Composite Materials: Analysis and Design

Homework no.6

Due Date:

Problem 1

A symmetric laminate is composed of four plies with ply angles $\pm\theta$. If the total thickness of the laminate is (t), determine the individual thicknesses which guarantee that the laminate is orthotropic with respect to bending force. That is $D_{13}=D_{23}=0$.

Problem 2

Show that as the number of plies increases in a regular symmetric cross-ply laminate of given total thickness, $D_{11}\rightarrow D_{22}$.

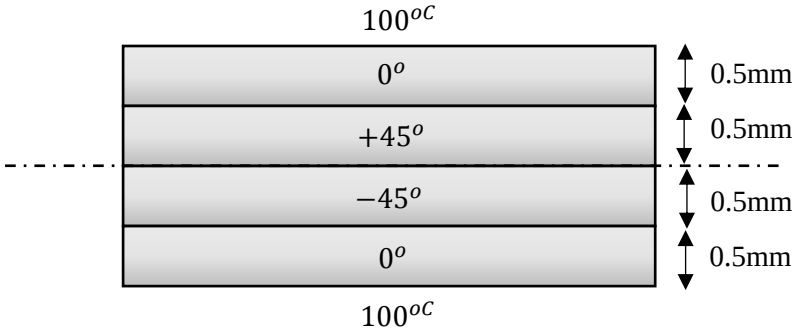
Problem 3

A thin flat sheet made from unidirectional fibers in a polymer matrix has the following elastic constants: $E_1 = 14^{GPa}, E_2 = 3.5^{GPa}, \nu_{12} = 0.4, G_{12} = 4.2^{GPa}$

In-plane loads are applied on x,y directions which make an angle of 60^o to the principal directions. A compressive stress of 3.5MPa is applied on x direction, a tensile stress of 7MPa on y direction and a shear stress of 1.4MPa. Calculate the stresses and the strains in the principal directions, and also the strains on x,y directions.

Problem 4

The composite laminate is cured at 130°C and is being used in such conditions that are illustrated in the figure:



a. Calculate the strains and curvatures

b. Calculate and illustrate graphically the through-the-thickness local stress distribution.

E_{11} = 164.0 GPa, E_{22} = 8.30 GPa, G_{12} = 2.10 GPa, ν_{12} = 0.30

Thermal properties:

α_1 = -4.5e-6 /°C, α_2 = 3.17e-5 /°C