TOBB EKONOMİ VE TEKNOLOJİ ÜNİVERSİTESİ

MAK 413 MECHANICS OF COMPOSITE MATERIALS

SPRING 2018

Due Date: 05.02.2018- Monday* (08:30)

HOMEWORK 1

1. Kaw 2nd ed. Prob. 2.2

2.2 The engineering constants for an orthotropic material are found to be

$$E_1 = 4\,Msi,\ E_3 = 3\,Msi,\ E_3 = 3.1\,Msi,$$

$$\nu_{12} = 0.2,\ \nu_{23} = 0.4,\ \nu_{31} = 0.6,$$

$$G_{12} = 6\,Msi,\ G_{23} = 7\,Msi,\ G_{31} = 2\,Msi$$

Find the stiffness matrix [C] and the compliance matrix [S] for the preceding orthotropic material.

2. Kaw 2nd ed. Prob. 2.3

2.3 Consider an orthotropic material with the stiffness matrix given by

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

Find:

1. The stresses in the principal directions of symmetry if the strains in the principal directions of symmetry at a point in the material are $\varepsilon_1 = 1\ \mu m/m$, $\varepsilon_2 = 3\ \mu m/m$, $\varepsilon_3 = 2\ \mu m/m$; $\gamma_{23} = 0$, $\gamma_{31} = 5\ \mu m/m$, $\gamma_{12} = 6\ \mu m/m$
2. The compliance matrix [S]
3. The engineering constants E_1, E_2, E_3, ν_{12}, ν_{23}, ν_{31}, G_{12}, G_{23}, G_{31}
4. The strain energy per unit volume at the point where strains are given in part (1.)

3. Kaw 2nd ed. Prob. 2.10

2.10 Find the reduced stiffness [Q] and the compliance [S] matrices for a unidirectional lamina of boron/epoxy. Use the properties of a unidirectional boron/epoxy lamina from Table 2.1.

4. Kaw 2nd ed. Prob. 2.11

2.11 Find the strains in the 1–2 coordinate system (local axes) in a unidirectional boron/epoxy lamina, if the stresses in the 1–2 coordinate system applied to are $\sigma_1 = 4$ MPa, $\sigma_2 = 2$ MPa, and $\tau_{12} = -3$ MPa. Use the properties of a unidirectional boron/epoxy lamina from Table 2.1.

5. Kaw 2nd ed. Prob. 2.14

2.14 Consider a unidirectional continuous fiber composite. Start from $[\sigma] = [Q]\,[\varepsilon]$ and follow the procedure in Section 2.4.3 to get

$$E_1 = Q_{11} - \frac{Q_{12}^2}{Q_{22}} \qquad \nu_{12} = \frac{Q_{12}}{Q_{22}}$$

$$E_2 = Q_{22} - \frac{Q_{12}^2}{Q_{11}} \qquad \nu_{21} = \frac{Q_{12}}{Q_{11}} \qquad G_{12} = Q_{66}.$$

Due date is **Monday 5th of February, 2018**. For each delayed day **15 points** will be reduced.