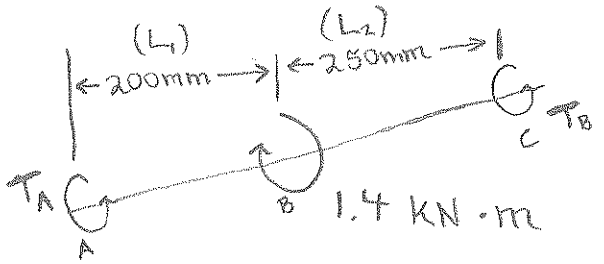
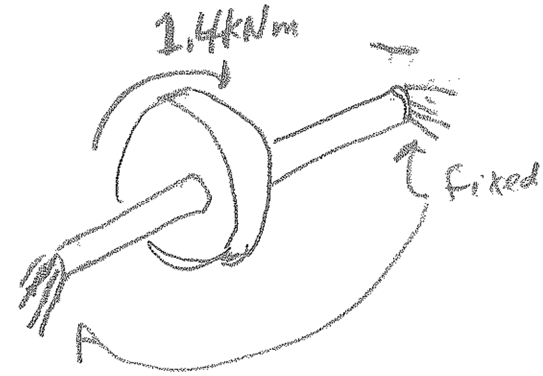
10.45

(a)

FBD





$$T_A + T_B = 1.4\,KN \cdot m \quad (1)$$

Since both sides of the shaft are restrained the total angle of twist must be zero, thus:

$$\phi = \phi_{AB} + \phi_{BC} = 0$$ (using same sign conv. for both)

Pluggin in for phi we get:

$$\phi = \phi_{AB} + \phi_{BC} = \frac{T_A L_1}{J_1 G} - \frac{T_B L_2}{J_2 G} = 0$$

Solving for T_B, we have

$$T_B = \frac{L_1 J_2}{L_2 J_1} T_A$$

Solving for J_1 & J_2 we get,

$$J_1 = \frac{1}{32}\pi\,(0.05\,m)^4 = 6.13 \times 10^{-7}\,m^4$$

$$J_2 = \frac{1}{32}\pi\,(0.038\,m)^4 = 2.04 \times 10^{-7}\,m^4$$

Thus T_B becomes

$$T_B = \frac{(0.2m)(2.04\times10^{-7}\,m^4)}{(0.25m)(6.13\times10^{-7}\,m^4)} T_A = 0.266\ T_A$$

Using Eqn. (1) to solve for T_A we get

$$T_A + 0.266\,T_A = 1.4\,KN \cdot m$$

$$1.266\,T_A = 1.4\,KN \cdot m$$

$$T_A = 1105\,N \cdot m$$

$$T_B = 1.4\,KN \cdot m - 1.105\,KN \cdot m$$

$$T_B = 295\,N \cdot m$$

Apply Eqn 10.10 from the book we can solve for the stress

(b) $\tau_{AB} = \frac{Tc}{J} = \frac{16 T_A}{\pi d_A^3} = \frac{16(1105\ N\cdot m)}{\pi(0.05\ m)^3} = 45\ MPa$

(c) $\tau_{max} = \frac{16T}{\pi d_{BC}^3} = \frac{16(295\ N\cdot m)}{\pi(0.038\ m)^3} = 27.4\ MPa$