Problem 4.1
An automobile tire normally requires internal pressure from 24-36 psi. This pressure might be higher under certain situations. We will take an internal pressure as 32 psi for this problem. Let’s say that a soda can have 3 inches diameter. We get that:

\[\sigma = p_i \left( \frac{R}{2t} \right)\]

\[\sigma_a = 32 \left( \frac{1.5}{2 \cdot 0.0025} \right) = 9600 \text{ psi}\]

Problem 4.2
In this problem, you can solve it either using mathematic equation or drawing a Mohr’s circle. I will provide the mathematic solution here (drawing a Mohr’s circle is an acceptable method and relatively easy and quick to do as well).

The stress transformation equations

\[\sigma' = \frac{\sigma_a + \sigma_y}{2} + \frac{\sigma_a - \sigma_y}{2} \cos 2\phi + \sigma_y \sin 2\phi \]

\[\sigma_y' = \frac{\sigma_a + \sigma_y}{2} - \frac{\sigma_a - \sigma_y}{2} \cos 2\phi - \sigma_y \sin 2\phi \]

We get that, when \(\phi = 30\) degree,

\[\sigma_x' = \left[ \frac{6 + (-2)}{2} \right] + \left[ \frac{6 - (-2)}{2} \right] \cos 60 + 4(\sin 60) = 7.464\]

\[\sigma_y' = \left[ \frac{6 + (-2)}{2} \right] - \left[ \frac{6 - (-2)}{2} \right] \cos 60 - 4(\sin 60) = -3.464\]

\[\sigma_{xy}' = -\left[ \frac{6 - (-2)}{2} \right] \sin 60 + 4(\cos 60) = -1.464\]

Knowing that the shear stress component will vanish on planes that yield maximum and minimum normal stress components, we get that:

So \(\phi = 22.5\) degree.

Problem 4.3
A thin walled glass tube of radius \(R = 1\) inch, and wall thickness \(t = 0.05\) inches, is closed at both ends and contains a fluid under pressure, \(p = 80\) psi. A torque, \(M_t\) of 300 inch-lbs, is applied about the axis of the tube.

Compute the stress components relative to a coordinate frame with its x axis in the direction of the tube’s axis, its y axis circumferentially directed and tangent to the surface.

Determine the maximum tensile stress and the orientation of the plane upon which it acts.

For this problem, we know that \(R = 1\) inch, \(t = 0.05\) inches, \(p_i = 80\) psi, and \(M_t = 300\) inch-lbs. Figure shows the sketch of the tube and an element subjected to the stresses caused by the internal pressure and the applied torque.

If we assume the torque produces a force per unit length, \(f_R\), uniformly distributed around the circumference, we have, from moment equilibrium about the axis of the can: \(M_t = 2\pi R \cdot f_R \cdot R\)
Now if we also assume the force per unit length of the circumference is uniformly distributed across the thickness of the can we have

\[ \tau = \frac{M_t}{2\pi R^2 \cdot t} = \frac{300}{2\pi 1^2 \cdot 0.05} = 955 \text{ psi} \]

The axial stress and the hoop stress components are:

\[ \sigma_a = \frac{p_t}{(R/2t)} = 80(10) = 800 \text{ psi} \]

\[ \sigma_\theta = \frac{p_t}{(R/t)} = 80(20) = 1600 \text{ psi} \]

From the stress transformation equations and the fact that the shear stress at the planes which have maximum and minimum normal stress is zero, we get that

\[ 0 = \left( \frac{800 - 1600}{2} \right) \sin 2\phi + 955 \cos 2\phi \]

so

\[ \tan 2\phi = -\frac{955}{400} = -2.4 \]

so

\[ 2\phi = -67^\circ, \phi = -33.6^\circ \]

The extreme values for the tensile stress is, substituting into the transformation relationship for \( \sigma_x' \) and \( \sigma_y' \)

\[ |\sigma_x'|_{\text{extreme}} = \left[ \frac{(800 + 1600)}{2} \right] + \left[ \frac{(800 - 1600)}{2} \cdot \cos 2\phi + 955 \sin(-67) \right] = 165 \text{ psi} \]

\[ |\sigma_y'|_{\text{extreme}} = \left[ \frac{(800 + 1600)}{2} \right] - \left[ \frac{(800 - 1600)}{2} \cdot \cos 2\phi - 955 \sin(-67) \right] = 2235 \text{ psi} \]

Note the invariance of the sum of the normal stress components (their sum = 2400 psi).

**Problem 4.4 (Potential Quiz Question).**

*Find the axial stress acting in member EF of the end-loaded truss if its cross-sectional area is 0.1 in\(^2\) and \(W = 1500 \text{ lb}\).*

We can solve this problem with but one isolation, as shown at the right. We want the force in member EF so we take moments about pt. B and require the resultant moment to be zero. This gives (cw positive):

\[ f_{EF} \cdot (a/2) + W \cdot (2a) = 0 \]

So

\[ f_{EF} = 4W \]

and the axial stress is then: \(4(1500)/(0.1) = 60,000 \text{ psi}\).