

Mechanical Engineering Department
MEL 791 – Composite Materials and Processing
MAJOR EXAM, 21st Nov 2008, III-336, 10-30am-12.30pm
Max Marks 40

Note: Use suitable assumptions if needed and highlight;

Q1. For a UD Graphite epoxy lamina having $E_1 = 181$ GPa, $E_2 = 10.3$ GPa, $G_{12} = 7.17$ GPa, $\nu_{12} = 0.28$;

- a) find the compliance and stiffness matrix (5)
- b) find the strains in the 1-2 coordinate system, if the applied stresses are $\sigma_1 = 2$ MPa, $\sigma_2 = -3$ MPa, $\tau_{12} = 4$ MPa (5)

Q2. a) Reduce the expression for

$$\bar{Q}_{11} = Q_{11} \cos^4 \theta + Q_{22} \sin^4 \theta + 2(Q_{12} + 2Q_{66}) \sin^2 \theta \cos^2 \theta$$
$$\bar{Q}_{11} = U_1 + U_2 \cos 2\theta + U_3 \cos 4\theta, \text{ where } U_i \text{ } i=1,2,3 \text{ are the invariants} \quad (5)$$

b) Can the value of modulus E_x of an angle lamina be less or greater than both the longitudinal and transverse Young's modulus of a unidirectional lamina? (5)

Q3. The elastic properties of a UD- Carbon fiber epoxy lamina are $E_1=181$ GPa, $E_2=10.3$ GPa, $G_{12}=7.17$ GPa and $\nu_{12} = 0.28$. Estimate the engineering elastic constants of the $[0/90]_s$ laminates manufactured from this lamina. (7)

Q4. a) A glass epoxy cuboid specimen with voids has dimensions of $a \times b \times c$ and its Mass is M_c . After its put into a mixture of sulfuric acid and hydrogen per oxide, the remaining glass fibers have a mass of M_f . From independent tests the densities of glass and epoxy are ρ_f and ρ_m respectively. Find the volume fraction of voids in terms of $a, b, c, M_f, M_c, \rho_f$ and ρ_m . (5)

b) A $[0/30/-45]$ graphite epoxy laminate is subjected to a load of $N_x=N_y=100$ N/m, using the properties of lamina given in Q3 above and assuming that each lamina is 0.5 mm thick

- i) find midplane strain and curvatures
- ii) percentage of load N_x taken by each ply

(8)
