



B.E DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Sixth Semester

AERONAUTICAL ENGINEERING

U18AEE0007: Composite Materials and Structures

COURSE OUTCOMES

- CO1:** Identify the properties of fiber and matrix materials used in commercial composite materials.
CO2: Determine the material properties of composites.
CO3: Apply the conventional failure theories to composite materials.
CO4: Design a laminate for a given load condition.
CO5: Identify the most appropriate manufacturing process for fabricating composite components based on its requirement.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 2 = 20 Marks)

(Answer not more than 40 words)

- | | | |
|--|-----|-------------------|
| 1. Define the term Composite material. | CO1 | [K ₁] |
| 2. How the polymer matrix materials are classified? | CO1 | [K ₁] |
| 3. Young's modulus and density of glass fiber are 85 GPa and 2500 kg/m ³ respectively. 'E' and 'ρ' of aluminium are 72 GPa and 2700 kg/m ³ respectively. Find the ratio of the specific modulus of glass fiber to that of aluminium. | CO2 | [K ₂] |
| 4. List the various applications of the composite material. | CO2 | [K ₂] |
| 5. Write the Halpin-Tsai relation for finding transverse modulus. | CO3 | [K ₁] |
| 6. A continuous and aligned glass fiber-reinforced composite has a fiber volume fraction of 40%, fiber has a modulus of elasticity of 69 GPa, and 60 vol% of a polyester resin. The modulus of the matrix is 3.4 GPa. Compute the modulus of elasticity of this composite in the longitudinal direction. | CO3 | [K ₂] |
| 7. What is the main purpose of the sandwich panel? | CO4 | [K ₂] |
| 8. How sandwich panels are made? | CO4 | [K ₂] |
| 9. What are the environmental effects on composites? | CO5 | [K ₂] |
| 10. Expand the following matrix materials. | CO5 | [K ₁] |
| i. ABS ii. PEEK | | |

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

- | | | | | |
|-----|--|----|-----|-------------------|
| 11. | Derive the expression for generalized Hooke's law. Write the stiffness matrix and compliance matrix for anisotropic and orthotropic materials. | 16 | CO1 | [K ₃] |
| 12. | A 30° unidirectional composite lamina is subjected to stresses $\sigma_x = 50$ MPa, $\sigma_y = -25$ MPa, $\tau_{xy} = 50$ MPa. It has an allowable tensile stress of 750 MPa in the fiber direction and 50 MPa in the fiber transverse direction and an allowable compressive stress of 400 MPa in the fiber direction and 100 MPa in the fiber transverse direction. The allowable shear stress is 50 MPa. Using the maximum-stress theory, determine whether the lamina will fail under the applied stresses. | 16 | CO2 | [K ₃] |
| 13. | a) Explain the failure modes of unidirectional composites with a neat stress-strain diagram. | 8 | CO3 | [K ₃] |
| | b) Estimate the transverse modulus (E_T), of the glass-epoxy composite with a fiber volume fraction of 25%. The modulus of elasticity of glass fiber and epoxy is 70 GPa, and 3.5 GPa, respectively. Assume that fibers have a circular cross-section. | 8 | CO3 | [K ₃] |
| 14. | Find the following for a 60° angle lamina of graphite/epoxy. Use the properties of unidirectional graphite/epoxy lamina of $E_1=181$ GPa; $E_2=10.3$ GPa; $\gamma_{12}=0.28$; $G_{12}=7.17$ GPa;
(i) Transformed Compliance Matrix
(ii) Transformed Stiffness Matrix | 16 | CO4 | [K ₃] |
| 15. | With a neat sketch briefly explain the following composite manufacturing processes.
i. Resin Transfer molding (RTM)
ii. Pultrusion | 16 | CO5 | [K ₂] |
| 16. | a) A burn-off test was performed to determine the volume fractions of constituents in a glass-fiber-reinforced epoxy composite. The following observations were made:
Mass of empty crucible = 47.6504 g
Mass of the crucible and a small piece of composite = 50.1817 g
Mass of crucible and glass after the burn-off = 49.4476 g
Assume that the densities of the fibers and resin are 2.5 and 1.2 g/cm ³ , respectively. Find the mass and volume fractions of epoxy resin. | 8 | CO1 | [K ₃] |
| | b) With a neat sketch explain how Glass fibers are produced. Describe the mechanical and thermal properties of it with a tabular column. | 8 | CO5 | [K ₂] |
