13. (a) (i) Derive the [A B; B D] matrix which relates the force and moment resultants with the in-plane and curvature strains for a composite material. (7)

(ii) Explain the steps involved in the analysis of multi-directional laminate. (6)

Or

(b) Find the stiffness matrices [A] and [D] for three ply [0/90/0] graphite epoxy laminate. Assume each lamina has a thickness of 5 mm. The properties of Graphite/Epoxy are E_1 = 181 GPa; E_2 = 10.3 GPa; G_{12} = 7.17 GPa and γ_{12} = 0.28. (13)

14. (a) (i) Explain the fabrication of fibre reinforced polymer matrix composite using compression moulding technique. (7)

(ii) Explain manufacturing of composite pre-preg. (6)

Or

(b) Explain different types of repairing techniques used in fibre reinforced composites. (13)

15. (a) (i) Derive the expression for the flexural modulus of a sandwich plate. (9)

(ii) The sandwich structures are very weak under shear loading. Why? (4)

Or

(b) Derive the relation between global stresses and local stresses of a symmetric composite beam having rectangular cross-section. (13)

PART C — ($1 \times 15 = 15$ marks)

16. (a) For a [0/±60] Graphite/Epoxy laminate, show that

(i) $A_{11} = A_{22}$; $A_{16} = A_{26} = 0$; $A_{66} = (A_{11} - A_{12})/2$. (8)

(ii) [B] not equal to zero unlike isotropic materials (7)

Each lamina is of 5 mm thickness and $E_1 = 181$ GPa; $E_2 = 10.3$ GPa; $G_{12} = 7.17$ GPa and $\gamma_{12} = 0.28$.

Or

(b) (i) Derive the hygrothermal stress-strain relationship for a unidirectional lamina. (7)

(ii) For a 60° angle lamina of Glass/Epoxy: Find the strains under a temperature change of –100°C and a moisture absorption of 0.02 kg/kg. Assume, the co-efficient of thermal expansions as $\alpha_1 = 8.6 \times 10^{-6}$ m/m/°C, $\alpha_2 = 22.1 \times 10^{-6}$ m/m/°C and co-efficient of moisture expansion as $\beta_1 = 0$ m/m/kg/kg , $\beta_{21} = 0.6$ m/m/kg/kg. (8)

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