R 3025

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Seventh Semester

Aeronautical Engineering

AE 1402 — COMPOSITE MATERIALS AND STRUCTURES

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are advanced composites?

2. Why are fiber reinforcements of a thin diameter?

3. What is meant by orthogonally anisotropic material? Give an example.

4. What are the assumptions made in micro mechanics?

5. Distinguish between symmetric cross ply laminate and symmetric angle by laminate.

6. Give an example of a laminate with zero coupling stiffness matrix.

7. What are the merits and demerits of Tsai-hill failure theory?

8. What are the assumptions made in classical small deformation theory for a laminate?

9. Distinguish between open mould and close mould processes.

10. List down the advantages of using a sandwich construction.

PART B — (5 × 16 = 80 marks)

11. (a) Determine the elastic stiffness matrix [C] and compliance matrix [S] for an orthotropic laminate. The material properties of the laminate with respect to the principal material directions are $E_l = 810$ MPa, $E_t = 270$ MPa, $\nu_{lt} = 0.25$ and $G_{lt} = 135$ MPa. Also calculate the elastic stiffness matrix [C] if the angle between the principal material direction $l$ and the arbitrary loading direction is 45°.

Or

(b) (i) For glass-epoxy composite $E_f = 85$ GPa, $E_m = 3.4$ GPa, $\nu_m = 0.3$ and $\nu_f = 0.25$, find the minor Poisson's ratio $\nu_{21}$ and $G_{12}$ for a fiber volume fraction of 60%.

(ii) What weight of glass fibers must be added to 1 kg of epoxy to produce a composite with a density of 1600 kg/m³, $\rho_f = 2500$ kg/m³ and $\rho_m = 1200$ kg/m³.

12. (a) Obtain an expression for $E_1$, $E_2$ and $G_{12}$ in terms of material properties with respect to principal material directions using mechanics of material approach.

Or

(b) Using elasticity approach, obtain an expression for the upper bound on apparent Young's modulus for anisotropic composite materials.

13. (a) Derive the governing differential equation for a laminated unidirectional anisotropic plate.

Or

(b) Find the stiffness matrices [A] and [B] for a three ply [0°/30°/–45°] graphite epoxy laminate. Assume each lamina has a thickness of 5 mm. The properties of graphite/Epoxy are $E_l = 181$ GPa, $E_t = 10.3$ GPa, $\nu_{lt} = 0.28$ and $G_{lt} = 7.17$ GPa.

14. (a) Obtain an expression for the flexural modulus of a

(i) Sandwich plate with different face thickness.

(ii) Sandwich plate with different face thickness and material.

Or

(b) (i) What are the materials used for sandwich construction? (4)

(ii) Write short notes on the failure modes of sandwich panels. (12)

15. (a) (i) Write short notes on vacuum bag molding and continuous poltrusion. (8)

(ii) What are the functions and desirable properties of resins? (8)

Or

(b) (i) Explain with neat sketches the production of carbon fibers. (10)

(ii) What are the commercial forms of fibers? (6)