Department of Aerospace Engineering
Indian Institute of Technology, Kanpur
AE333: AEROSPACE STRUCTURES I

Practice Set #1 **August 16, 2024**

Instructions

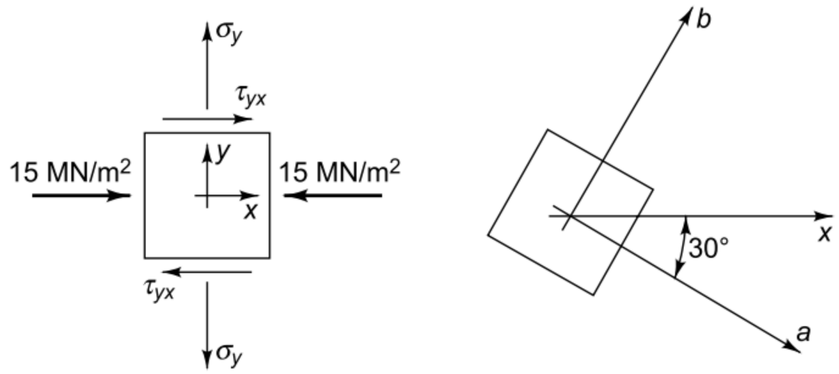
- Note that these questions are intended for your practice and are not required to be submitted anywhere.

Questions

Problem 1: Listed below are varying combinations of stresses acting at a point and referred to axes x and y in an elastic material. Using Mohr's circle of stress determine the principal stresses at the point and their directions for each combination.

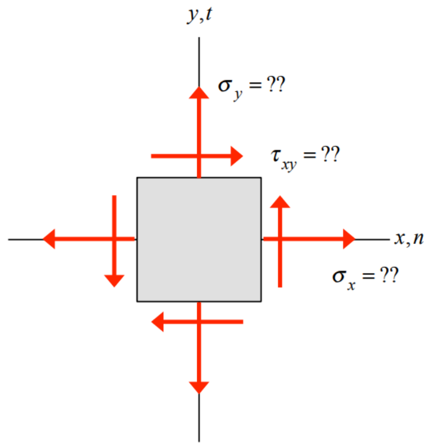
	σ_x (N/mm^2)	σ_y (N/mm^2)	τ_{xy} (N/mm^2)
(i)	+54	+30	+5
(ii)	+30	+54	−5
(iii)	−60	−36	+5
(iv)	+30	−50	+30

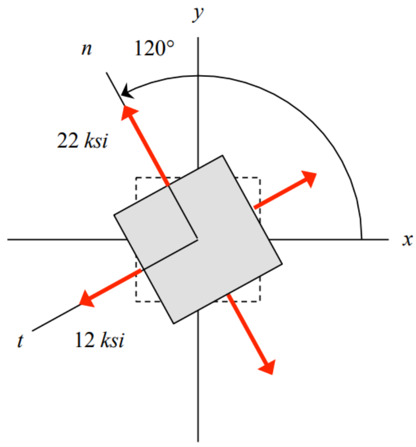
Problem 2: A rectangular plate is under a uniform state of plane stress in the **xy** plane. It is known that the maximum tensile stress acting on any face (whose normal lies in the xy plane) is 75 MN/m^2 . It is also known that on a face perpendicular to the x axis there is acting a compressive stress of 15 MN/m^2 and no shear stress. No explicit information is available as to the values of the normal stress σ_y, and the shear stress τ_{yx} acting on the face perpendicular to the y axis. Find the stress components acting on the faces perpendicular to the a and b axes which are located as shown in the lower sketch. Report your results in a Mohr's circle.



Problem 3: A state of stress is characterized by its unknown x-y components on the stress element shown below. When the stress element is rotated through an angle of 120° , the state of stress has the n-t components shown below right.

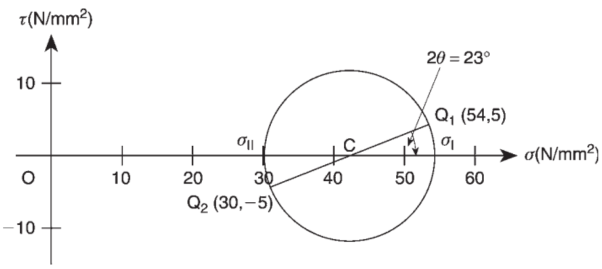
1. Draw the Mohr's circle for this state of stress on the axes provided below. Carefully label the center of the circle as well as its radius. Show the x-axis on the Mohr's circle.
2. What is the maximum in-plane shear stress?
3. What are the σ_x, σ_y and τ_{xy} components of this state of stress?

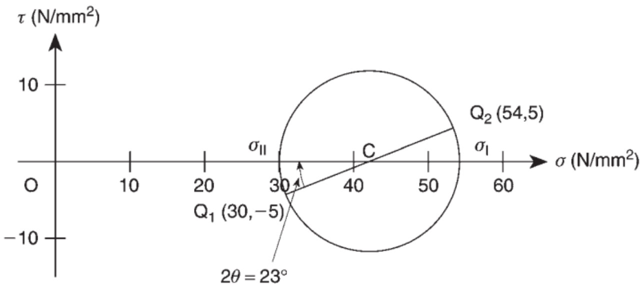

y,t
$\sigma_y = ??$
$\tau_{xy} = ??$
x,n
$\sigma_x = ??$

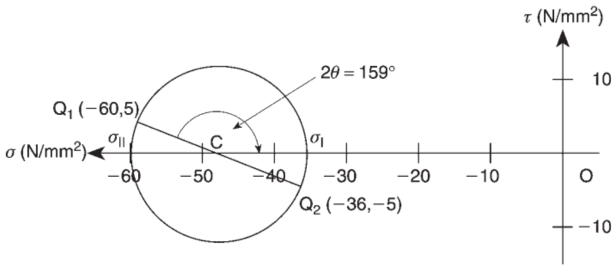

y
n
120°
22 ksi
x
t
12 ksi

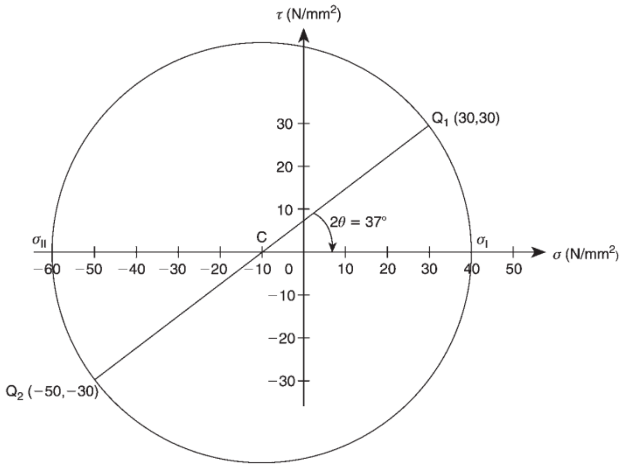
Solutions

Solution 1:

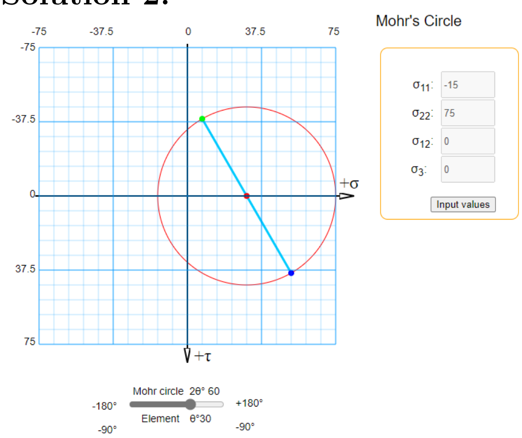








Solution 2:



Shear stress $= 0$. $\tau_{xy} = 0$

$\sigma_y = 75\ MN/m^2$, $\sigma_x = -15\ MN/m^2$

$\sigma_a = \frac{-15+75}{2} + \frac{-15-75}{2} \cos(-60^\circ)$

$= 7.5\ (MN/m^2)$

$\sigma_b = 30 + 45\cos(-60^\circ) = 52.5\ (MN/m^2)$

$\tau_{ab} = 45 \sin(-60^\circ)$

$= -38.97\ (MN/m^2)$

Ans.) $\begin{cases} \sigma_a = 7.5\ MN/m^2 \\ \sigma_b = 52.5\ MN/m^2 \\ \tau_{ab} = -38.97\ MN/m^2 \end{cases}$

Solution 3:

$$\sigma_{ave} = \frac{\sigma_{P1}+\sigma_{P2}}{2} = \frac{22+12}{2} = 17\ ksi$$

$$R = \frac{\sigma_{P1}-\sigma_{P2}}{2} = \frac{22-12}{2} = 5\ ksi$$

$$|\tau|_{max,in-plane} = R = 5\ ksi$$

From Mohr's circle shown:

$$\sigma_x = \sigma_{ave} - R\cos 60^\circ = 17-(5)\cos 60^\circ = 14.5\ ksi$$

$$\sigma_y = \sigma_{ave} + R\cos 60^\circ = 17+(5)\cos 60^\circ = 19.5\ ksi$$

$$\tau_{xy} = -R\sin 60^\circ = -(5)\sin 60^\circ = -4.33\ ksi$$