Reg. No. :

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B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Sixth Semester

Aeronautical Engineering

AE 6603 — COMPOSITE MATERIALS AND STRUCTURES

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write any four applications of composite materials.
2. What is Orthotropic material?
3. Differentiate natural axis and arbitrary axis.
4. What is meant by lamina?
5. Write the advantages and disadvantages of Tsai–hill failure theory.
6. State the significance of curing stresses in a laminate.
7. Differentiate open mould and close mould processes with examples.
8. List out the different types of resin materials.
9. Distinguish between face dimpling and face wrinkling.
10. Name any five components of aircraft where sandwich panels are used.

PART B — (5 × 13 = 65 marks)

11. (a) Show the reduction of an isotropic material stress-strain equations to those of a monoclinic material stress-strain equations. (13)

Or

(b) Enumerate in detail about the properties, characteristics and applications of particulate and fibrous composite materials. (13)

12. (a) For the lamina considered in Fig. 12 (a). first find the stresses and strains in the longitudinal and transverse directions and then transform the strains to the x and y directions. (13)

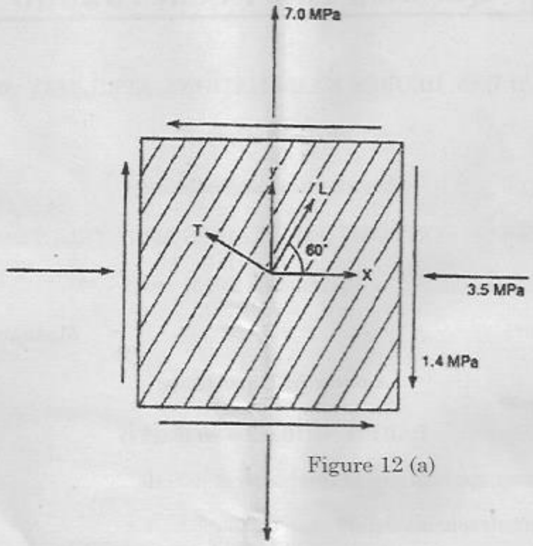

Figure 12 (a)

Or

(b) To demonstrate the difference between υ_{12} and υ_{21} consider the following example in which a square composite plate containing unidirectional continuous T–300 carbon fiber–reinforced epoxy is subjected to a uniaxial tensile load of 1000 N. The plate thickness is 1 mm. The length (L_o) and width (W_0) of the plate are 100 mm each. Consider two loading cases, where

(i) Load is applied parallel to the fiber direction

(ii) Load is applied normal to the fiber direction

Calculate the changes in length and width of the plate in each case. The basic elastic properties of the composite are given as follows: E_{11} = 138 GPa, E_{22} = 10 GPa, υ_{12} = 0.21. (13)

13. (a) A 12.5 mm–thick plate of graphite–epoxy composite with an initial moisture of 0.5% is exposed on both sides to air at 25°C and 90% relative humidity. Estimate the time required to reach 1 % moisture content. For the composite, at 25°C, assume transverse diffusivity, D_T = 2.6×10^7 mm²/s. (13)

Or

(b) Explain the various characteristics of the following laminates with mathematical expressions for stress-strain relationship:

(i) Symmetric laminates (7)

(ii) Cross-ply laminates (6)

14. (a) Explain in detail about the pressure bag moulding process with a neat sketch. Write the relative merits and demerits of the pressure bagging process. (13)

Or

(b) Enumerate about the various process flow involved for Resin Transfer Molding process. (13)

15. (a) Describe in detail about the Integrally Co-cured Structures used for the fabrication of airplane structural components. (13)

Or

(b) Explain briefly about the honeycomb processing prior to the adhesive bonding process. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Residual stress is generated because of cooling from high curing temperatures : A $[0/90_2]s$ laminate of AS–4 carbon fiber–epoxy is cured at temperature T_i = 190°C and slowly cooled down to room temperature T_f = 23°C. Determine the residual stresses generated in each layer because of cooling from the curing temperature. Assume each layer in the laminate has a thickness t_0. Following material properties are known:

E_{11} = 142 GPa, E_{22} = 10.3 GPa, v_{12} = 0.27, G_{12} = 7.6 GPa, $\alpha_{11} = -1.8 \times 10^{-6}$ per °C, $\alpha_{22} = 27 \times 10^{-6}$ per °C. (15)

Or

(b) Distinguish between carbon fiber and graphite in terms of merits and demerits. Explain with a schematic diagram of manufacturing of carbon fiber from PAN based precursors. (15)

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