ME 323: Mechanics of Materials **Homework 10**

Spring 2025 **Due: April 18th , 2025**

Problem 1 (10 points):

Figure 1 (a) shows bar AB which has a square cross section of side 1 mm and subject to a compressive load P. Stresses were measured along an element which has its x' axis oriented along the line CC' as shown in Figure 1 (b). Using Mohr's circle determine:

a) The principal stresses acting in the bar AB

b) The magnitude of angle α

c) Load P

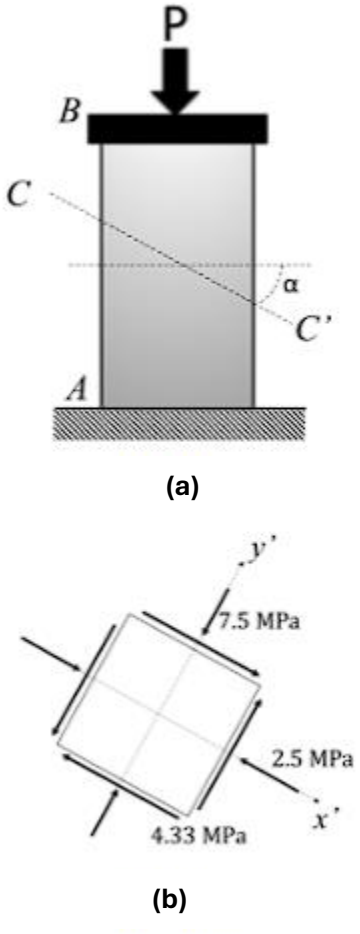


Figure 1: a) Bar AB under compression b) Stress element at CC'

Problem 2 (10 points):

For the given state of stress:

(a) Determine the three principal stresses.

(b) What is the absolute maximum shear stress for this state of stress?

(c) Draw the in plane (x,y) Mohr's circle. Determine the magnitude of the maximum in-plane shear stress in the xy plane. Also determine the orientation (angle) of the maximum in-plane shear stress relative to the x-axis and draw the corresponding stress element.

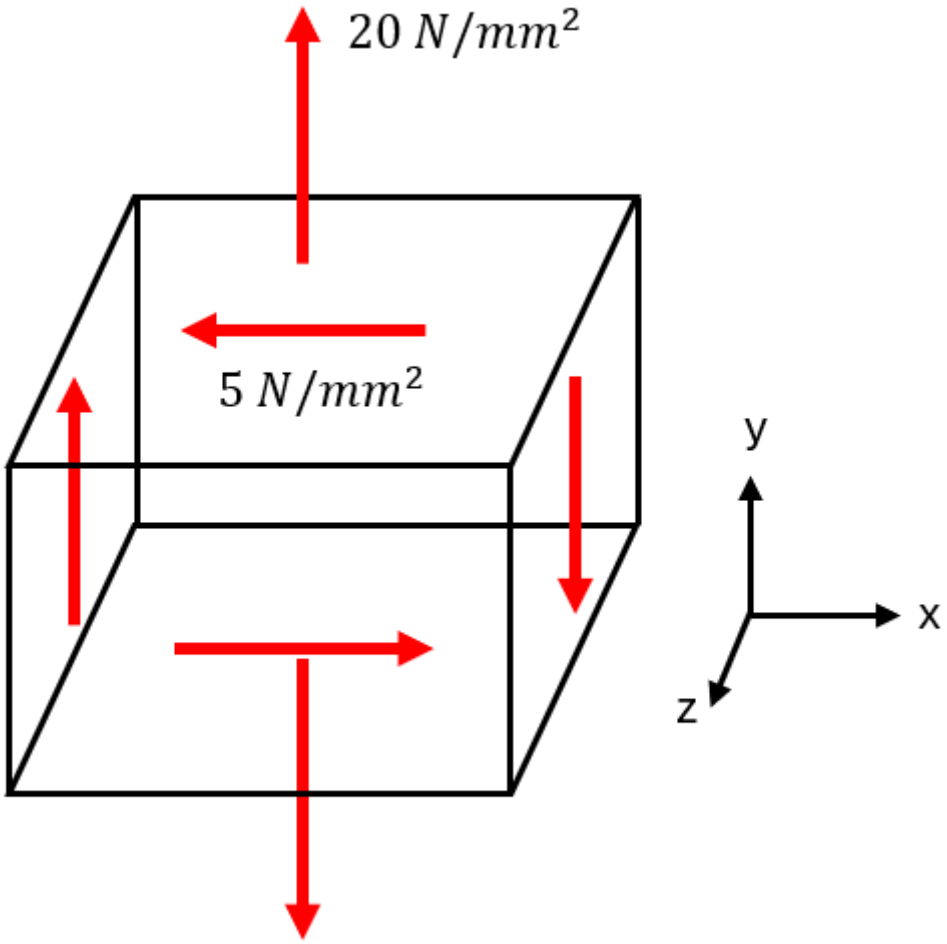


Figure 2: Stress element for problem 2

Problem 3 (10 points):

The vertically oriented circular shaft (having a radius of R) shown below supports a thick plate at C, with the attached plate having a weight of W. A torque T acts along the longitudinal axis of the shaft, as shown. For this problem, ignore the weight of the shaft, and use the following: $\frac{T}{WR} = \frac{1}{4}$.

(a) Determine the state of stress at point **a** on the outer surface of the shaft. Show the stress state on the stress element below.

(b) Draw Mohr's circle for this state of stress. Clearly indicate the location of the center of the circle, the radius of the circle and point X (which represents the stress state on the x-face) in this drawing.

(c) Determine the in-plane principal components of stress and the maximum in-plane shear stress component for this state of stress. Show the locations of these components of stress on your Mohr's circle. Draw the principal stress element and maximum in-plane shear stress element with their rotation angles relative to the x-axis.

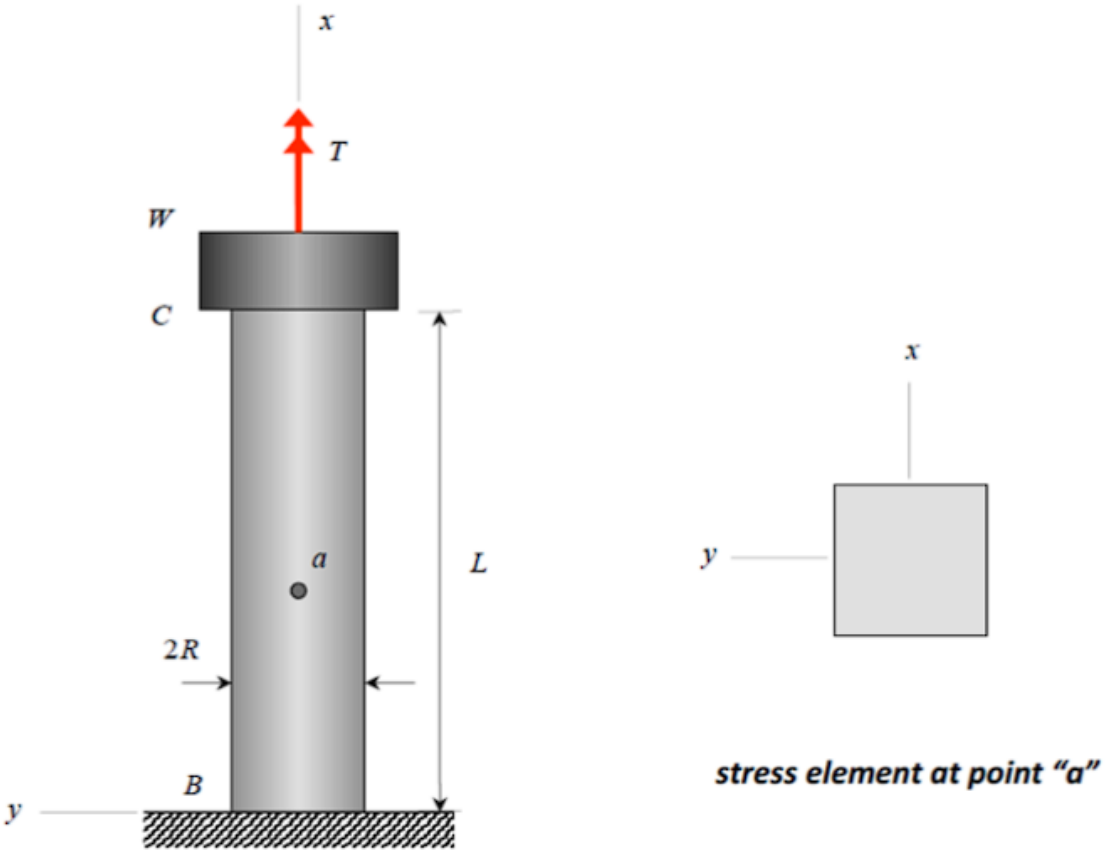


Figure 3: Shaft for problem 3

Problem 4 (2.5 points + 2.5 points):

4.1. A tensile bar (shown below) fails due to shear stress, at what angle will it fail (along which plane is it most likely to fail)?

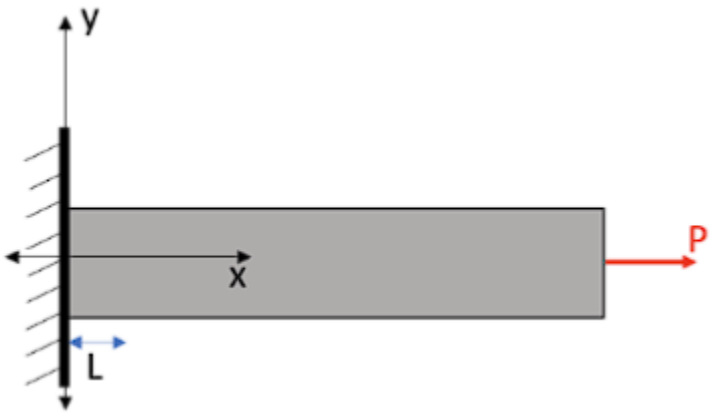
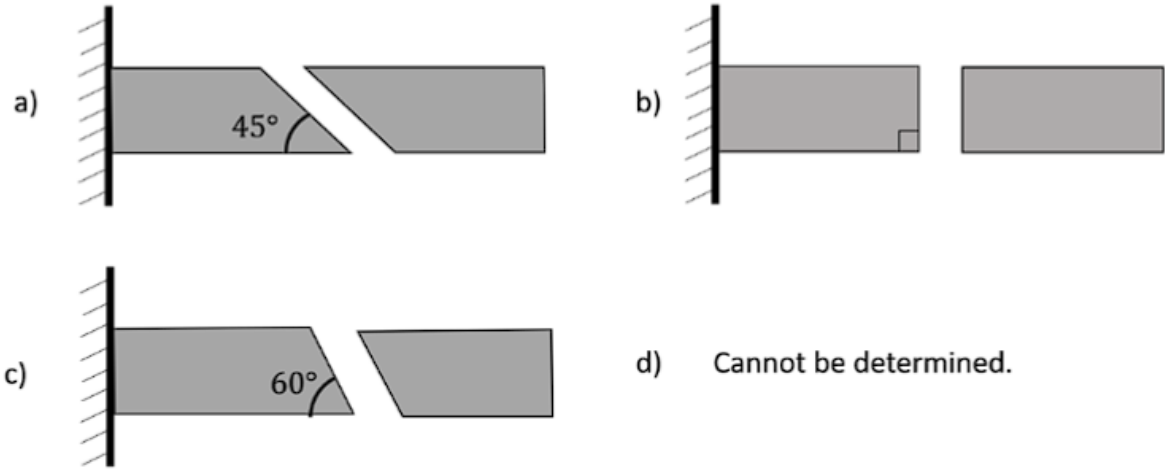


Figure 4.1: Tensile bar 4.1



4.2. Consider stress states (a) and (b) shown above, with $|\sigma 1| > |\sigma 2|$. Let $(|\tau|max,abs)a$ and $(|\tau|max,abs)b$ represent the absolute maximum shear stress corresponding to stress states (a) and (b), respectively. Choose the response below that describes the relative sizes of these stresses:

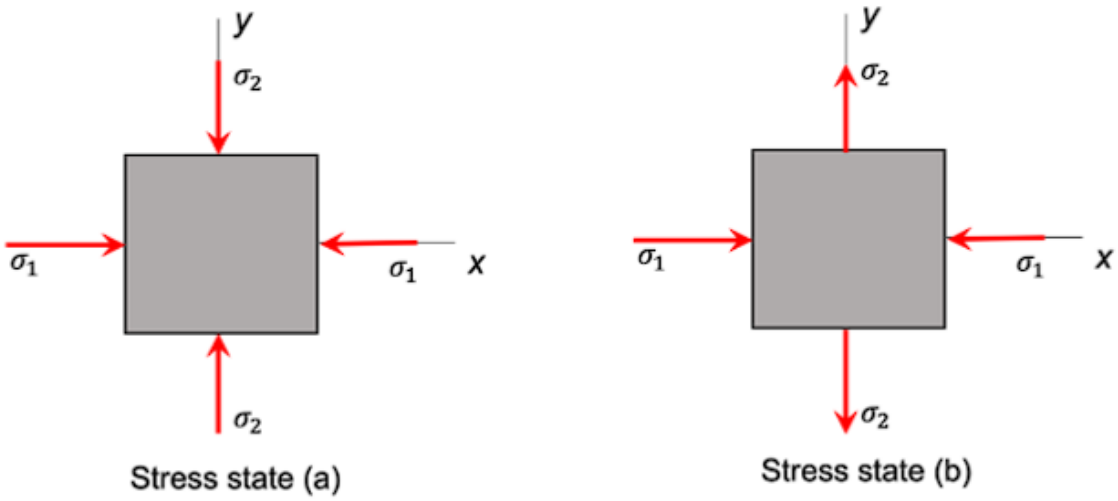


Figure 4.2: Stress states a) and b)

i. $(|\tau|_{max,abs})_a > (|\tau|_{max,abs})_b$

ii. $(|\tau|_{max,abs})_a = (|\tau|_{max,abs})_b$

iii. $(|\tau|_{max,abs})_a < (|\tau|_{max,abs})_a$