EX/PG/ME/T/113A/24/2017

Master of Mechanical Engineering Examination, 2017

(1st Semester)

Mechanics of Composite Materials

Time: Three hours Full Marks: 100

Answer **all** questions.

1. Define on-axis lamina and off-axis lamina. For a 2-D lamina derive the stress transformation matrix $[T_\sigma^+]$ to determine on-axis stress components from those of off-axis components. Also with usual notations show that $[Q_{ij}]_{off} = [T_\sigma^-][Q_{ij}]_{on}[T_\varepsilon^+]$. (20)

2. Derive the strain transformation matrix $[T_\varepsilon^+]$ for a 2-D lamina to determine on-axis stress components from those of off-axis components. Also with usual notations show that $[S_{ij}]_{off} = [T_\varepsilon^-][S_{ij}]_{on}[T_\sigma^+]$. (20)

3. Define symmetric and anti-symmetric laminates. State the assumptions of Kirchhoff's classical bending theory of thin plates. Express stress [N] and moment [M] resultants of a composite laminate in terms of strain vector and curvature vector. Also write down the expressions for A_{ij}, B_{ij} and D_{ij} of the elasticity matrix of a laminate and identify them. (20)

4. Considering classical laminated plate theory show that

   i) $N_{1,1} + N_{6,2} + q_1 = 0$

   ii) $Q_5 = M_{2,2} + M_{6,1}$

contd....

A specially orthotropic symmetric laminated plate with all edges simply supported is subjected to a transverse load of uniform intensity q. The bending equation is given as

$$D_{11} W_{.1111} + 2(D_{12} + 2D_{66}) W_{.1122} + D_{22} W_{.2222} = q$$

Write down the boundary conditions. Derive the expressions for the amplitudes of deflection W_{mn} and transverse load q_{mn}. Also find q_{mn} when $q(X_1, X_2) = q_0$ where the symbols have their usual meanings). (20)

5. Explain the independent failure theories of laminated composite structures. Name the interactive failure theories of composites. Derive the expression for Tsai-Hill-Hoffman criterion for failure of composites. (20)