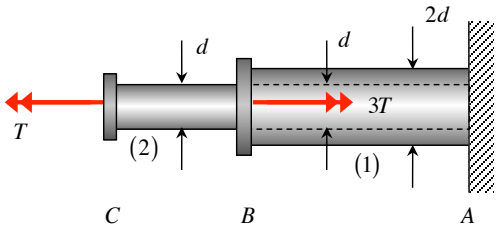
Quiz No. 11 ***Name*** SOLUTION

ME 270 – Summer 2024 - Prague



Given: A circular cross-sectioned shaft is made up of components (1) and (2). Component (1) has a tubular cross section, with inner and outer diameters of d and $2d$. Component (2) has a solid cross section with a diameter of d. Components (1) and (2) are joined by a rigid connector at B with (1) being attached to a fixed wall at end A. Rigid connector C is attached to end C of component (2). Torques $3T$ and T act on connectors B and C, respectively, as shown.

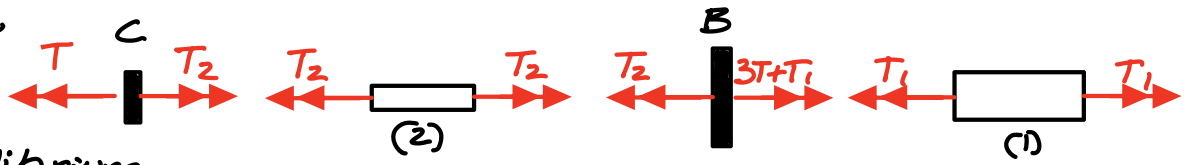
Find: Leaving your answers in terms of T and d:

a) Determine the torque load on component (1) as a result of the applied torques.

b) What is the maximum shear stress in component (1) of the shaft? At what location on the cross-section does this maximum shear stress exist?

<u>*NOTE*</u>: In your work, you must show the four steps of analysis: 1) FBDs, 2) equilibrium, 3) solvability, and 4) solve.

1. <u>FBDs</u>



2. <u>Equilibrium</u>

(1) C: $\Sigma M = -T + T_2 = 0$

(2) B: $\Sigma M = -T_2 + 3T + T_1 = 0$

3. <u>Solvability</u>: 2 eqns / 2 unknowns

4. <u>Solve</u>:

(1) $\Rightarrow T_2 = T$

(2) $\Rightarrow T_1 = T_2 - 3T = -2T$

<u>Stress in (1)</u>:

$$\tau_{1,max} = \frac{T_1 \frac{2d}{2}}{J_1} \quad ; \quad J_1 = \frac{\pi}{2}\left(\frac{2d}{2}\right)^4 - \frac{\pi}{2}\left(\frac{d}{2}\right)^4 = \frac{15}{32}\pi d^2$$

$$= \frac{-(2T)d}{\frac{15}{32}\pi d^4} = -\frac{64}{15\pi}\frac{T}{d^3} \text{ @ } \rho = 2d$$