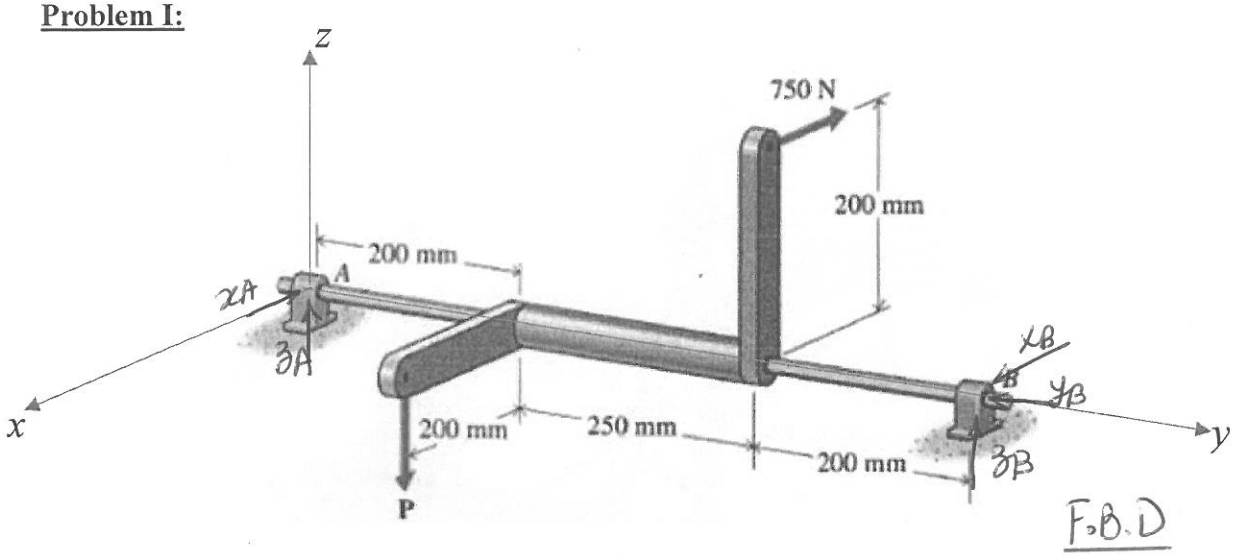
Problem I:



The shaft with the two levers shown is used to change the direction of a force. Determine the force **P** for equilibrium and the reactions at supports **A** and **B**. The support at A is a ball bearing (*can slide along y-axis*) and the support at B is a thrust bearing (*pin*). *The two bearings exert only force reactions on the shaft, i.e allows rotations. (25 points)*

Note: FBD must be included

Calculations:

Scalar Approach:

$+\circlearrowleft \sum M_{Ay} = 0 \Rightarrow P(200) - 750(200) = 0 \Rightarrow \boxed{P = 750\ N}$

$+\rightarrow \sum F_y = 0 \Rightarrow \boxed{y_B = 0}$

$+\circlearrowleft \sum M_{Ax} = 0 \Rightarrow z_B(650) - 750(200) = 0 \Rightarrow \boxed{z_B = 230.77\ N}$

$+\uparrow \sum F_z = 0 \Rightarrow z_A + 230.77 - 750 = 0 \Rightarrow \boxed{z_A = 519.23\ N}$

$+\circlearrowleft \sum M_{Az} = 0 \Rightarrow 750(450) - x_B(650) \Rightarrow \boxed{x_B = 519.23\ N}$

$\pm \sum F_x = 0 \Rightarrow -x_A + x_B - 750 = 0 \Rightarrow \boxed{x_A = -230.77\ N}$

or use vector Approach

$$\Sigma \vec{F}_x = \vec{0} \Rightarrow -x_A + 750 + X_B = 0 \quad \text{---} (1)$$

$$\Sigma \vec{F}_y = \vec{0} \rightarrow -y_B = 0 \quad \text{---} (2)$$

$$\Sigma \vec{F}_z = 0 \rightarrow z_A - P + z_B = 0 \quad \text{---} (3)$$

$$\vec{M}_A = \vec{r} \times \vec{F}$$

$$\vec{M}_A = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 200 & 200 & 0 \\ 0 & 0 & -P \end{vmatrix} + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 450 & 200 \\ -750 & 0 & 0 \end{vmatrix} + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 650 & 0 \\ x_B & -y_B & z_B \end{vmatrix}$$

$$= \left[(-200P)\vec{i} - (-200P)\vec{j} + 0\vec{k}\right] + \left[0\vec{i} - (200 \times 750)\vec{j} + 450(750)\vec{k}\right]$$

$$+ \left[(650 z_B)\vec{i} - (0)\vec{j} - (650 x_B)\vec{k}\right]$$

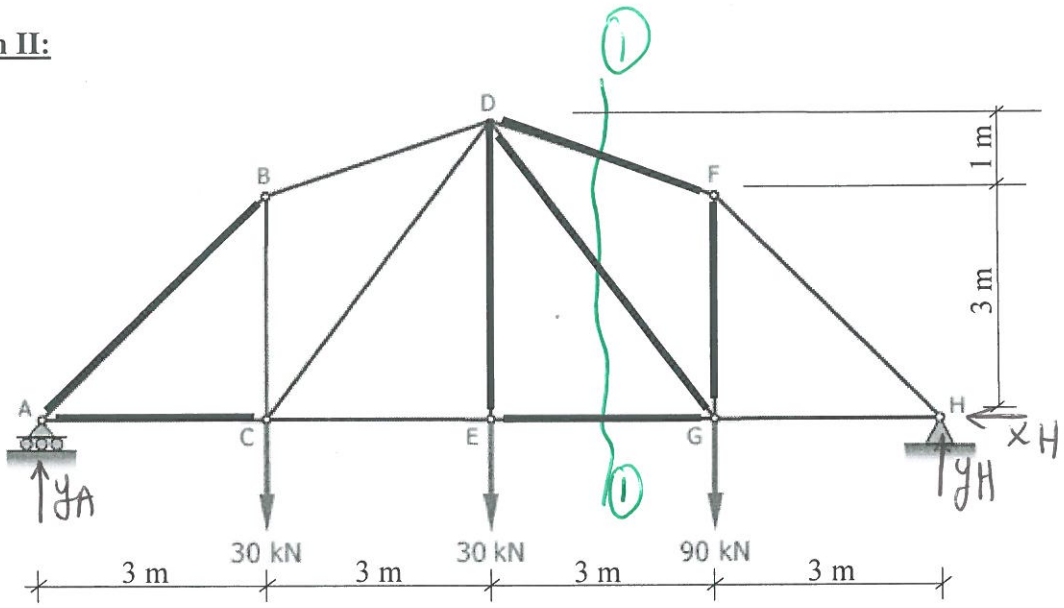
$$\Rightarrow \Sigma \vec{M}_x = \vec{0} \Rightarrow -200P + 650 z_B = 0 \quad \text{---} (4)$$

$$\Sigma \vec{M}_y = \vec{0} \rightarrow 200P - (200 \times 750) = 0 \quad \text{---} (5)$$

$$\Sigma \vec{M}_z = 0 \rightarrow 450(750) - (650) x_B = 0 \quad \text{---} (6)$$

By solving the six equations, get P, x_A, z_A, x_B, y_B & z_B

Problem II:



1) Determine the external reactions at the roller support A and the pin at H. *(5 points)*
2) Determine the force in members DF, DG, EG ***using the section method***. Also solve for the force on members FG, DE, AB, and AC using the appropriate method of analysis. *(35 points)*

Note: FBD must be included
Calculations:

1- Reactions:

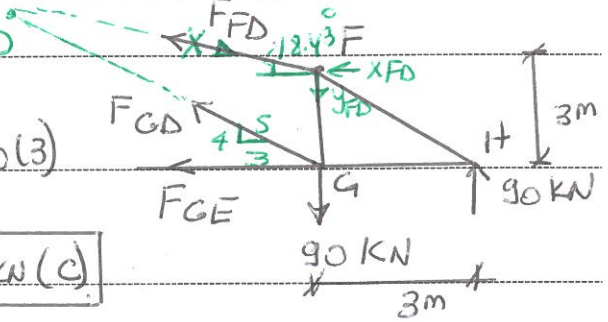
$+\circlearrowleft \Sigma M_A = 0 \Rightarrow -30(3) - 30(6) - 90(9) + y_H(12) = 0 \Rightarrow y_H = 90\ KN$

$+\circlearrowleft \Sigma M_H = 0 \Rightarrow -y_A(12) + 30(9) + 30(6) + 90(3) = 0 \Rightarrow y_A = 60\ KN$

CHECK! $+\uparrow \Sigma F_y = 0 \Rightarrow 90 - 30 - 30 - 90 + 60 = 0 \therefore OK$

$\pm \Sigma F_x = 0 \Rightarrow x_H = 0$

Sec 1-1



$+\circlearrowleft \Sigma M_G = 0 \Rightarrow F_{FD}\cos 18.43(3) + 90(3)$

$\boxed{F_{FD} = -94.87\ KN = 94.87\ KN\ (C)}$

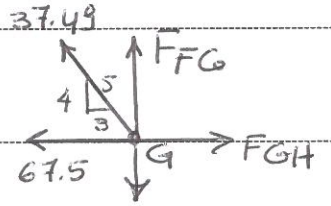
$+\circlearrowleft \Sigma M_D = 0 \Rightarrow -F_{GE}(4) - 90(3) + 90(6) = 0 \Rightarrow \boxed{F_{GE} = 67.5\ KN\ (T)}$

$+\uparrow \Sigma F_y = 0 \Rightarrow -94.87\sin 18.43 + F_{GD}\left(\frac{4}{5}\right) - 90 + 90 = 0$

$\Rightarrow \boxed{F_{GD} = 37.49\ KN\ (T)}$

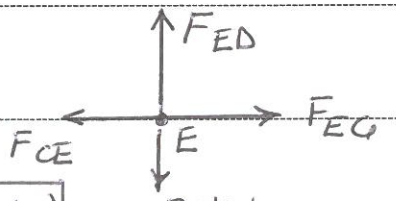
CHECK! $\pm \Sigma F_x = 0 \Rightarrow -94.87\cos 18.43 + 37.49 * \frac{3}{5} + 67.5 = 0$ OK.

* Equilibrium at joint G



$+\uparrow \Sigma F_y = 0 \Rightarrow 37.49\left(\frac{4}{5}\right) - 90 + F_{FG} = 0 \Rightarrow \boxed{F_{FG} = 60\ KN\ (T)}$

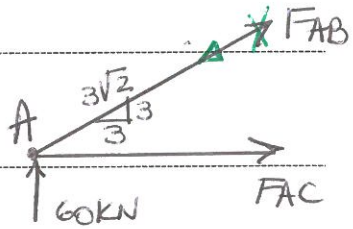
Equilibrium at E



$+\uparrow \Sigma F_y = 0 \Rightarrow$

$F_{ED} - 30 = 0 \Rightarrow \boxed{F_{ED} = 30\ KN\ (T)}$

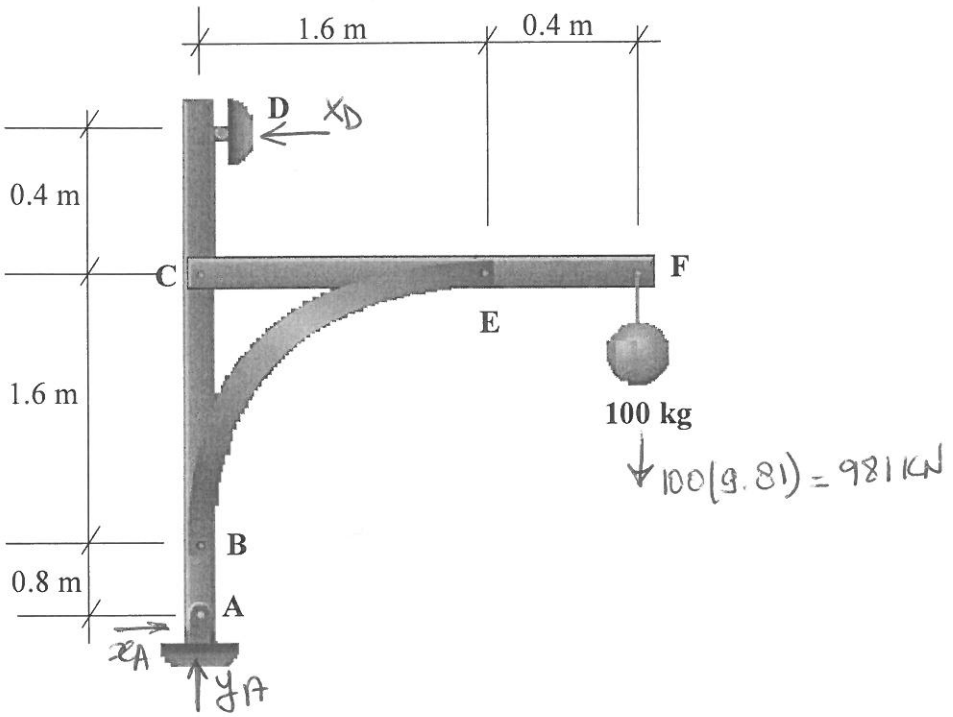
Equilibrium at A



$+\uparrow \Sigma F_y = 0 \Rightarrow 60 + F_{AB}\left(\frac{3}{3\sqrt{2}}\right) \Rightarrow \boxed{F_{AB} = -84.85\ KN\ (C)}$

$\pm \Sigma F_x = 0 \Rightarrow F_{AC} - 84.85 * \frac{3}{3\sqrt{2}} \Rightarrow \boxed{F_{AC} = 60\ KN\ (T)}$

Problem III:



1) Determine the external reactions at pin A and roller D, and the internal forces of the frame. *(35 points)*

Note: FBD must be included

Calculations:

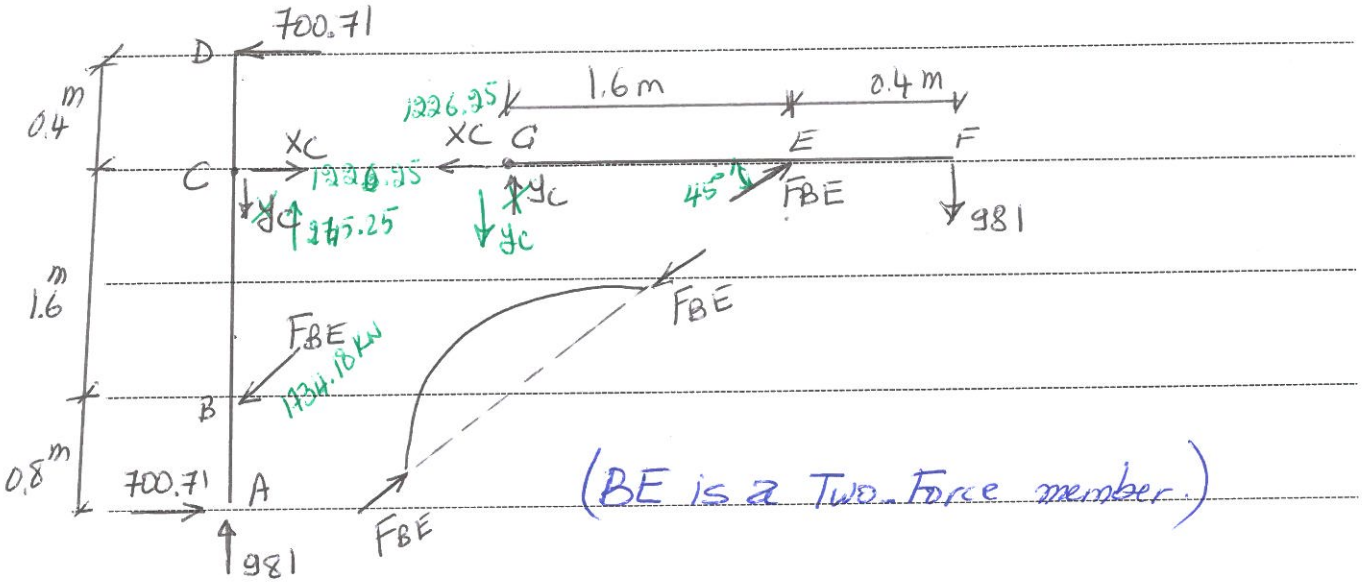
Using the whole Frame:-

$+\circlearrowleft \Sigma M_A = 0 \Rightarrow x_D(2.8) - 981(2) = 0 \Rightarrow \boxed{x_D = 700.71\ KN}$

$\overset{+}{\rightarrow} \Sigma F_x = 0 \Rightarrow x_A - 700.71 = 0 \Rightarrow \boxed{x_A = 700.71\ KN}$

$+\uparrow \Sigma F_y = 0 \Rightarrow y_A - 981 = 0 \Rightarrow \boxed{y_A = 981\ KN}$

F.B.D



Part CF:

$+\circlearrowleft \sum M_C = 0 \Rightarrow F_{BE}\sin 45\,(1.6) - 981(2) = 0$

$\Rightarrow \boxed{F_{BE} = 1734.18\ KN}$

$+\uparrow \sum F_y = 0 \Rightarrow y_c + 1734.18\sin 45 - 981 = 0 \Rightarrow y_c = -245.25\ KN$

$\boxed{y_c = 245.25\ \downarrow\ KN}$

$+\rightarrow \sum F_x = 0 \Rightarrow -x_c + 1734.18\cos 45 \Rightarrow \boxed{x_c = 1226.25\ KN}\ \leftarrow$

Part AD

CHECK! $+\rightarrow \sum F_x = 0 \Rightarrow -700.71 + 1226.25 - 1734.18\cos 45 + 700.71 = 0$ O.K.

CHECK! $+\uparrow \sum F_y = 0 \Rightarrow 981 - 1734.18\sin 45 + 245.25 = 0$ ∴ OK