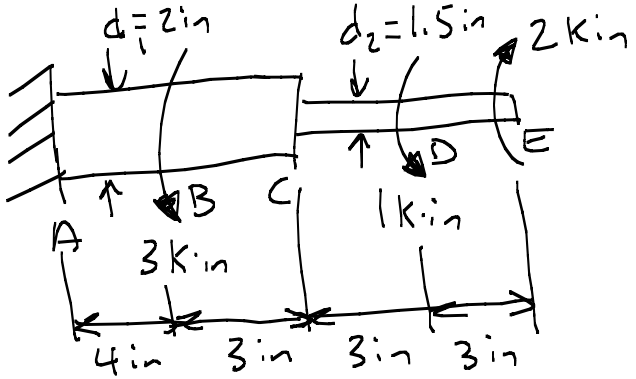
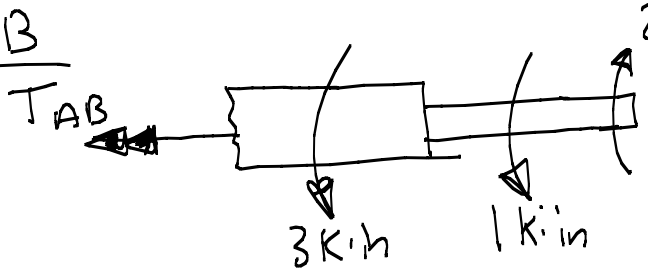
Problem 2

Determine the total angle of twist



Four segments AB, BC, CD, DE

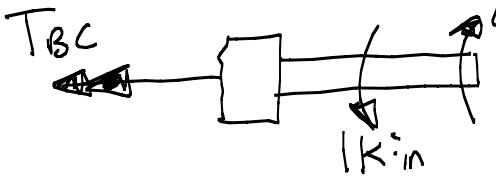
AB



$\curvearrowleft \Sigma T = 0 \Rightarrow T_{AB} - 3\,K\cdot in - 1\,K\cdot in + 2\,K\cdot in = 0$

$$\boxed{T_{AB} = 2\,K\cdot in}$$

BC



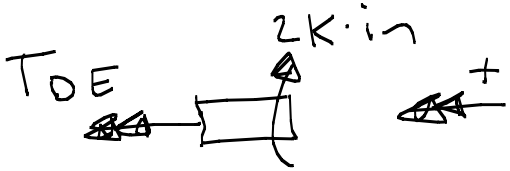
$+\curvearrowleft \Sigma T = 0 \Rightarrow T_{BC} - 1K\cdot in + 2K\cdot in = 0$

$$\boxed{T_{BC} = -1K\cdot in}$$

CD

$$T_{CD} = T_{BC} = -1\,K\cdot in$$

DE



$+\circlearrowleft \sum T = 0 \Rightarrow T_{DE} + 2\,K\cdot in = 0$

$$\boxed{T_{DE} = -2\,K\cdot in}$$

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

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

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

$$+\frac{(-2\,K\cdot in)(3in)}{(10{,}000ksi)(0.497\,in^4)}$$

$$\phi = -14.921\times10^{-4}\ radians$$

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