



TOBB EKONOMİ VE TEKNOLOJİ ÜNİVERSİTESİ
MAK 413 MECHANICS OF COMPOSITE MATERIALS



SPRING 2018

Due Date: 12.02.2018- Monday* (14:30)

HOMEWORK 3

1. Kaw 2nd ed. Prob. 2.23

2.23 A bidirectional woven composite ply may yield equal longitudinal and transverse Young's modulus but is still orthotropic. Determine the angles of the ply for which the shear modulus (G_{xy}) are maximum and minimum. Also find these maximum and minimum values. Given: $E_1 = 69$ GPa, $E_2 = 69$ GPa, $\nu_{12} = 0.3$, $G_{12} = 20$ GPa.

2. Kaw 2nd ed. Prob. 2.25

2.25 A uniaxial load is applied to a 10° ply. The linear stress-strain curve along the line of load is related as $\sigma_x = 123\epsilon_x$, 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 (2) modulus E_x for a 60° ply.

3. Kaw 2nd ed. Prob. 2.26

2.26 The tensile modulus of a 0° , 90° , and 45° graphite/epoxy ply is measured as follows to give $E_1 = 26.25$ Msi, $E_2 = 1.494$ Msi, $E_x = 2.427$ Msi for the 45° ply, respectively.

1. What is the value E_x for a 30° ply?
2. Can you calculate the values of ν_{12} and G_{12} from the previous three measured values of elastic moduli?

4. Kaw 2nd ed. Prob. 2.35

2.35 Find the off-axis shear strength and mode of failure of a 60° boron/epoxy lamina. Use the properties of a unidirectional boron/epoxy lamina from [Table 2.1](#). Apply the maximum stress failure, maximum strain, Tsai-Hill, and Tsai-Wu failure theories.

5. Kaw 2nd ed. Prob. 2.41

2.41 An off-axis test is used to find the value of H_{12} for use in the Tsai–Wu failure theory for a boron/epoxy system. The five lamina strengths of a unidirectional boron/epoxy system are given as follows:

$$(\sigma_1^T)_{ult} = 188 \text{ ksi}, (\sigma_1^C)_{ult} = 361 \text{ ksi}, (\sigma_2^T)_{ult} = 9 \text{ ksi}, (\sigma_2^C)_{ult} = 45 \text{ ksi},$$
$$\text{and } (\tau_{12})_{ult} = 10 \text{ ksi}.$$

A 15° specimen fails at a uniaxial load of 33.546 ksi. Find the value of H_{12} . Does it satisfy the inequality $H_{12}^2 < H_{11}H_{22}$, which is a stability criterion for Tsai–Wu failure theory that says failure surfaces intercept all stress axes and form a closed geometric surface¹³?

Due date is **Tuesday 12th of February, 2018**. For each delayed day **15 points** will be reduced.