Homework # 7

Corner A becomes less than 90°.

Question 1

Exercises for Section 7.6, Exercise 3 (p. 324)

From eq. 7.158 and 7.147,

$$\varepsilon_x^o = a_{16}N_{xy} = (0.0271x10^{-9})\ (10^5) = 2.71x10^{-6}$$

$$\Delta L_x = \varepsilon_x^o L_x = (2.71x10^{-6})\ (250\text{mm}) = 6.78x10^{-4}\text{mm}$$

Therefore the deformed length is 250.000678 mm.

$$\varepsilon_y^o = a_{26}N_{xy} = (-22.6x10^{-9})\ (10^5) = -2260x10^{-6}$$

$$\Delta L_y = \varepsilon_y^o L_y = (-2260x10^{-6})\ 125\text{mm} = -0.282\text{mm}$$

So the deformed width is 124.718 mm.

$$\gamma_{xy}^o = a_{66}N_{xy} = (57.8x10^{-9})\ (10^5) = 5780x10^{-6}\text{radians}$$

$$\gamma_{xy}^o = 0.331\,\text{degrees}$$

Corner *A* becomes less than 90°.

Question 2

Exercises for Section 7.7, Exercise 1 (p. 326)

From eq. 7.89a

$$A_{11} = 102.4x10^6 \text{N/m} \qquad A_{12} = 18.94x10^6 \qquad A_{22} = 16.25x10^6$$

$$A_{66} = 20.2x10^6 \qquad h = 150x10^{-6}\text{m} \qquad H = 6x150x10^{-6} = 900x10^{-6}\text{m}$$

From eq. 7.184

$$\bar{E}_x = 89.2\text{GPa}$$

$$\bar{E}_y = 14.16\text{GPa}$$

$$\bar{G}_{xy} = 22.4\text{GPa}$$

$$\bar{\nu}_{xy} = 1.166$$

$$\bar{\nu}_{yx} = 0.1850$$

The modulus $\bar{E}_x$ is more than six times larger than the modulus $\bar{E}_y$ since the majority of the fibers are in the x direction. However, there are enough off-axis fibers to make $\bar{G}_{xy}$ five times greater than G_{12}. A value of $\bar{\nu}_{xy} > 1$ means that if the laminate is subjected to a tensile load in the x direction, the laminate contracts in the y direction more than it stretches in the x direction!