APPLIED MECHANICS DEPARTMENT

Major test in AML 835 (Mechanics of Composite Materials)
II Semester, 2006-2007

Time: 2.Hours   Marks: 100

Attempt all questions

1 (a)   Discuss the important advantages of composite materials that are responsible for their increasing use as engineering materials.   (8)

(b)   Why the following materials are not considered as composites although they consist of two or more constituents :   (i) wood, (ii) alloys   (5)

2.   Clearly stating the assumptions involved, derive an expression for the strength of an aligned continuous fibre-reinforced composite material with load being applied in the direction of fibers. In actual materials how are these assumptions violated?   (10)

Also discuss various failure mechanisms which are in operation when the above-said load is applied. Draw simple sketches to discuss your answer.   (5)

3.   In the classical laminate theory (CLT) what are [A], [B] and [D] matriees? Write down the relationship between deformations and resultant stresses and moments.

For a +45°/0°/-45° laminate, obtain these matrices. The thickness of each ply is 1.00mm and the reduced stiffness matrix in principal material coordinates is:

$$\begin{bmatrix} 134.\tilde{0}3 & 2.29 & 0 \\ 2.29 & 8.82 & 0 \\ 0 & 0 & 3.25 \end{bmatrix} \text{ GPa}$$

This laminate is loaded in tension along the fibre-direction of the middle-ply. Sketch the distributions of stresses and stains through the thickness. What couplings will be encountered for this laminate?

(30)

4.   Discuss the Tsai-Hill failure criterion for an aligned fibre lamina. A specimen of aligned fibre composite is loaded in tension. Plot the dependence of the failure strength on the fibre-orientation to the load axis, using the above criterion.   (12)

Q5. Three tubular specimens of glass-fibre reinforced nylon with fibre volume fraction of 20% were injection molded under three different processing conditions and gate designs for the mold . It was found that in one specimen most of the fibres are oriented axially while in the other specimen, the orientation is mostly circumferential. In the third specimen, the fibre are randomly oriented. These specimens were tested in axial tension to obtain material stiffness. Compare the values obtained for the three specimens. Use the following data:

$E_f = 72.4$ GPa, $E_m = 2.76$ GPa. (10)

Fibre length = 3.2 mm, Fibre diameter = $10 \mu m$

Which specimen would you expect to fail first and why? If the tubular (5) specimen is subjected to internal pressure, what failure mode is expected?

Q6. Briefly discuss the following; using schematic sketches wherever needed or possible:

(i)   Hand lay-up method of composite fabrication
(ii) Micro-bucking mode of compressive failure
(iii) Bio-medical applications of composite materials. (15)