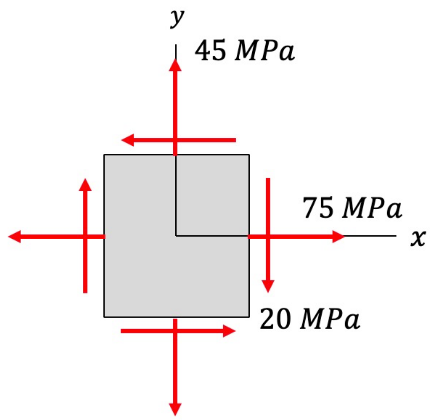
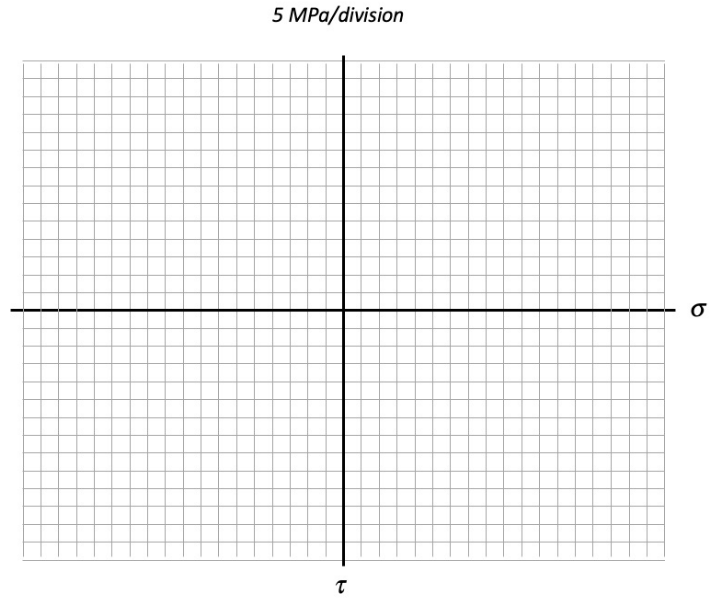
Problem 11.1 (10 points)

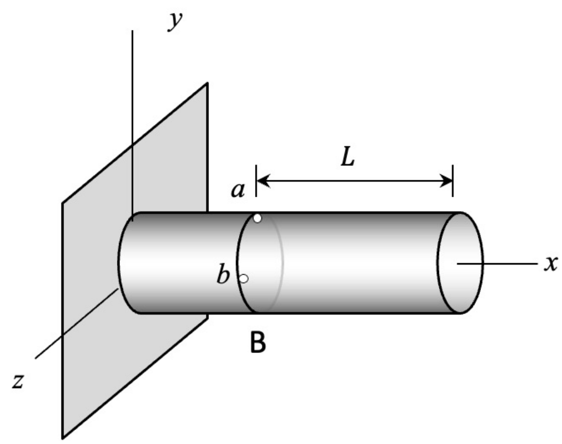


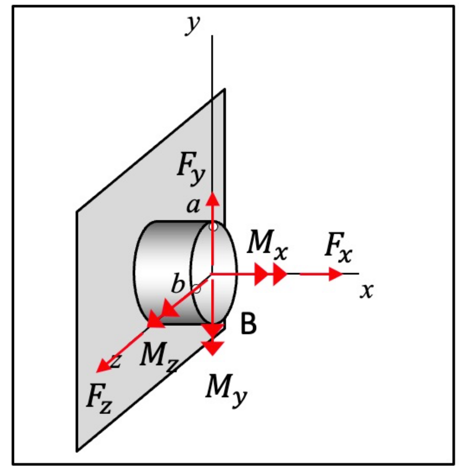


Consider the state of stress shown above in terms of its *xy*-components for a point on a structure. For this state of stress:

1. Draw the in-plane Mohr's circle. Clearly indicate the location of the center and radius of the circle.
2. Show the location of the *x*-axis on your in-plane Mohr's circle.
3. From your in-plane Mohr's circle, determine the two principal components of stress, σ_{P1} and σ_{P2}, and the magnitude of the maximum in-plane shear stress $|\tau_{max,inplane}|$.
4. Determine the counter-clockwise angles that define the planes on which the principal stress components σ_{P1} and σ_{P2} exist, and show these angles on your in-plane Mohr's circle.
5. Add the two out-of-plane Mohr's circles to your Mohr's circle diagram.
6. Determine the magnitude of the absolute maximum shear stress, $|\tau_{max,abs}|$.
7. If the material of the rod is ductile with a yield strength of $\sigma_Y = 40MPa$, determine if the material fail at this point in the structure using the maximum shear stress failure theory.

Problem 11.2 (10 points)



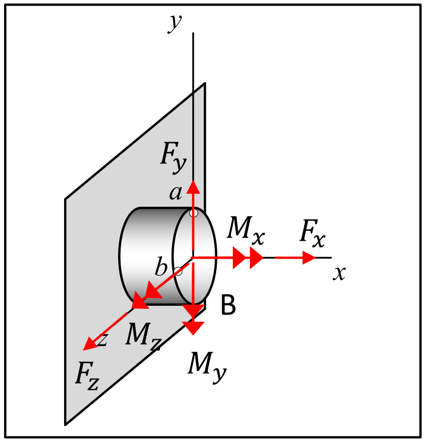


A circular cross-section rod (with a cross-section radius of R) is fixed to a wall at its left end. Loadings are applied to the rod (with the loadings not shown in the figure) in such a way to produce a set of internal forces and couples acting on the positive x-face of a cross-section of the rod at location B, where B is located at a distance of L from the right end of the rod. The following are known about these internal resultant components: $F_x = F_y = P$, $F_z = 2P$, $M_x = M_z = PL$ and $M_y = 3PL$. The stress distributions for these internal resultants are shown on the positive x-face at B on the next page.

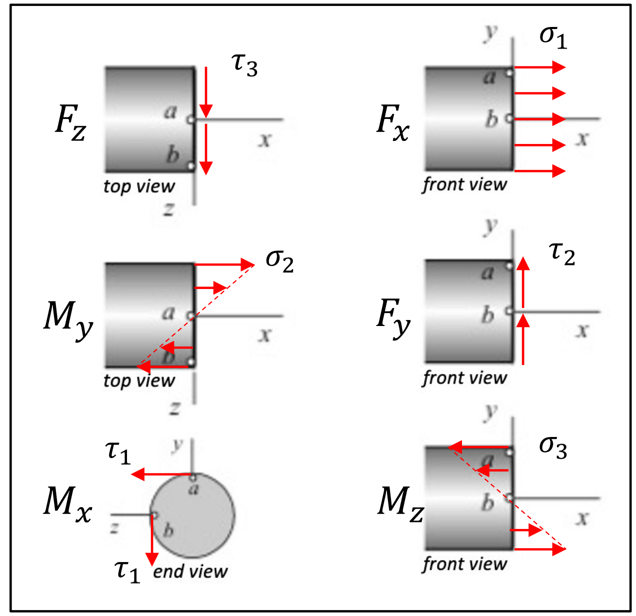
It is desired to understand the states of stress at two points "a" and "b" on the cross-section of the rod at location B. As you work through this problem, use the drawings and the table found on the next page. Please use $L = 10R$.

1. For each of the internal resultant components provided, show in the supplied table the equation for the corresponding stress at points "a" and "b" on the rod cross-section.
2. Based on the stress distributions found in Part 1, draw the stress components on the stress elements provided for points "a" and "b" on the rod cross-section.
3. What is the absolute maximum shear stress at points "a" and "b" on the cross-section? Leave your answers in terms of, at most: P and R.
4. If the material of the rod is ductile with a yield strength of $\sigma_Y = 60MPa$, determine the maximum value of $P\ /\ R^2$ for which the material will not fail at point "a" using the maximum distortional energy failure theory.

+x-face at B

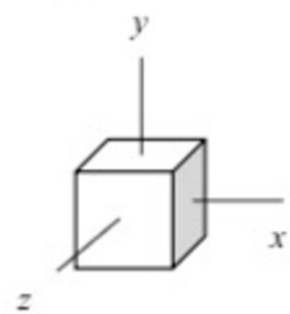


stress distributions

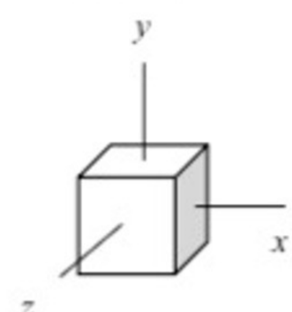


internal resultant	Stress comp. @ "a"	Stress comp. @ "b"
F_x		
F_y		
F_z		
M_x		
M_y		
M_z		

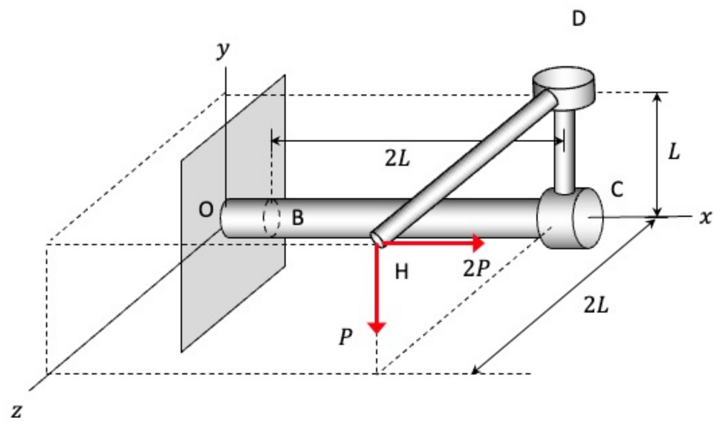
point "a"

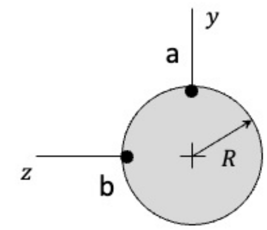


point "b"



Problem 11.3 (10 points)





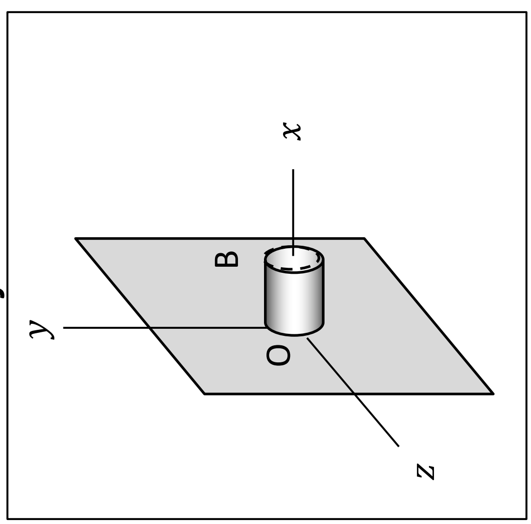
cross-section of OC at B

A structure is made up of three sections of solid rod as shown in the above figure. It is desired to understand the states of stress at two points "a" and "b" on the cross-section of the rod at location B, where B is located on rod section OC. As you work through this problem, use the drawings and table found on the next page. Please use: $L = 5R$.

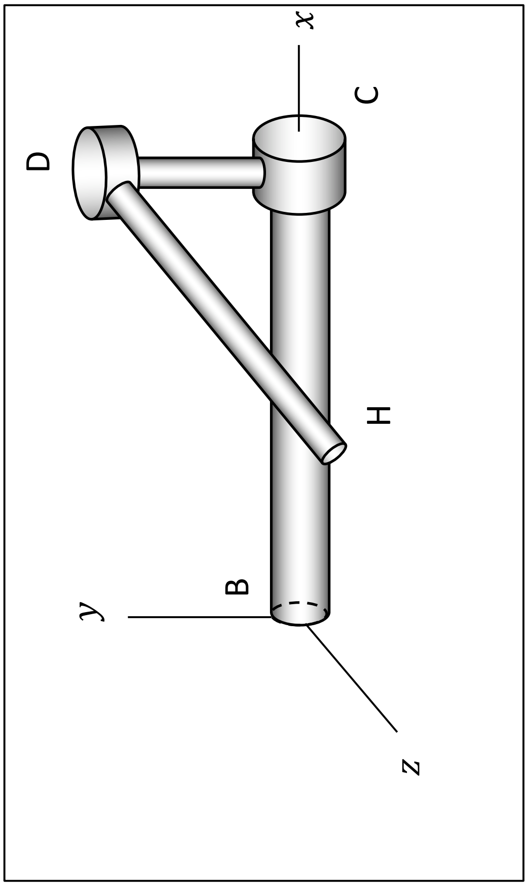
1. Consider a mathematical cut through the rod section OC at location B. Draw a free body diagram (FBD) of the right end of the structure clearly indicating on the FBD the internal resultants acting on the cut through the rod at B.
2. Calculate the internal resultant components shown in your FBD in Part 1.
3. Using your results from Part 2, show the internal resultants on the +x-face of the cut at B. Show these resultant components as the actually are; that is, for example, if a force is pointing in the negative x-direction, then show it as being in the negative x-direction.
4. For each of the non-zero resultant components found in Part 2, show the corresponding stress distribution of the resultant in the figures provided.
5. For each of the non-zero resultant components found in Part 2, show in the supplied table the equation for the corresponding stress at points "a" and "b" on the rod cross-section.
6. Based on the stress results found in Part 5, draw the stress components on the stress elements provided for points "a" and "b" on the rod cross-section.
7. What are the principal components of stress at points "a" and "b" on the cross-section at B?

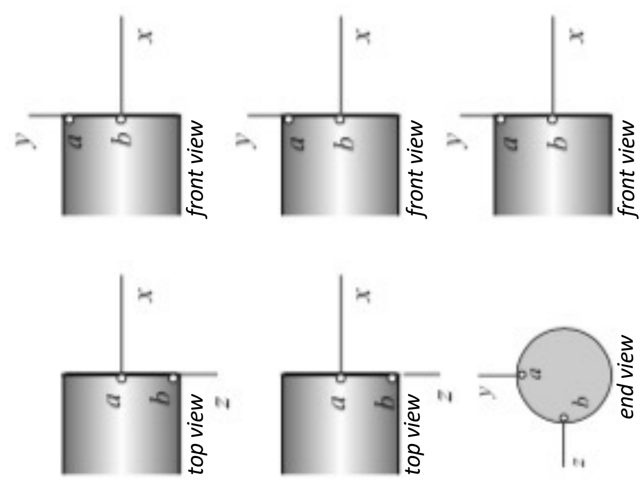
Leave your answers in terms of, at most: P and R.

"+" x-face at B



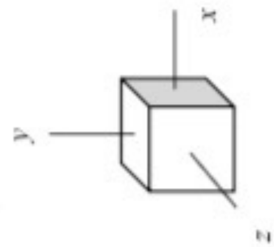
FBD



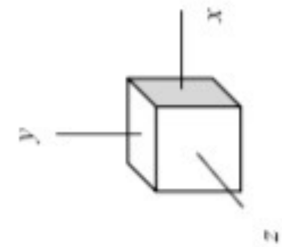


internal resultant	*stress comp. @ "a"*	*stress comp. @ "b"*

point "a"



point "b"



Problem 11.4 (conceptual questions)

Shown on the following page are eight states of stress (a)-(h) and nine in-plane Mohr's circles (i)-(ix).

Part 11.4A (8 points)

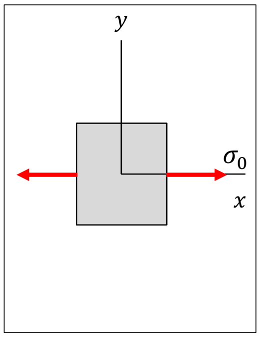
Match the Mohr's circle that most closely represents the Mohr's circle for the following stress states by writing in the name of the Mohr's circle (i)-(ix) in the blanks below:

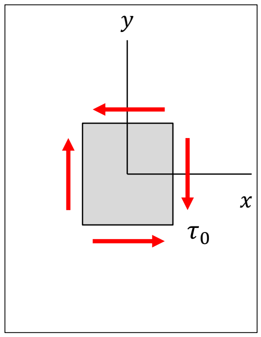
Stress state (a): __________________	Stress state (b): __________________
Stress state (c): __________________	Stress state (d): __________________
Stress state (e): __________________	Stress state (f): __________________
Stress state (g): __________________	Stress state (h): __________________

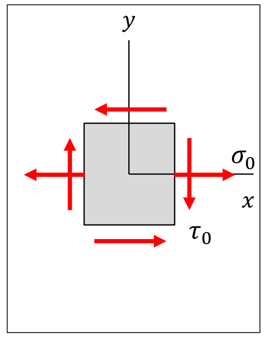
Part 11.4B (8 points)

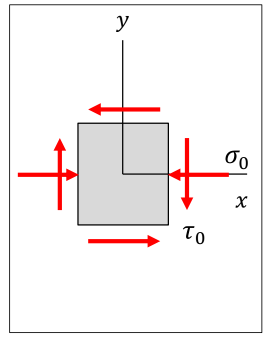
Let $\tau_{max,inplane}$ and $\tau_{max,abs}$ represent the maximum in-plane and absolute maximum shear stress for a given state of stress. For each of the stress states provided here state whether $\tau_{max,inplane} < \tau_{max,abs}$, $\tau_{max,inplane} = \tau_{max,abs}$ or $\tau_{max,inplane} > \tau_{max,abs}$ by writing in "<", "=" or ">", respectively, in the blanks below.

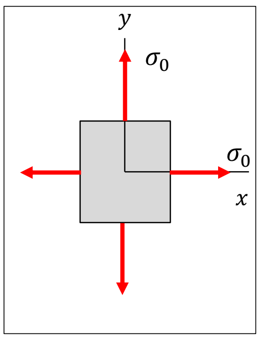
Stress state (a): __________________	Stress state (b): __________________
Stress state (c): __________________	Stress state (d): __________________
Stress state (e): __________________	Stress state (f): __________________
Stress state (g): __________________	Stress state (h): __________________

(a)


(b)


(c)


(d)


(e)


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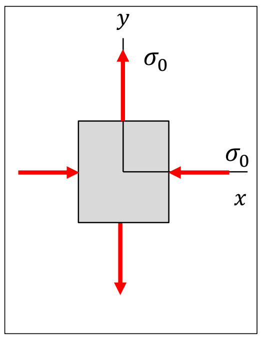
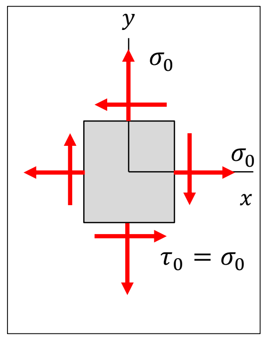
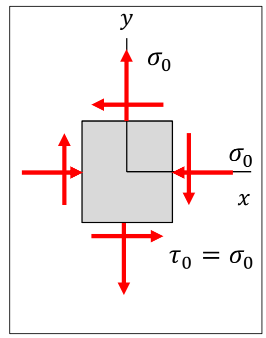
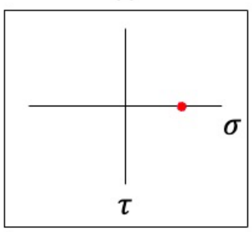


(g)


(h)


(i)


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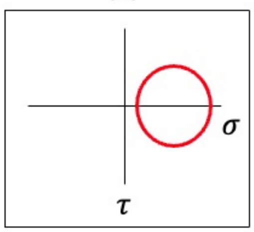

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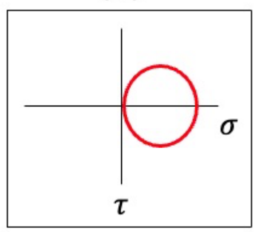

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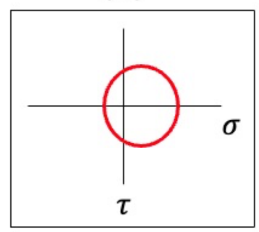

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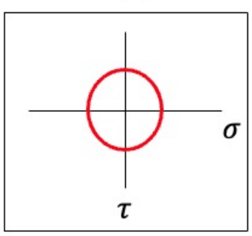

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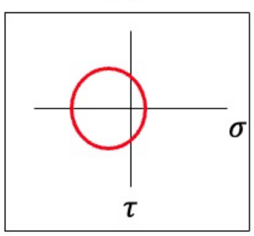

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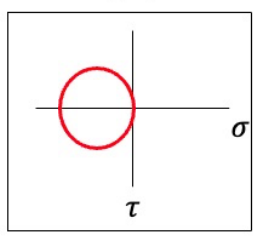

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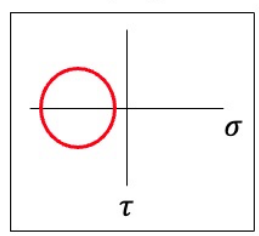

(ix)