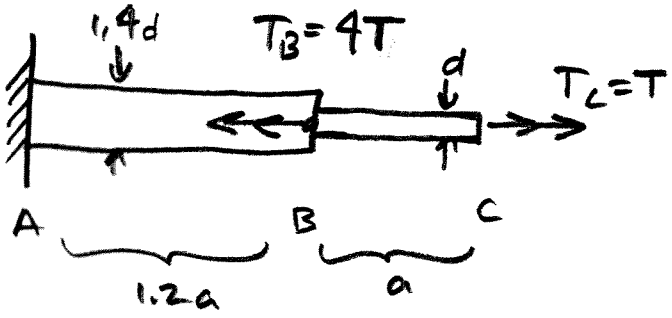
ME 423 Test #4

name key



Find the total strain energy U in the solid stepped cylinder of circular cross-section

Express your answer in terms of G, T, a, d

For section B-C



T_{BC}

$\Rightarrow T_{BC} = T$

$J_{BC} = \frac{\pi}{2}\left(\frac{d}{2}\right)^4, \quad L_{BC} = a$

For section AB



$J_{AB} = \frac{\pi}{2}\left(\frac{1.4d}{2}\right)^4$

$\Rightarrow T_{AB} = -3T$ ← not knowing this was by far the most common mistake. Taking this to be 4T cost you 2 points.

$$U = \frac{1}{2}\frac{(T_{AB})^2}{G J_{AB}} L_{AB} + \frac{1}{2}\frac{(T_{BC})^2}{G J_{BC}} L_{BC} = \frac{1}{2G}\left[\frac{(3T)^2 (1.2a)}{\frac{\pi}{2}(.7d)^4} + \frac{T^2 a}{\frac{\pi}{2}(.5d)^4}\right]$$

$$= \frac{T^2 a}{\pi G d^4}\left[\frac{3^2 \cdot 1.2}{(.7)^4} + \frac{1}{(.5)^4}\right] = \frac{T^2 a}{\pi G d^4}(44.98 + 16)$$

$$U = \underline{60.98 \frac{T^2 a}{\pi G d^2}}$$

← algebra mistakes cost one point
⇒ knowing $T_{AB} = 3T$ but getting a different number ⇒ 9 points total
⇒ Thinking $T_{AB} = 4T$ but not getting as far ⇒ 7 points total