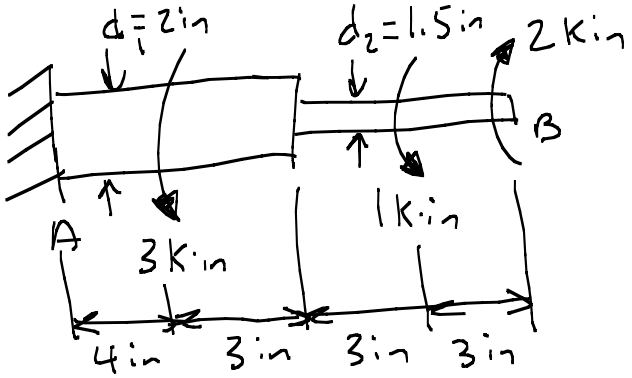
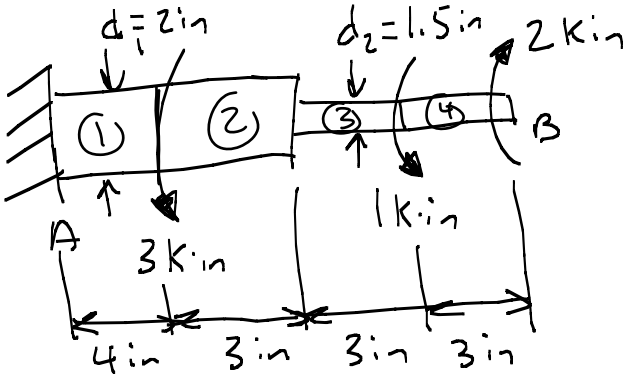
Torsion

Problem Statement: Determine the total angle of twist.

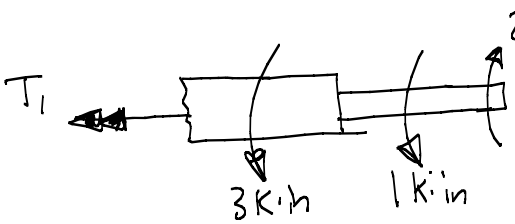


1.) Determine the number of segments.

4 segments

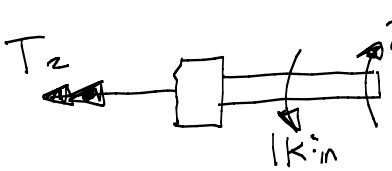


2.) Determine the internal force in each segment



$\overleftarrow{\Sigma T = 0} \Rightarrow T_1 - 3\,k\cdot in - 1\,k\cdot in + 2\,k\cdot in = 0$

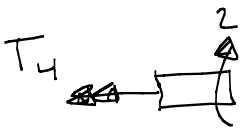
$\boxed{T_1 = 2\,k\cdot in}$



$+\overleftarrow{\Sigma T = 0} \Rightarrow T_2 - 1\,k\cdot in + 2\,k\cdot in = 0$

$\boxed{T_2 = -1\,k\cdot in}$

$T_3 = T_2 = -1\,k\cdot in$



$+\overleftarrow{\Sigma T = 0} \Rightarrow T_4 + 2\,k\cdot in = 0$

$\boxed{T_4 = -2\,k\cdot in}$

3.) Determine the total angle of twist and other quantities

$$I_{P_1} = \frac{\pi}{32}(2\text{in})^4 = 1.57\,\text{in}^4 \qquad I_{P_2} = \frac{\pi}{32}(1.5\text{in})^4 = 0.497\,\text{in}^4$$

$$\frac{TL}{GI_P}$$

$$\phi = \frac{(2\,\text{k·in})(4\text{in})}{(10{,}000\,\text{ksi})(1.57\,\text{in}^4)} + \frac{(-1\,\text{k·in})(3\text{in})}{(10{,}000\,\text{ksi})(1.57\,\text{in}^4)} + \frac{(-1\,\text{k·in})(3\text{in})}{(10{,}000\,\text{ksi})(0.497\,\text{in}^4)}$$

$$+ \frac{(-2\,\text{k·in})(3\text{in})}{(10{,}000\,\text{ksi})(0.497\,\text{in}^4)}$$

$$\phi = -14.921 \times 10^{-4}\ \text{radians}$$

$$\boxed{\phi = -0.085^\circ}$$