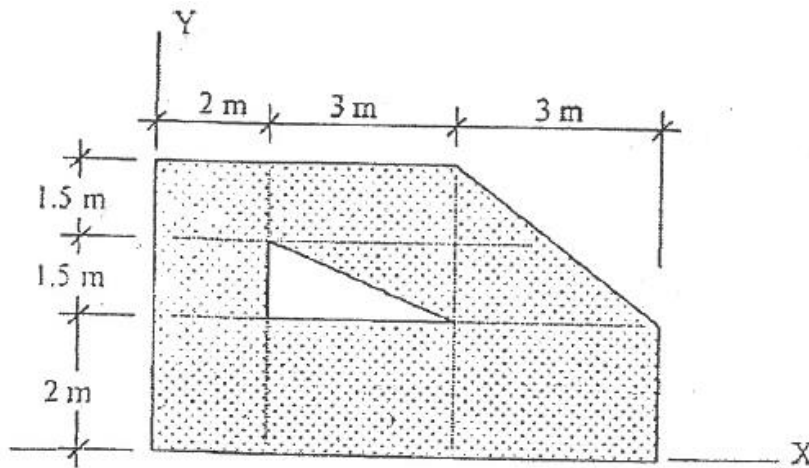


ES 221 MECHANICS I (STATICS) RECITATION XIII

Q1)

For the composite area given (shaded area), determine (a) the coordinates (x_c , y_c) of the centroid with respect to the given X-Y axis, (b) its moment of inertia with respect to the centroidal X axis.

**Solution to Q1**

(a)

$$\bar{x} = \frac{8 \times 5 \times 2.5 - \left(1.5 \times \frac{3}{2}\right) \times 2.5 - \left(3 \times \frac{3}{2}\right) \times 4}{8 \times 5 - \left(1.5 \times \frac{3}{2}\right) - \left(3 \times \frac{3}{2}\right)} \cong 2.3 \text{ m} \uparrow$$

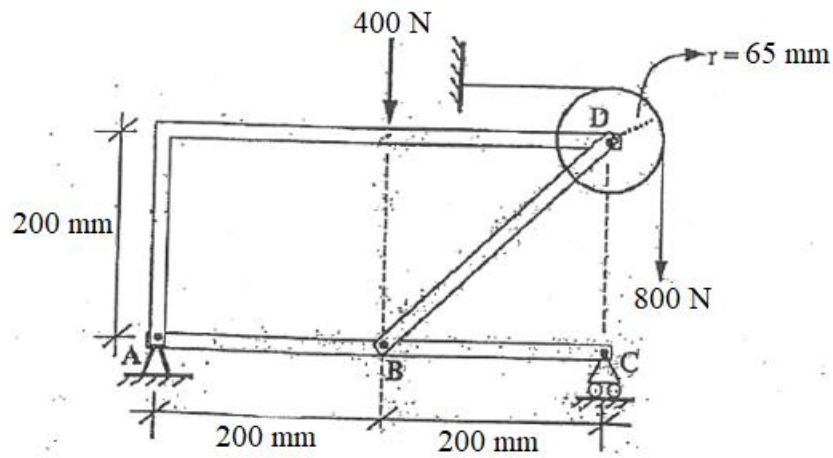
$$\bar{y} = \frac{8 \times 5 \times 4 - \left(1.5 \times \frac{3}{2}\right) \times 3 - \left(3 \times \frac{3}{2}\right) \times 7}{8 \times 5 - \left(1.5 \times \frac{3}{2}\right) - \left(3 \times \frac{3}{2}\right)} \cong 3.66 \text{ m} \rightarrow$$

(b)

$$I_{x'} = \frac{8 \times 5^3}{12} + 8 \times 5 \times (2.5 - 2.3)^2 - \frac{3 \times 1.5^3}{36} - \left(\frac{3 \times 1.5}{2}\right) \times (2.5 - 2.3)^2 - \frac{3 \times 3^3}{36} - \frac{3 \times 3}{2} \times (4 - 2.3)^2 \cong 69.3 \text{ m}^4$$

Q2)

Determine the forces acting on member AD.



Question to Q2

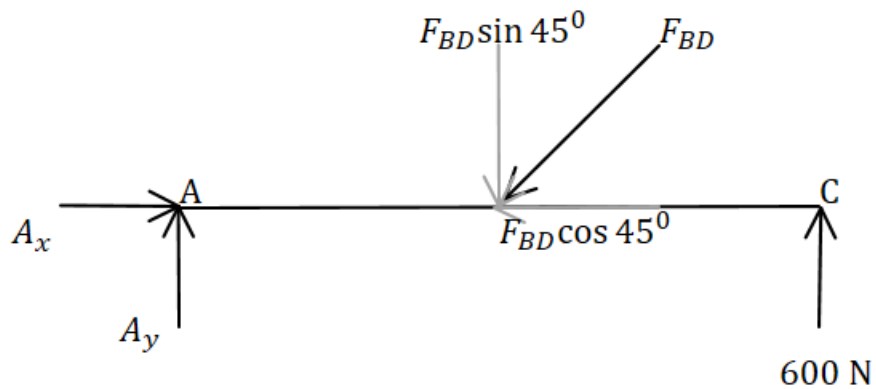
$$\sum M_A = 0$$

$$-400 \text{ N} \times 0.2 \text{ m} - 800 \text{ N} \times 0.465 \text{ m} + 800 \text{ N} \times 0.265 \text{ m} + C_y \times 0.4 \text{ m} = 0$$

$$C_y = 600 \text{ N} \uparrow$$

$$A_y = 600 \text{ N} \uparrow$$

Free Body Diagram of Member AC:



$$\circlearrowleft \sum M_A = 0$$

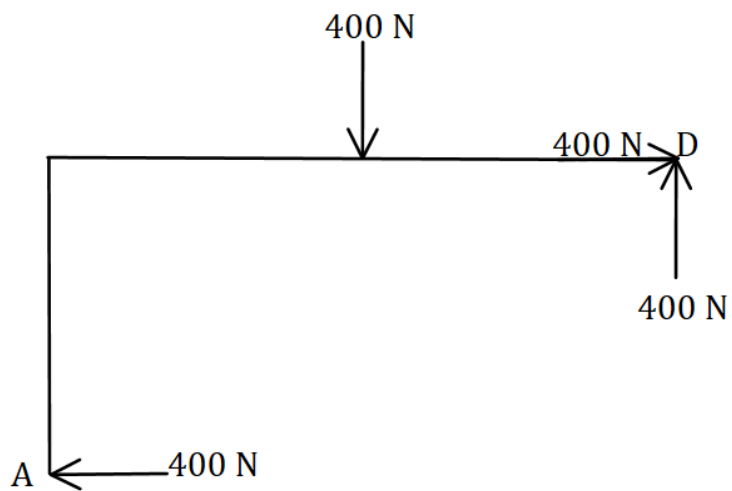
$$600 \text{ N} \times 0.4 \text{ m} - F_{BD} \sin 45^\circ \times 0.2 \text{ m} = 0$$

$$F_{BD} \approx 1697 \text{ N}$$

$$A_y = 600 \text{ N} \uparrow$$

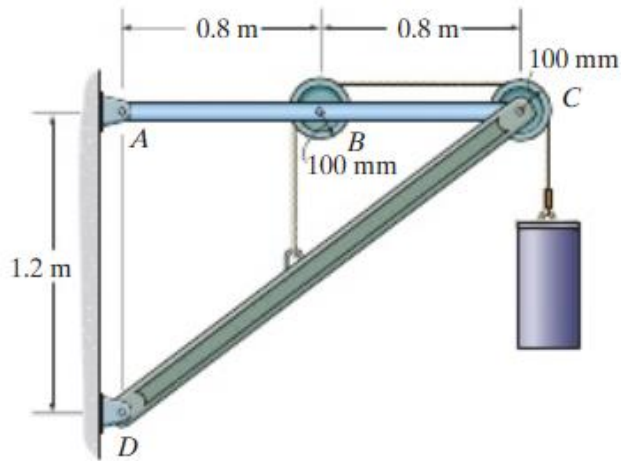
$$A_x = 1200 \text{ N} \rightarrow$$

Free Body Diagram of Member AD:



Q3)

The frame is used to support the 50-kg cylinder. Determine the force of the pin at C on member ABC and on member CD.



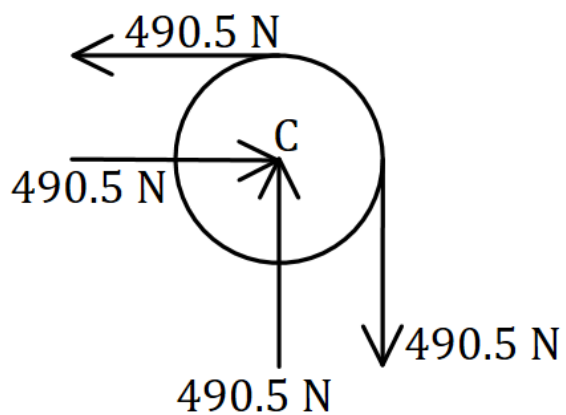
Solution to Q3

$$\sum M_D = 0$$

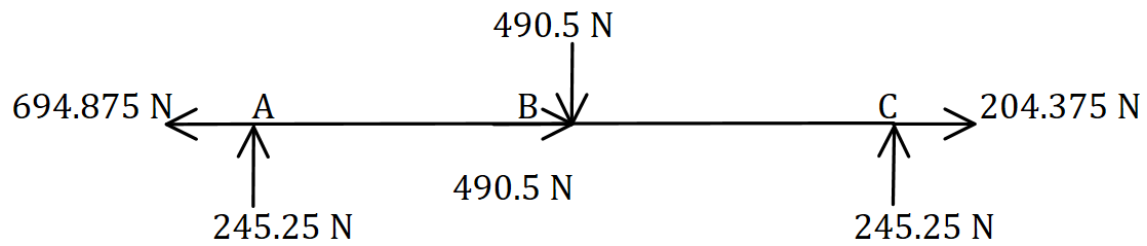
$$-50 \times 9.81 \times 1.7 + A_x \times 1.2 = 0$$

$$A_x = 694.875 \text{ N} \leftarrow \quad D_x = 694.875 \text{ N} \rightarrow$$

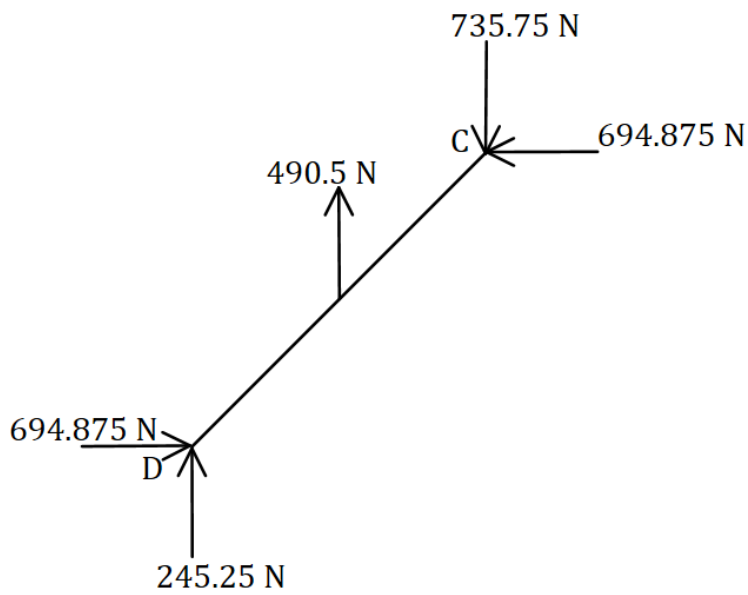
Free Body Diagram of the Pulley at C:



Free Body Diagram of Member ABC:



Free Body Diagram of Member CD:



$$F_{C_{ABC}} = 319 \text{ N}$$

$$F_{C_{CD}} = 1.01 \text{ kN}$$