Code No: J1508/R16

M. Tech. II Semester Regular Examinations, May-2017

MECHANICS OF COMPOSITE MATERIALS

(Common to Machine Design (15), Mechanical Engg. Design (14) , Computer Aided Analysis & Design (16)

Time: 3 Hours **Max. Marks: 60**

Answer any FIVE Questions
All Questions Carry Equal Marks

1. a Name any two matrices and two fibers and give the main advantages of each.
   b How is the mechanical advantage of composite measured?

2. a What is the relationship between the elements of the transformed compliance matrix for a 0 and 90° lamina?
   b 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 $\nu_{12} = 0.25$, find the value of (1) shear modulus, G_{12}; and Young's modulus E_x for a 60° ply.

3. a Explain the two principal effects of changes in hygrothermal environment on the mechanical behavior of polymer composites.
   b An angle –ply lamina made of S-glass/epoxy has the following properties in the principal fibre direction.
   $F_{1T} = 1280$ MPa; $F_{1C} = 622$ MPa; $F_{2T} = 49$ MPa; $F_{2C} = 245$ MPa; $F_6 = 69$ MPa;
   $E_1 = 35$ GPa; $E_2 = 7$ GPa; $E_6 = 3$ GPa; $\nu_{12} = 0.3$
   A tensile load of 2 MPa is applied at an angle of 60^o to the principal fibre direction. Check the safety of the laminate with any three failure theories.

4. a Reduce the monoclinic stress–strain relationships to those of an orthotropic material
   b Consider an orthotropic material with the stiffness matrix given by

$$[C] = \begin{bmatrix} -0.67308 & -1.8269 & -1.0577 & 0 & 0 & 0 \\ -1.8269 & -0.67308 & -1.4423 & 0 & 0 & 0 \\ -1.0577 & -1.4423 & 0.48077 & 0 & 0 & 0 \\ 0 & 0 & 0 & 4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.5 \end{bmatrix} \text{GPa},$$

Find the engineering constants E_1, E_2, E_3, ν_{12}, ν_{23}, ν_{31}, G_{12}, G_{23}, G_{31}.

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5. a List the assumptions for plane stress condition.
   b A unidirectional lamina which is treated under plane stress condition is subjected to a pure shear. Derive the relationship for compliance and stiffness matrix in terms of engineering elastic constants of a lamina.

6. a The transverse matrix is a matrix dominated property. Justify the statement.
   b A hybrid lamina uses glass and graphite fibers in a matrix of epoxy for its construction. The fiber volume fractions of glass and graphite are 40 and 20%, respectively. The specific gravity of glass, graphite, and epoxy is 2.6, 1.8, and 1.2, respectively.
   Find
   (i) Mass fractions and
   (ii) Density of the composite

7. a What are the types of laminates given below?
   (i) [30|-45|-30|45]
   (ii) [0|90|0|90]
   (iii) [0|45|90|-45]
   b Compute in-plane stiffness matrix [A] for a [0±45] laminate with the following laminate properties.
   E_1 = 145 GPa; E_2 = 10.5 GPa; E_6 = 7.5 GPa; ν_{12} = 0.28
   Thickness of each lamina is 0.25 mm

8. a What are the assumptions in the thin plate laminate theory?
   b Differentiate between the total – ply failure method and partial – ply failure method.

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