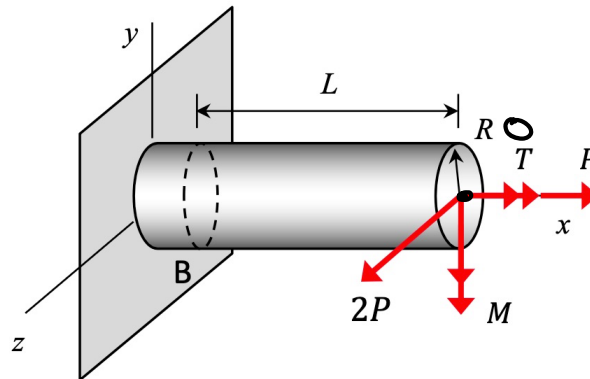


A solid circular cross-section shaft is acted upon by two forces (P and $2P$), a torque T and a bending moment M at the right end, as shown. It is desired to know the state of stress at two points "a" and "b" on the cross-section of the beam at location B. *For this, please use the worksheet provided on the next page.*

- Determine the internal resultants (F_x , T_x , M_y and F_z) acting on the +x-face of the cut through the shaft at point B.
- Show the stress distributions acting on the +x-face at the cut at location B. Please use the front/top views of this cut provided on the next page. Show these distributions as they actually are - do not include signs.
- Fill in the table provided on the next page with the stress components at "a" and "b". Please do not include signs. Show the relationships between the stress components and applied loads in this table.
- Based on the results in your table from Part c), show the state of stress at "a" and "b" on the stress elements on the next page.



From FBD:

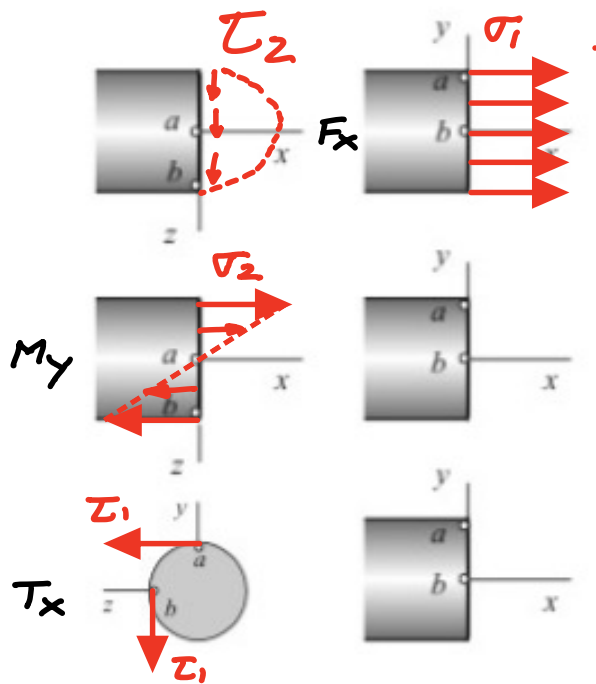
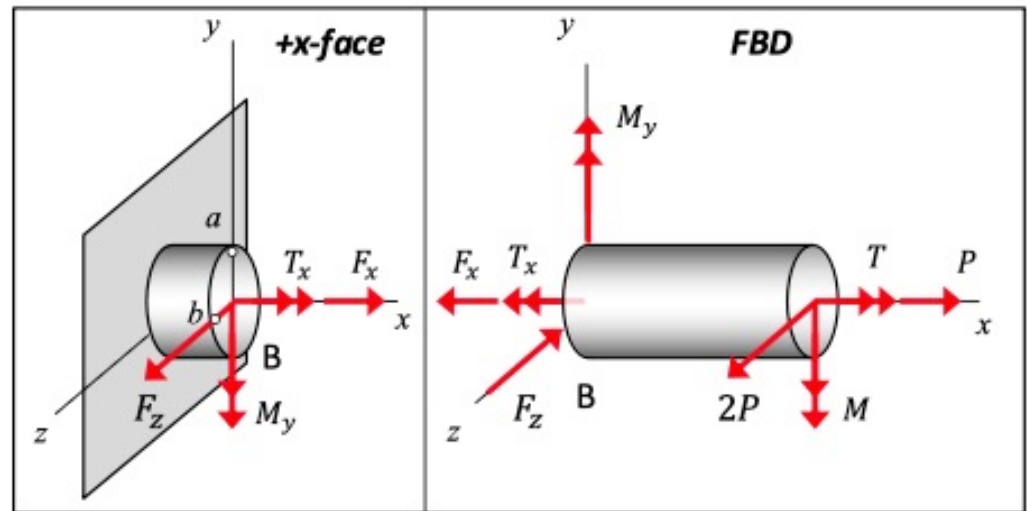
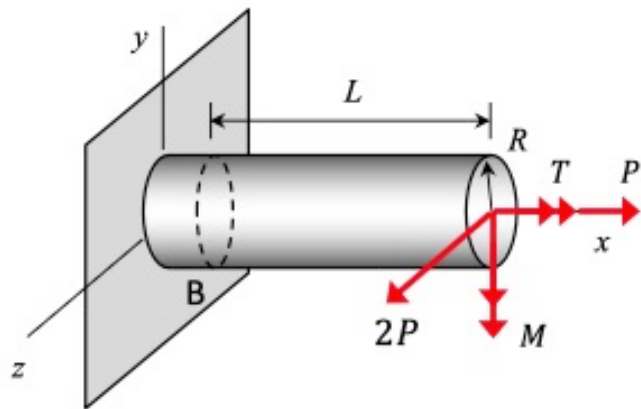
$$\sum F_x = P - F_x = 0 \Rightarrow F_x = P$$

$$\sum F_z = 2P - F_z = 0 \Rightarrow F_z = 2P$$

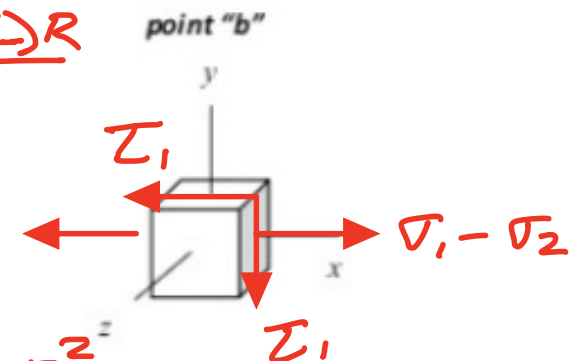
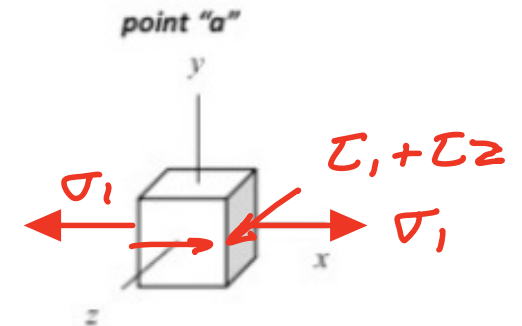
$$\sum M_{ox} = T - T_x = 0 \Rightarrow T_x = T$$

$$\sum M_{oy} = -M + M_y - F_z L = 0$$

$$\hookrightarrow M_y = M + F_z L = M + 2PL$$



loading	stress comp. @ "a"	stress comp. @ "b"
F_x	$\sigma_1 = \frac{P}{A}$	$\sigma_1 = \frac{P}{A}$
T_x	$\tau_1 = \frac{TR}{I_P}$	$\tau_1 = \frac{TR}{I_P}$
M_y	0	$\sigma_2 = \frac{(1+2PL)R}{I}$
F_z	$\tau_2 = \frac{4}{3} \left(\frac{2P}{A} \right)$	0



$$I = \frac{\pi}{4} R^4; \quad I_P = \frac{\pi}{2} R^4; \quad A = \pi R^2$$