Final Exam Problem 4

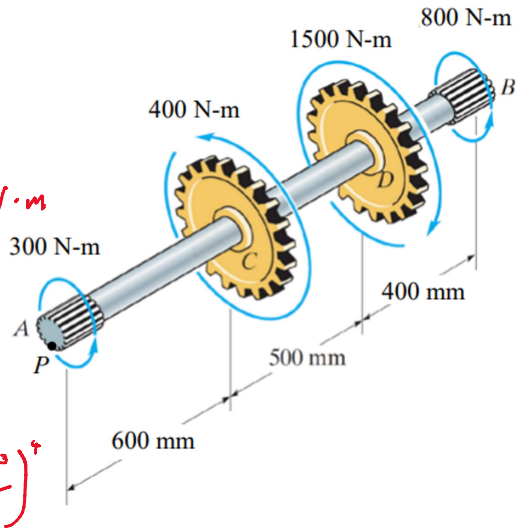
Friday, December 18, 2020 8:01 AM

Problem 4.

The solid steel shaft has a diameter of 30 mm and is loaded by the torques shown. For steel, $E = 200$ GPa and $G = 75$ GPa.

a. Determine the absolute maximum shear stress in the shaft. **Clearly state where this maximum stress occurs.**

b. Determine the angle of twist of end A relative to end B. Does this correspond to a clockwise or counterclockwise motion of point P ?



A.) $T_{AC} = -300$ N·m

$T_{CD} = -300 - 400$

$T_{DB} = 100 - (-700) = 800$ N·m

$\tau = \frac{Tr}{J}$ $\quad J = \frac{\pi}{4}(r^4)$

$= \frac{\pi}{2}\left(\frac{30\times10^{-3}}{2}\right)^4$

$= 7.952\times10^{-8}\ m^4$

$r = .015$ m.

$\tau = \frac{(800)(.015)}{7.952\times10^{-8}}$

$\tau = 151$ MPa

B.) $\phi = \sum \frac{TL}{JG} = \frac{1}{(7.952\times10^{-8})(75\times10^{9})}\left(-300(.6) - 700(.5) + 800(.4)\right)$

$\phi = -.035$ rads counterclockwise to P