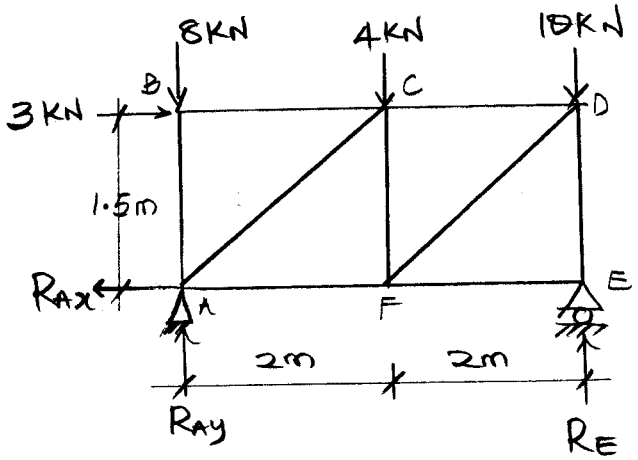
CE 202 HW #4

#1. Determine the force in each member of the truss and state if the members are in tension or compression



External reactions

$\Sigma M_A = 4R_E - 3(1.5) - 4(2) - 10(4) = 0$

$4R_E = 52.5$

$R_E = \frac{52.5}{4} = \underline{13.125 KN}$

$\Sigma F_x = R_{AX} - 3 = 0$

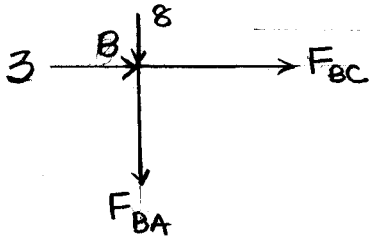
$R_{AX} = \underline{3 KN}$

$\Sigma F_y = R_{AY} - 8 - 4 - 10 + 13.125 = 0$

$R_{AY} = 8.875 KN$

Member forces

Joint B

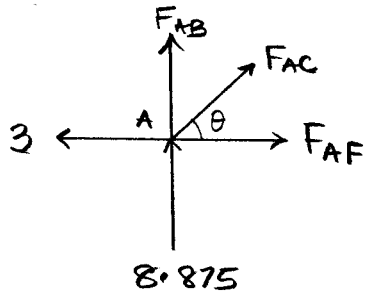


$\Sigma F_x = 3 + F_{BC} = 0 \Rightarrow F_{BC} = \underline{-3 KN (C)}$

$\Sigma F_y = F_{BA} + 8 = 0 \Rightarrow F_{BA} = \underline{-8 KN (C)}$

$\sin\theta = \frac{1.5}{\sqrt{1.5^2+2^2}} = 0.6, \cos\theta = \frac{2}{2.5} = 0.8$

Joint A



$\Sigma F_y = 8.875 + F_{AB} + F_{AC}\sin\theta = 0$

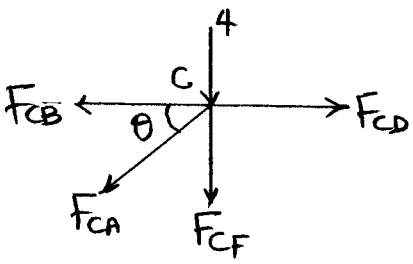
$8.875 - 8 + 0.6F_{AC} = 0$

$F_{AC} = \underline{-1.458 KN (C)}$

$\Sigma F_x = -3 + F_{AC}\cos\theta + F_{AF} = 0$

$-3 - 1.458(0.8) + F_{AF} = 0$

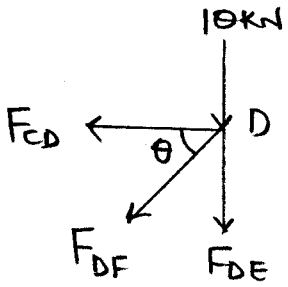
Joint C



$$\Sigma F_x = -F_{CB} - F_{CA}\cos\theta + F_{CD} = 0$$
$$3 + 1.458(0.8) + F_{CD} = 0$$
$$F_{CD} = \underline{-4.166\ kN\ (C)}$$

$$\Sigma F_y = -4 - F_{CA}\sin\theta - F_{CF} = 0$$
$$-4 + 1.458(0.6) - F_{CF} = 0$$
$$F_{CF} = \underline{-3.125\ kN\ (C)}$$

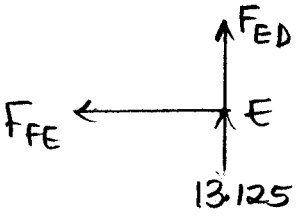
Joint D



$$\Sigma F_x = -F_{DF}\cos\theta - F_{CD} = 0$$
$$-0.8F_{DF} + 4.166 = 0$$
$$F_{DF} = \underline{5.208\ kN\ (T)}$$

$$\Sigma F_y = -F_{DF}\sin\theta - F_{DE} - 10 = 0$$
$$-5.208(0.6) - F_{DE} - 10 = 0 \Rightarrow F_{DE} = \underline{-13.125\ kN\ (C)}$$

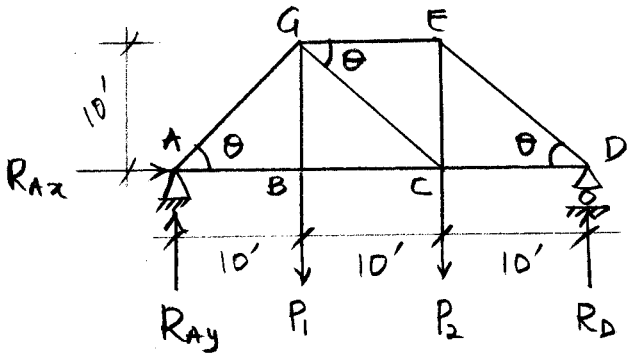
Joint E



$$\Sigma F_x = -F_{FE} = 0 \Rightarrow \underline{F_{FE} = 0}$$

In fact, this member force requires no calculation of any sort. By inspection, we can see there's no horizontal load at joint E and all members meeting at this joint have no horizontal force components. This is one of the simple ways of identifying 'zero force' members by inspection.

#2. Determine the force in each member of the truss and state if the members are in tension or compression. Set $P_1 = 500\,lb$, $P_2 = 1500\,lb$



External Reactions

$\sum M_A = 30R_D - 10(500) - 20(1500) = 0$

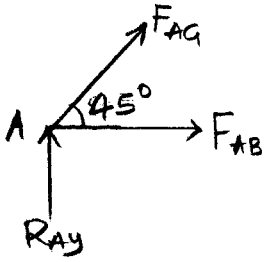
$R_D = 1166.667\,lb \uparrow$

No horizontal loading, so $R_{Ax} = 0$

$R_{Ay} = 500 + 1500 - 1166.667$

$= 833.333\,lb \uparrow$

Joint A



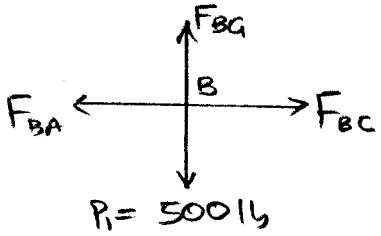
$\sum F_y = 833.333 + F_{AG}\sin 45°$

$F_{AG} = -1178.51\,lb$ (C)

$\sum F_x = F_{AG}\cos 45° + F_{AB} = 0$

$F_{AB} = 1178.51\cos 45° = 833.333\,lb$ (T)

Joint B

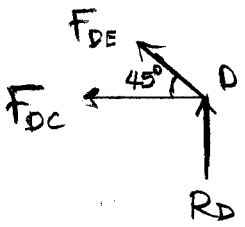


$\sum F_x = -F_{BA} + F_{BC} = 0$

$F_{BC} = F_{BA} = 833.333\,lb$ (T)

$\sum F_y = F_{BG} - 500 = 0 \Rightarrow F_{BG} = 500\,lb$ (T)

Joint D



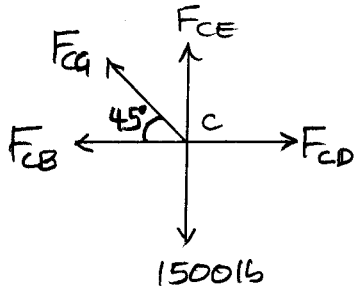
$\sum F_y = R_D + F_{DE}\sin 45° = 0$

$F_{DE} = -1649.916\,lb$ (C)

$\sum F_x = -F_{DE}\cos 45° - F_{DC} = 0$

$F_{DC} = 1166.667\,lb$ (T)

Joint C



$$\Sigma F_x = -F_{CB} - F_{CG}\cos 45^\circ + F_{CD} = 0$$

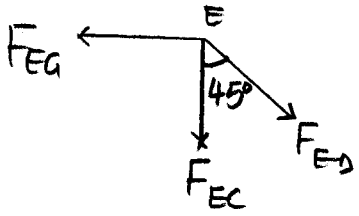
$$-833.333 - F_{CG}\cos 45^\circ + 1166.667 = 0$$

$$F_{CG} = 471.405\ \text{lb (T)}$$

$$\Sigma F_y = F_{CG}\sin 45^\circ + F_{CE} - 1500 = 0$$

$$F_{CE} = 1166.667\ \text{lb (T)}$$

Joint E



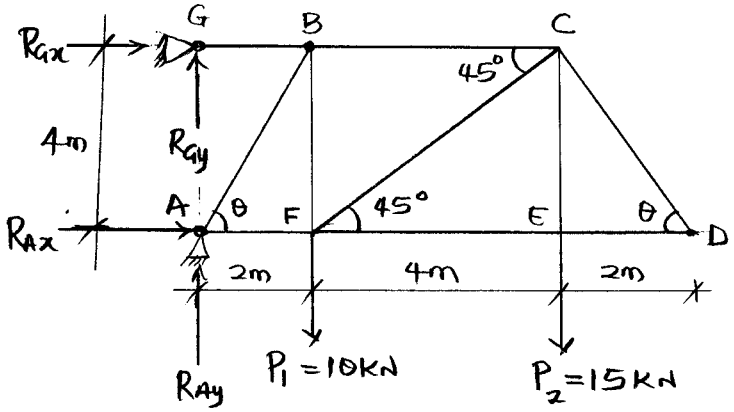
$$\Sigma F_x = -F_{EG} + F_{ED}\sin 45^\circ = 0$$

$$F_{EG} = -1649.916\sin 45^\circ$$

$$= -1166.667\ \text{lb (C)}$$

#3. Determine the force in each member and state if the members are in tension or compression.

Set $P_1 = 10\,kN$, $P_2 = 15\,kN$



External Reactions

$\Sigma M_G = 4R_{Ax} - 2(10) - 15(6) = 0$

$4R_{Ax} = 110$

$R_{Ax} = 27.5\,kN$

$\Sigma F_x = R_{Gx} + R_{Ax} = 0$

$R_{Gx} = -R_{Ax} = -27.5\,kN$

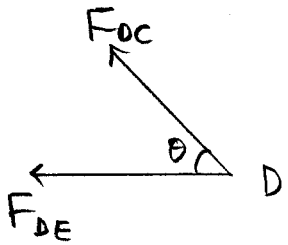
$= 25.5\,kN \leftarrow$

GB is a swinging member, hence $R_{Gy} = 0$

$\Sigma F_y = R_{Ay} - 10 - 15 = 0 \Rightarrow R_{Ay} = 25\,kN$

$\cos\theta = \frac{2}{\sqrt{(2^2+4^2)}} = 0.4472$; $\sin\theta = \frac{4}{\sqrt{(2^2+4^2)}} = 0.8944$

Joint D

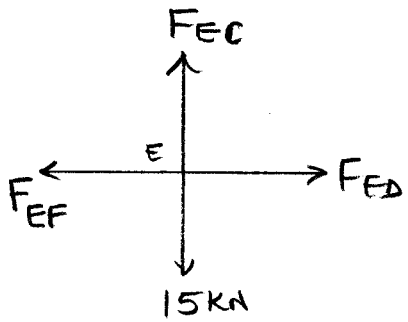


$\Sigma F_y = F_{DC} = 0$

$\Sigma F_x = -F_{DC}\cos\theta - F_{DE} = 0$

$F_{DC} = F_{DE} = 0$

Joint E



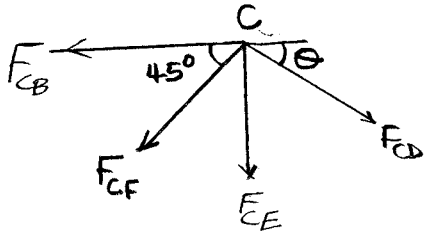
$\Sigma F_x = F_{ED} - F_{EF} = 0$

$F_{EF} = F_{ED} = 0$

$\Sigma F_y = F_{EC} - 15 = 0$

$F_{EC} = 15\,kN\,(T)$

Joint C



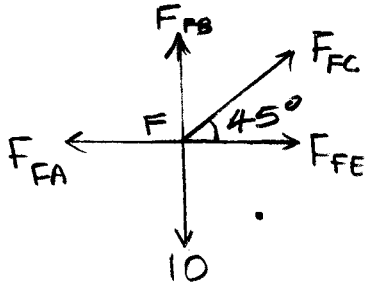
$$\Sigma F_y = -F_{CF}\sin 45° - F_{CE} - F_{CD}\sin\theta = 0$$

$$F_{CF} = \frac{-F_{CE}}{\sin 45°} = -21.213\ \text{KN (C)}$$

$$\Sigma F_x = -F_{CB} - F_{CF}\cos 45° + F_{CD} = 0$$

$$F_{CB} = -F_{CF}\cos 45° = 15\text{KN (T)}$$

Joint F



$$\Sigma F_y = F_{FB} + F_{FC}\sin 45° - 10 = 0$$

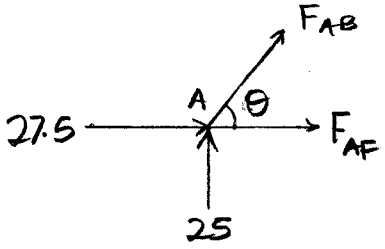
$$F_{FB} - 21.213\sin 45° - 10 = 0$$

$$F_{FB} = 25\,\text{KN (T)}$$

$$\Sigma F_x = -F_{FA} + F_{FC}\cos 45° + F_{FE} = 0$$

$$F_{FA} = F_{FC}\cos 45° = -15\,\text{KN (C)}$$

Joint A



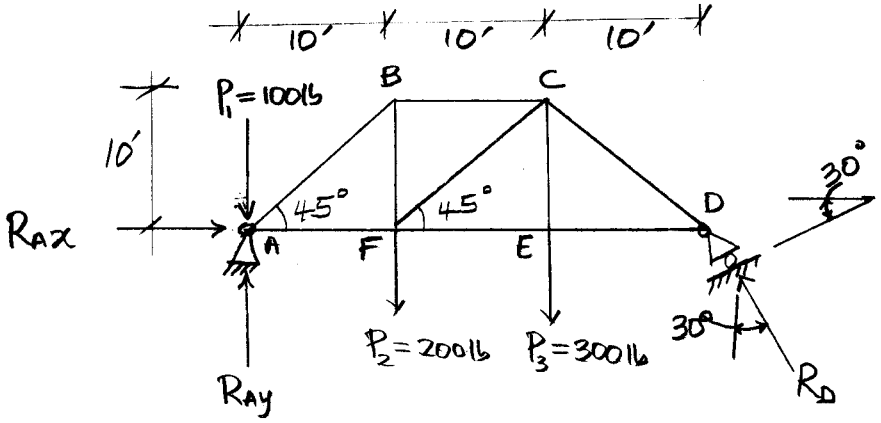
$$\Sigma F_y = 25 + F_{AB}\sin\theta$$

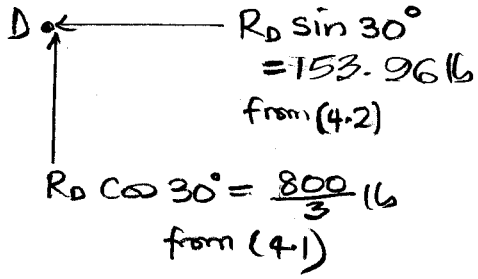
$$F_{AB} = -\frac{25}{0.8944} = -27.952\ \text{KN (C)}$$

At joint G, $\Sigma F_x = R_{Gx} + F_{GB} = 0 \Rightarrow F_{GB} = 27.5\,\text{KN (T)}$

#4. Determine the force in each member and state whether they are in tension or compression.

Set $P_1 = 100$ lb, $P_2 = 200$ lb, $P_3 = 300$ lb





External reactions

$$\sum M_D = -30R_{Ay} + 100(30) + 200(20) + 300(10) = 0$$

$$30R_{Ay} = 10000 \Rightarrow R_{Ay} = \frac{1000}{3} = 333.333 \text{ lb} \uparrow$$

$$\sum F_y = -100 - 200 - 300 + R_D \cos 30° + R_{Ay}$$

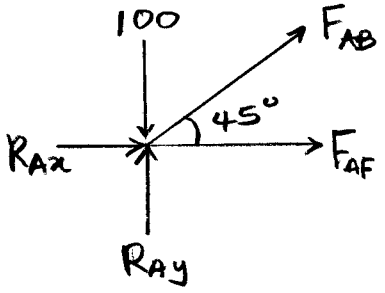
(4.1) $$R_D \cos 30° = \frac{800}{3} \Rightarrow R_D = 307.92 \text{ lb} \nwarrow$$

$$\sum F_x = R_{Ax} - R_D \sin 30° = 0$$

(4.2) $$R_{Ax} = R_D \sin 30° = 307.92 \sin 30° = 153.96 \text{ lb} \rightarrow$$

Member forces:

Joint A



$$\sum F_y = R_{Ay} + F_{AB} \sin 45° - 100 = 0$$

$$F_{AB} \sin 45° = -\frac{1000}{3} + 100$$

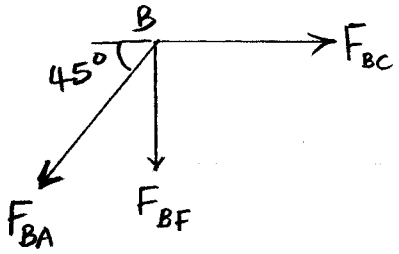
$$F_{AB} = -329.983 \text{ lb (C)}$$

$$\sum F_x = R_{Ax} + F_{AB} \cos 45° + F_{AF} = 0$$

$$153.96 - 329.983 \cos 45° + F_{AF} = 0$$

$$F_{AF} = +79.373 \text{ lb (T)}$$

Joint B



$\Sigma F_x = -F_{BA}\cos 45° + F_{BC} = 0$

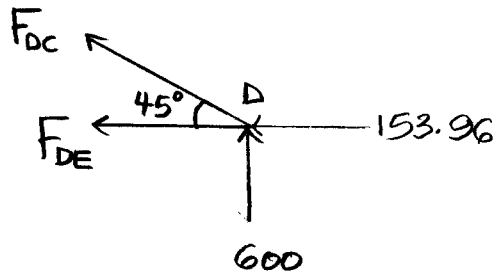
$F_{BC} = -233.333$ lb (C)

$\Sigma F_y = -F_{BF} - F_{BA}\sin 45° = 0$

$\rightarrow F_{BF} = 329.983 \sin 45°$

$F_{BF} = 333.333$ lb (T)

Joint D



$\Sigma F_y = F_{DC}\cos 45 + \frac{800}{3} = 0$

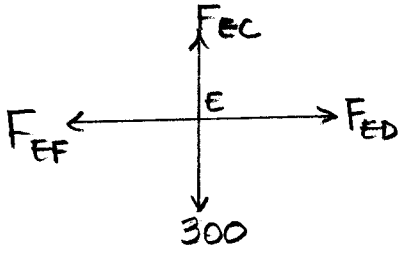
$F_{DC} = -377.124$ lb (C)

$\Sigma F_x = -F_{DC}\cos 45° - F_{DE} - 153.96 = 0$

$F_{DE} = 377.124 \cos 45° - 153.96$

$F_{DE} = 112.707$ (T)

Joint E



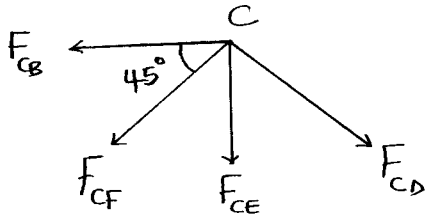
$\Sigma F_x = F_{ED} - F_{EF} = 0$

$F_{EF} = F_{ED} = 112.707$ lb (T)

$\Sigma F_y = F_{EC} - 300 = 0$

$F_{EC} = 300$ lb (T)

Joint C

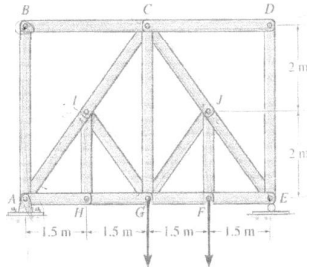


$\Sigma F_x = -F_{CB} - F_{CF}\cos 45° + F_{CD}\cos 45°$

$F_{CF}\cos 45° = 233.333 - 377.124 \cos 45°$

$F_{CF} = -47.141$ (C)

5. Indicate** all zero force **members in the truss.

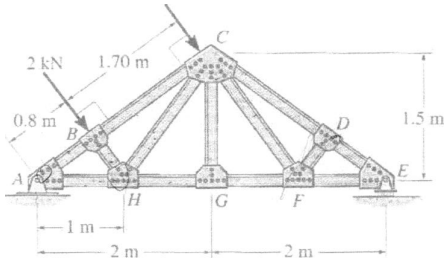


By inspection of joints *B*, *D*, *H* and *I,* Members

AB, BC, CD, DE, HI and GI

are all zero-force members

6. Indicate** all zero force **members in the truss.



By inspection of joints *D* and *G,* Members

CG and DF

are both zero-force members