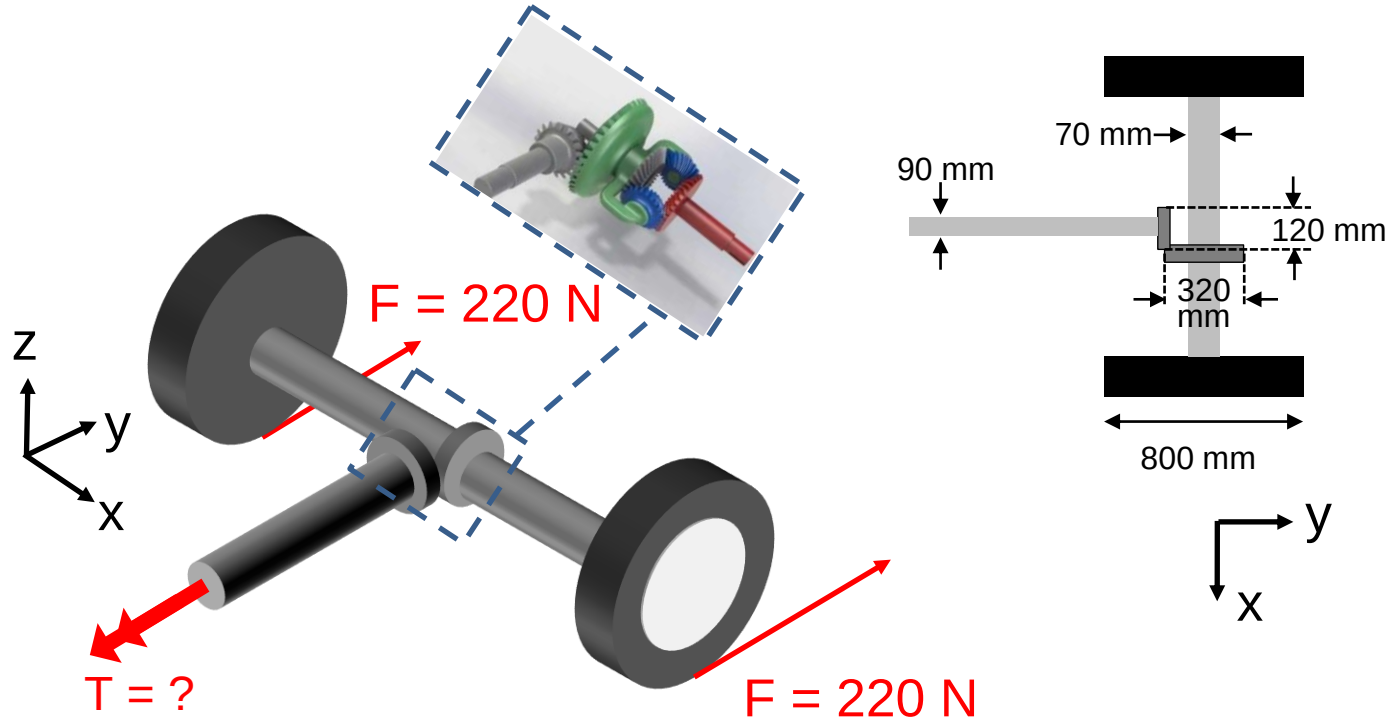
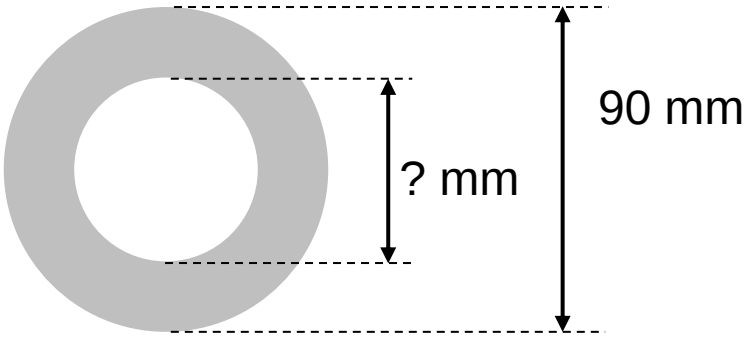
Lecture 12 Quiz

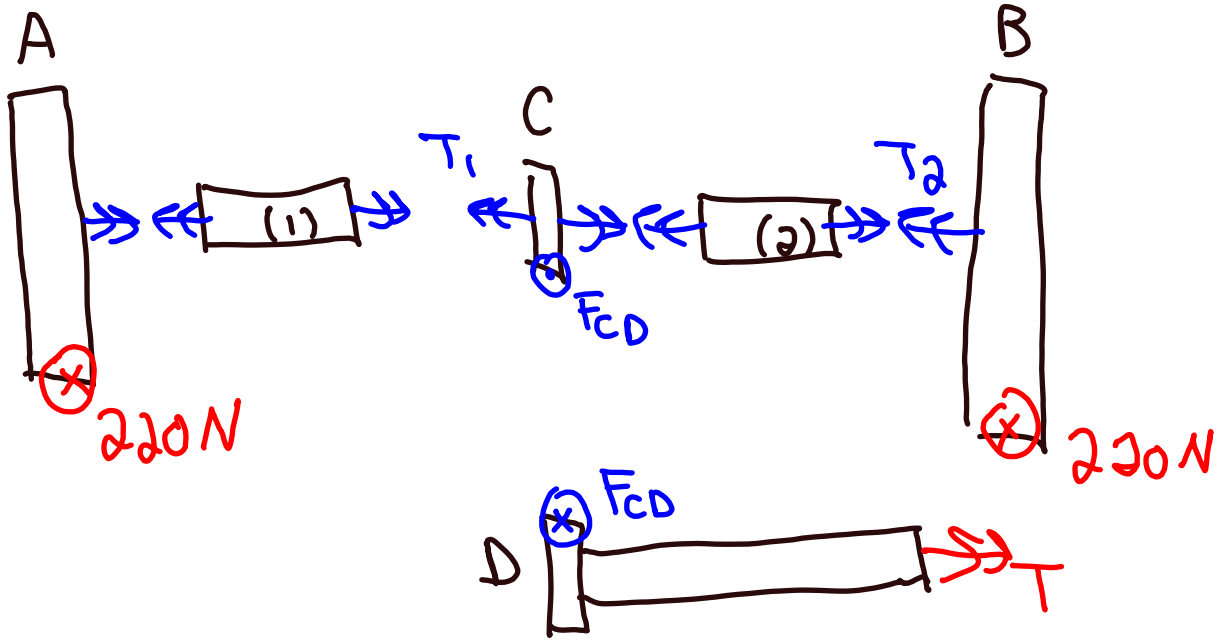


(a) What torque needs to be applied to the drive shaft for each wheel to output a force of 220 N?

(b) (completely separate from part a) A drive shaft must be designed to operate at a torque of 3200 N*m with an outer diameter of 90 mm and a length of 1320 mm. Using a hollow aluminum tube, what inner diameter is required? The shear modulus of aluminum is 27 GPa. The allowable shear stress in the aluminum is 60 MPa.



a)



$$(\Sigma M)_A = T_1 + 220(0.4) = 0 \qquad T_1 = -220(0.4)$$

$$(\Sigma M)_B = -T_2 + 220(0.4) = 0 \qquad T_2 = 220(0.4)$$

$$(\Sigma M)_C = T_2 - T_1 - F_{CD} r_C = 0$$

$$220(2)(0.4) = F_{CD} r_C$$

$$(\Sigma M)_D = T - F_{CD} r_D = 0$$

$$T = \frac{r_D}{r_C}(220\,N)(0.4\,m)(2)$$

$$T = \frac{0.06}{0.16}(220\,N)(0.4\,m)(2)$$

$$T = 66\ N \cdot m$$

b) $\tau_{max} = \frac{TR}{I_p}$ $\qquad I_p = \frac{\pi}{2}\left(R^4 - r_i^4\right)$

$$60\times10^6 = \frac{3200(0.045)}{\frac{\pi}{2}\left(0.045^4 - r_i^4\right)}$$

$$0.045^4 - r_i^4 = \frac{3200(2)(0.045)}{\pi(60\times10^6)}$$

$$r_i = \left[0.045^4 - \frac{3200(2)(0.045)}{\pi(60\times10^6)}\right]^{1/4}$$

$$r_i = 0.040\ m$$

$$d_i = 80\ mm$$