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Question Paper Code : 82322

M.E. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Elective

Structural Engineering

ST 9258/UST 9158/10211 SEE 51 — MECHANICS OF COMPOSITE MATERIALS

(Regulation 2009/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. How are the composite materials classified?
2. What are the advantages of ceramic matrix composites?
3. State: Hooke's law.
4. Are V_{12} and V_{21} independent of each other for a unidirectional orthotropic lamina?
5. Define the major Poisson's ratio.
6. Distinguish: Specially orthotropic plies and generally orthotropic plies.
7. Is a nonzero [B] matrix attributed to the orthotropy of layers?
8. Determine the Tsai-Hill failure criteria for pure shear at various angles θ to the principal Material directions.
9. What are the applications of composites in various fields?
10. State whether natural fiber composites are environmentally superior to glass fiber reinforced composites?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Give a brief historical review of composites. (8)

(ii) Compare the flexibility of a 0.3 mm diameter steel wire to 0.6 mm diameter Aluminium wire. The young's modulus of steel is 200 GPa and that of aluminium is 70 GPa. (8)

Or

(b) (i) Describe any one manufacturing method of polymer matrix composites. (8)

(ii) A lamina consists of 100 fibers of 10μm diameter. The fibers are 10 mm long. Find the interfacial area. What is the increase in the interfacial area if the diameter of the fiber is reduced to 5μm and the total volume of fibers is kept constant? (8)

12. (a) A uniaxial load is applied to a 10° ply. The linear stress-strain curve along the line of load is related as $\sigma_x = 123\ \varepsilon_x$, where the stress is measured in GPa and strain in m/m. Given $E_1 = 180$ GPa, $E_2 = 10$ GPa and $\upsilon_{12} = 0.25$. Find the value

(i) shear modulus, G_{12} and (8)

(ii) modulus E_x for a 60° ply. (8)

Or

(b) (i) Reduce the monoclinic stress-strain relationships to those of an orthotropic material. (8)

(ii) A lamina is loaded at angles $\theta = 30°$ and 45° with the fiber direction, and the corresponding moduli obtained are E_{x30} and E_{x60}, Determine a relationship between E_1, E_2, E_{x30} and E_{x45}. Determine an expression for E_2 in terms of E_{x30} and E_{x45} for $E_1 >> E_2$. (8)

13. (a) A cross-ply laminate $[0|90]_s$ made from high strength carbon/ epoxy unidirectional plies and subjected to a tensile membrane longitudinal force of $N_x = 100$ N/mm. Each ply is 0.125 mm thick and have identical properties as given below in Fig. 1. Determine the longitudinal stress and strain. (16)

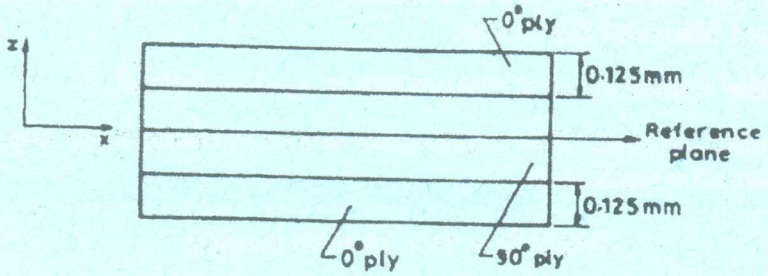

Fig. 1

Or

(b) (i) Derive the expressions for the stiffness matrices [A],[B] and [D] for an isotropic material in terms of its thickness, t, Young's modulus, E, and Poisson's ratio, ν. (10)

(ii) Show that for a symmetric laminate, the coupling stiffness matrix is equal to zero. (6)

14. (a) (i) An E-glass/epoxy composite has the following properties of its constituents

$v_f = 0.65$ $E_{1f} = 70$ GPa $E_m = 3.5$ GPa

$F_{1ft} = 3500$ Mpa and $F_{mt} = 100$ MPa

Determine the longitudinal modulus of the composite E_1 and longitudinal tensile strength F_{1T} of the composite. (10)

(ii) Find the Tsai-Hill failure criteria for pure shear at various angles θ to the principal material directions. (6)

Or

(b) (i) The loading axis is inclined at an angle θ to the fibre axis. Tension along they axis is the only load applied. Using maximum strain criteria, Determine F_{mt} and θ so that prediction of inplane shear and tensile failure load coincide. (8)

(ii) A lamina is loaded as shown Fig 2. Using Tsai-Wu failure criterion, determine F_0. (8)

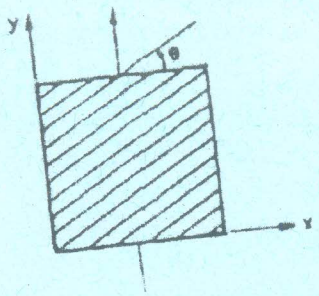

Fig 2

15. (a) (i) Explain the geometry and stress variation of adhesive joint with a neat diagram. (12)

(ii) Write the advantages and disadvantages of Mechanical joints. (4)

Or

(b) (i) Describe about the mode of failure of mechanical joints. (8)

(ii) What are the factors affecting the laminate selection for fibre reinforced polymer? (8)
