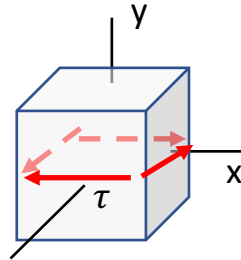
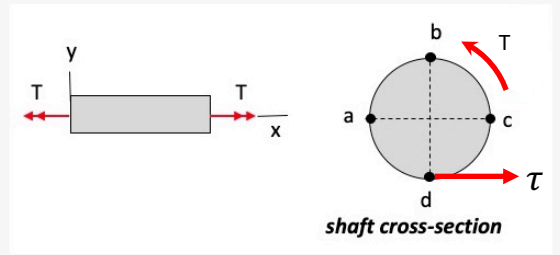


Quiz 4 – ME 323 – Fall 2023

Q1 Stress element in a circular shaft

5 Points

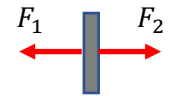
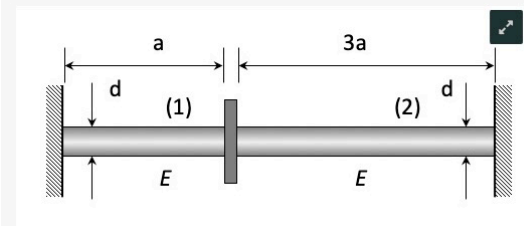
A circular shaft experiences an applied torque  $T$ , as in the cross-section shown. Draw a stress element for point  $d$  on the cross-section. Clearly label your coordinate axes for your stress element.



Q3 Thermal loads

5 Points

For the rod system shown, element (1) is increased in temperature by an amount of  $\Delta T$ , and the temperature of element (2) is held constant. As a result of this temperature change, which element carries the largest axial force: element (1) or element (2), or are the axial forces the same?



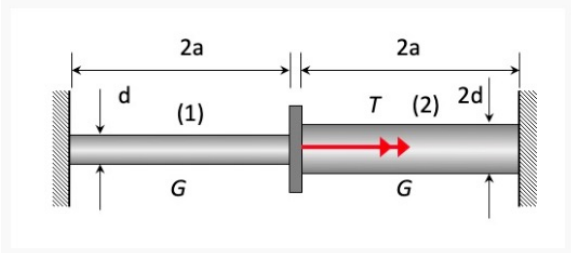
$$\sum F = F_2 - F_1 = 0$$

$$\Rightarrow F_1 = F_2$$

Q2 Torque loading on a shaft

5 Points

A torque  $T$  acts on the shaft as shown in the figure. Which element, (1) or (2), carries the largest magnitude torque, or are the torques in the two elements the same?



$$|\Delta\phi_1| = |\Delta\phi_2| \Rightarrow$$

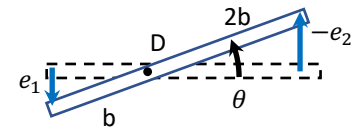
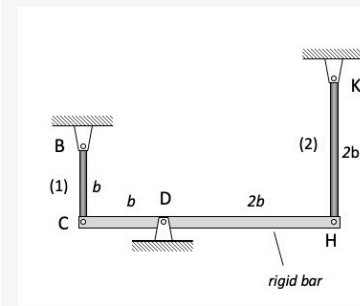
$$\frac{|T_1|(2a)}{GI_{P1}} = \frac{|T_2|(2a)}{GI_{P2}} \Rightarrow$$

$$|T_1| = \frac{I_{P1}}{I_{P2}} |T_2| < |T_2|$$

Q4 Compatibility

5 Points

Rigid bar CH is pinned to ground at D. Elastic elements (1) and (2) are pinned to CH at ends C and H. The temperatures of both (1) and (2) are increased, but different amounts. Let  $e_1$  and  $e_2$  represent the elongations of elements (1) and (2) as a result of the temperature changes. Provide the single compatibility equation that relates the elongations of (1) and (2) as a result of the temperature changes. Assume that the angular rotation of CH is small.



$$\sin\theta = \frac{e_1}{b} = -\frac{e_2}{2b} \Rightarrow$$

$$e_2 = -2e_1$$