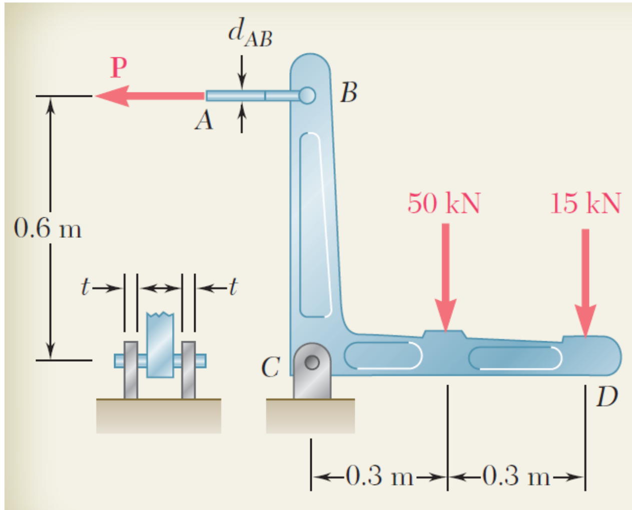
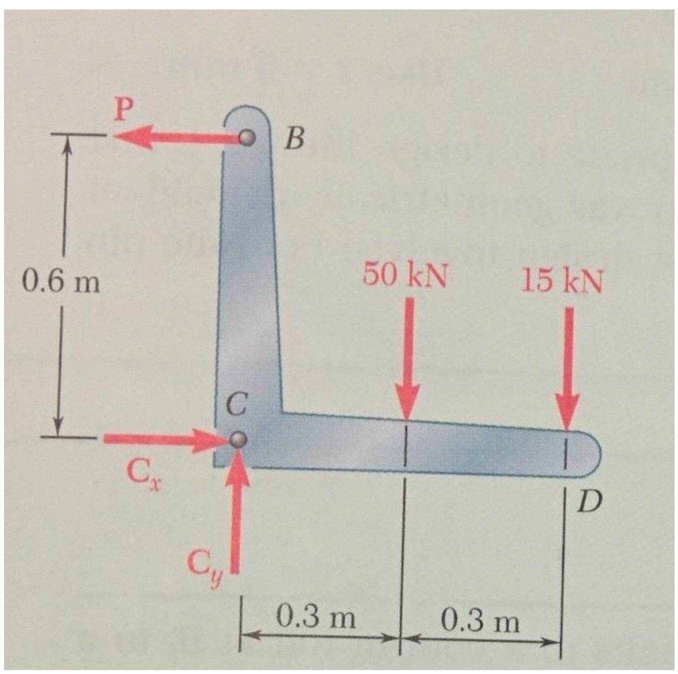
Q1 (10 Points): Two forces are applied to the rigid bracket *BCD* as shown. (a) Knowing that the control rod *AB* is to be made of steel having an ultimate normal stress of 600 MPa, determine the minimum diameter of the rod. (b) The pin at *C* is to be made of steel having an ultimate shearing stress of 350 MPa. Determine the minimum diameter of the pin *C*.



FBD:



(2 pt)

Part (a)

$$\sum M_c = +(P)(0.6) - (50 * 10^3)(0.3) - (15 * 10^3)(0.6) = 0$$

$$=> \quad P = 40 * 10^3 N$$ **(2 pt)**

Ultimate Normal Stress = $\sigma_u = \sigma_{allowed} = 600 \times 10^6 \ \ Pa$ (given)

$$\sigma_{allowed} = \frac{P}{Area} \Rightarrow 600 \times 10^6 \ \ Pa = \frac{40 \times 10^3 \ \ N}{\left(\frac{\pi}{4} d_{AB}^2\right)}$$

$$\Rightarrow d_{AB}^2 = 8.488 \times 10^{-5} \ \ m^2$$

$$\boxed{d_{AB} = 9.213 \times 10^{-3} m^2 = 9.213 \ \ mm}$$

(2 pt)

Part (b)

$\sum F_x = -P + C_x = 0$ => $C_x = P = 40 * 10^3 N$

$\sum F_y = +C_y - (50 * 10^3) - (15 * 10^3) = 0$ => $C_y = 65 * 10^3 N$ **(2 pt)**

Overall Reaction Force at C = $F_c = \sqrt[2]{C_x^2 + C_y^2}$ = 76321.69 N

Ultimate Shear Stress of Pin at C = $\tau_u = \tau_{allowed} = 350 \times 10^6 \ \ Pa$ (given)

$\tau_{allowed} = \frac{F_c}{2 * Area}$ (double shear, therefore 2*Area)

$$\Rightarrow 350 \times 10^6 \ \ Pa = \frac{76321.69 \ \ N}{2\left(\frac{\pi}{4} d_c^2\right)} \Rightarrow d_C^2 = 1.388 \times 10^{-4} \ \ m^2$$

=> $\boxed{d_C = 0.01178 \ \ m = 11.78 \ \ mm}$

Using the next higher (whole number) diameter $\boxed{d_C = 12 \ \ mm}$

(2 pt)