MAE5009: Continuum Mechanics B

Assignment 01: Stress

Due September 29, 2021

1. Given σ_x = -14 MPa, σ_y = 6 MPa, and τ_{xy} = -17 MPa, determine both by formulas and by the Mohr's circle,

   (a) the principal stresses and their directions,

   (b) the direction having the maximum shear stress and the corresponding shear and normal stress magnitudes,

   (c) the stress components on the x' and y' planes when α = 45°

2. Given a three-dimensional stress state with

   σ_x = 10 MPa, σ_y = 20 MPa, σ_z =-10 MPa

   τ_{xy} = 5 MPa, τ_{xz} = -10 MPa, τ_{yz} =-15 MPa

   (a) find the magnitude and direction of the stress vector *p* on the x' plane where the x' direction is defined by

   $\cos(x', x) = 1/2$, $\cos(x', y) = 1/\sqrt{2}$ and $\cos(x', z)$ is positive

   (b) find σ and τ on this plane

   (c) determine the angle between *p* and σ

   (d) solve for $\tau_{x'y'}$ and $\tau_{x'z'}$, if $\cos(x, y') = 1/2$ and $\cos(z, y')$ is negative. Please note that both the *x*-*y*-*z* and x' - y' - z' coordinates system follow the right-hand rule.

   (e) evaluate all of the stress components acting on the x', y' and z' planes

   (f) determine the principal stresses and the direction cosines of the principal axes with respect to the *x*, *y* and *z* axis.

3. Given the following stress functions,

$$\sigma_x = 3x^2 + 3y^2 - z \qquad \tau_{xy} = z - 6xy - \tfrac{3}{4}$$
$$\sigma_y = 3y^2 \qquad \tau_{xz} = x + y - \tfrac{3}{2}$$
$$\sigma_z = 3x + y - z + \tfrac{5}{4} \qquad \tau_{yz} = 0$$

(a) show that the above stress state is in equilibrium

(b) for the stress state at point x = 1/2, y = 1, and z = 3/4, determine the principal stresses.