

Homework #2

Provide your answers on separate attached pages. Attach copies of your Matlab calculations.

Problem 1

Which of the following could describe the stress state at a point in equilibrium? Why or why not? (4 points total)

$$\begin{array}{cc} \begin{bmatrix} 1MPa & 2MPa \\ 2MPa & 20MPa \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 2 & 20 \end{bmatrix} & \begin{bmatrix} 1MPa & -2MPa \\ 2MPa & 20MPa \end{bmatrix} \begin{bmatrix} 1MPa & 0MPa \\ 0MPa & 1MPa \end{bmatrix} \\ \text{A} & \text{B} \qquad \qquad \qquad \text{C} \qquad \qquad \qquad \text{D} \end{array}$$

Problem 2

Multiply the matrices on the right side of equation 4.12 to show that they indeed yield the stresses in the primed reference frame of equations 4.3, 4.5, 4.7, and 4.9. (16 points total)

Problem 3

Set to zero the derivative of equation 4.3 with respect to $\theta = \theta_{x'x}$, and show that the angle at which the maximum and minimum values of the normal stress occur is

$$\theta = \theta_{x'x} = \frac{1}{2} \tan^{-1} \left(\frac{-2\sigma_{xy}}{\sigma_{yy} - \sigma_{xx}} \right) = \frac{1}{2} \tan^{-1} \left(\frac{2\sigma_{xy}}{\sigma_{xx} - \sigma_{yy}} \right). \quad (8 \text{ points total})$$

Problem 4

Consider the following stress state at a point: $\sigma_{ij} = \begin{bmatrix} \sigma_{xx} & \sigma_{xy} \\ \sigma_{yx} & \sigma_{yy} \end{bmatrix} = \begin{bmatrix} 10MPa & 8MPa \\ 8MPa & 4MPa \end{bmatrix}$

- 1 Draw a box with sides perpendicular to the x- and y-axes and draw the stress components acting on the sides of the box. Let the x-axis be horizontal and the y-axis be vertical, and label the axes (5 points total)
- 2 Draw a new set of axes (the x'- and y'-axes), where the x' axis is 20° clockwise from the x-axis. Label the following angles on this diagram: $\theta_{x'x}$, $\theta_{x'y}$, $\theta_{y'x}$, and $\theta_{y'y}$ (5 points total)
- 3 Draw a new box with sides perpendicular to the (labeled) x'- and y'-axes and then draw arrows representing positive normal and shear stresses on the sides of the box.
- 4 Calculate the stresses in the primed reference frame $\sigma_{i'j'} = \begin{bmatrix} \sigma_{x'x'} & \sigma_{x'y'} \\ \sigma_{y'x'} & \sigma_{y'y'} \end{bmatrix}$ using equations 4.3, 4.5, 4.7, and 4.9. (5 points total)
- 5 Calculate the stresses in the primed reference frame $\sigma_{i'j'} = \begin{bmatrix} \sigma_{x'x'} & \sigma_{x'y'} \\ \sigma_{y'x'} & \sigma_{y'y'} \end{bmatrix}$ using equation 4.14 and Matlab. Include a printout of your Matlab work. (5 points total)