Q1) Let's name the angles

$\hat{BAC} = \alpha$ $\quad \hat{BCA} = \beta$ $\quad \hat{DCE} = \gamma$ $\quad \hat{DEC} = \phi$ $\quad \hat{GEH} = \delta$ $\quad \hat{GHE} = \theta$

length of BI, DJ, GK calculate

Consider the similar triangles ADJ and AEF

$$\frac{BI}{EF} = \frac{AI}{AE}$$

$$\frac{BI}{6m} = \frac{4m}{12m}$$

$\boxed{BI = 2m}$

Length of GK,
similar triangles HKG and HEF

$$\frac{GK}{EF} = \frac{HK}{HE} \quad \frac{GK}{6m} = \frac{3m}{6m} \quad \boxed{GK = 3m}$$

similar triangles ABI and AEF
length of DJ

$$\frac{DJ}{EF} = \frac{AJ}{AE}$$

$$\frac{DJ}{6m} = \frac{8}{12m} \quad \boxed{DJ = 4m}$$

In triangle ABI,

$$\tan\alpha = \frac{BI}{AI}$$

$$\alpha = \tan^{-1}\left(\frac{2m}{4m}\right)$$

$$= 26.57°$$

In the triangle CBI

$$\tan\beta = \frac{BI}{IC}$$

$$\beta = \tan^{-1}\left(\frac{BI}{AC-AI}\right) = \tan^{-1}\left(\frac{2}{6-4}\right) = \boxed{45°}$$

required angles

CDJ

$$\tan\gamma = \frac{DJ}{CJ}$$

$$\gamma = \tan^{-1}\left(\frac{DJ}{AJ-AC}\right)$$

$$= \tan^{-1}\left(\frac{4}{8-6}\right) = 63.43°$$

HGK

$$\tan\theta = \frac{GK}{HK}$$

$$\theta = \tan^{-1}\left(\frac{3}{3}\right) = \boxed{45°}$$

EDJ

$$\tan\phi = \frac{DJ}{EJ} \quad \phi = \tan^{-1}\left(\frac{4}{4}\right) = \boxed{45°}$$

Take the moments about the point A.

$$\Sigma M_A = 0$$

$$\left.\begin{aligned} &-(2kN)(4m) - (2kN)(8m) \\ &-(1.75kN)(12m) - (1.5kN)(15m) \\ &-(0.75kN)(18m) + (H_y)(18m) \end{aligned}\right\} = 0$$

$$H_y = \frac{1}{18}(8+16+21+22.5+13.5)$$

$$H_y = 4.5kN$$

Apply force equilibrium equation along the y direction

$$\Sigma F_x = 0$$

$$+A_y + H_y - (1kN) - (2kN) - (2kN) - (1.75kN)$$
$$-(1.5kN) - (0.75kN) = 0$$

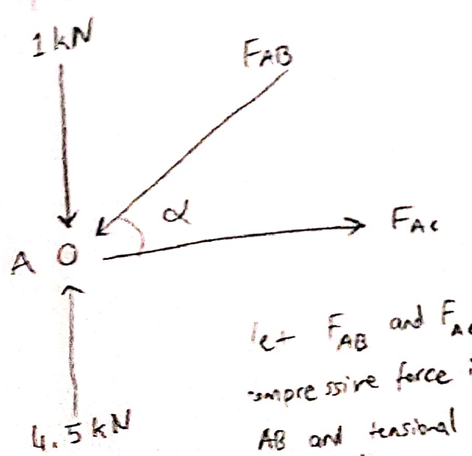
$$A_y + H_y = 9\ kN$$

$$A_y = (9kN) - H_y$$

Substitude 4.5kN for H_y

$$A_y = (9kN) - (4.5kN)$$
$$= 4.5kN$$

Free body diagram of joint A,



let F_{AB} and F_{AC} be the compressive force in the member AB and tensional force in the member AC respectively

Apply force equilibrium equation along vertical direction.

$4.5\text{ kN} = (1\text{ kN}) + F_{AB}\sin\alpha$

$F_{AB} = \dfrac{3.5\text{ kN}}{\sin\alpha}$

Substitude $26.57°$ for α

$F_{AB} = \dfrac{3.5\text{ kN}}{\sin 26.57°}$

$= 7.83\text{ kN}$

Hence, the force in the member AB is $\boxed{7.83\text{ kN (compressive)}}$

apply force eqilibrium equation along horizontal direction.

$F_{AC} = F_{AB}\cos\alpha$

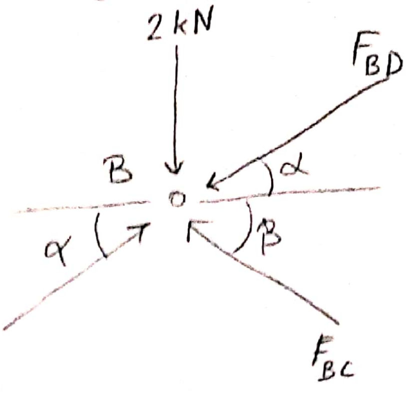
Substitute 7.83 kN for F_{AB} and $26.57°$ for α

$F_{AC} = (7.83\text{ kN})\cos 26.57°$

$= 7\text{ kN}$

hence, the force in the member AC is $\boxed{7\text{ kN (tensile)}}$

Free body diagram of the Joint B,



Here, F_{BD} and F_{BC} are the compressive forces in the members BD and BC respectively.

Balance the forces in the vertical direction,

$F_{AB}\sin\alpha + F_{BC}\sin\beta = F_{BD}\sin\alpha + (2\text{ kN})$

Substitute $26.57°$ for α, $45°$ for β and 7.83 kN for F_{AB}

$(7.83\text{ kN})\sin 26.57° + F_{BC}\sin 45° =$

$F_{BD}\sin 26.57° + (2\text{ kN})$

$3.5 + 0.707F_{BC} = 0.447F_{BD} + 2$

$0.447F_{BD} - 0.707F_{BC} = 1.5 \quad \ldots (1)$

Balance the forces in the horizontal direction,

$F_{BD}\cos\alpha + F_{BC}\cos\beta = F_{AB}\cdot\cos\alpha$

Substitute $26.57°$ for α, $45°$ for β, and 7.83 kN for F_{AB}

$F_{BD}\cos 26.57° + F_{BC}\cos 45° = (7.83\text{ kN})\cos 26.57°$

$0.894F_{BD} + 0.707F_{BC} = 7 \quad \ldots (2)$

Add equations (1) and (2)

$0.447F_{BD} - 0.707F_{BC} + 0.894F_{BD} + 0.707F_{BC}$

$= 1.5 + 7$

$1.341F_{BD} = 8.5$

$F_{BD} = 6.34\text{ kN}$

Hence, the force in the member BD is

$\boxed{6.34\text{ kN (compressive)}}$

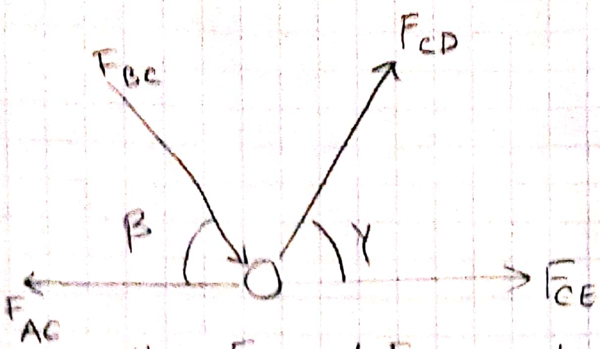
Substitute 6.34 kN for F_{BD} in the equation (2)

$0.894F_{BD} + 0.707F_{BC} = 7$

$0.707F_{BC} = 7 - 0.894(6.34)$

$\boxed{F_{BC} = 1.89\text{ kN}}$

Free body diagram of the Joint C,



Here, F_{CD} and F_{CE} are the tensile forces in the members CD and CE respectively.

Balance the forces in the vertical direction,

$$F_{CD} \sin\gamma = F_{BC} \cdot \sin\beta$$

$$F_{CD} = \frac{F_{BC} \cdot \sin\beta}{\sin\gamma}$$

Substitute $63.43°$ for γ, $45°$ for β and $1,89$ kN for F_{BC}

$$F_{CD} = \frac{(1.89\,kN).\sin 45°}{\sin 63.43°} = 1.49\,kN$$

Hence, the force in the member CD is $\boxed{1.49\,kN \text{ (tensile)}}$

Balance the forces in the horizontal direction,

$$F_{CE} + F_{CD} \cos\gamma + F_{BC} \cos\beta = F_{AC}$$

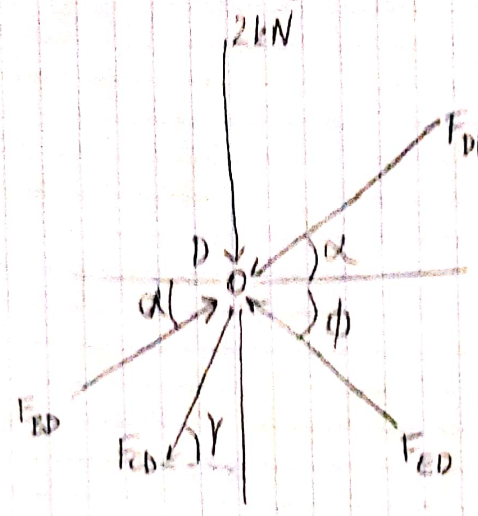
$$F_{CE} = F_{AC} - F_{CD} \cdot \cos\gamma - F_{BC} \cos\beta$$

Substitude $63.43°$ for γ, $45°$ for β, 7 kN for F_{AC}, $1,49$ kN for F_{CD}, and $1,89$ kN for F_{BC}

$$F_{CE} = (7\,kN) - (1.49\,kN)\cos 63.43° - (1.89\,kN).\cos 45°$$

$$= \boxed{5\,kN} \text{ (tensile)}$$

Free body diagram of the Joint D.



$F_{BD}\sin\alpha + F_{ED}\sin\phi = F_{DF}\sin\alpha + (2kN) + F_{CD}\sin\gamma$

$(6.34kN)\sin 26.57° + F_{ED}\sin 45° = F_{DF}\sin 26.57° + (2kN)$
$+ (1.49kN)\sin 63.43°$

$0.707F_{ED} - 0.447F_{DF} = 0.497 \ldots (3)$

$F_{DF}\cos\alpha + F_{ED}\cos\phi + F_{CD}\cos\gamma = F_{BD}\cos\alpha$

$F_{DF}\cos 26.57° + F_{ED}\cos 45° + (1.49kN)\cos 63.43° = (6.34kN)\cos 26.57°$

$0.894F_{DF} + 0.707F_{ED} = 5 \ldots (4)$

Subtract equation (3) and (4)

$0.894F_{DF} + 0.707F_{ED} - 0.707F_{ED} + 0.447F_{DF} = 5 - 0.497$

$1.341F_{DF} = 4.503$

$\boxed{F_{DF} = 3.36\ kN}$

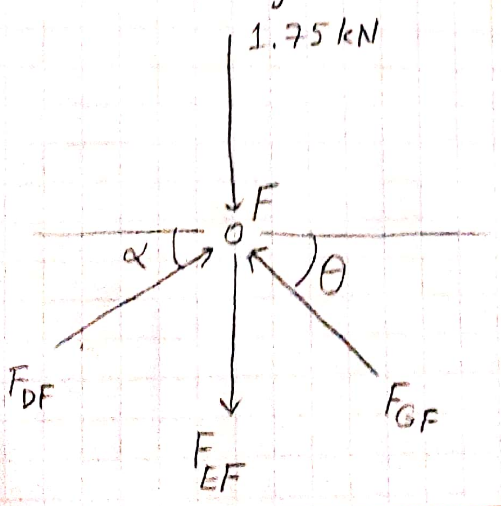
Substitute 3.36 kN for F_{DF} in the equation (3).

$0.707F_{ED} - 0.447F_{DF} = 0.497$

$0.707F_{ED} - 0.447(3.36kN) = 0.497$

$\boxed{F_{ED} = 2.83\ kN}$

Free body diagram of the Joint F



$F_{GF}\cos\theta = F_{DF}\cos\alpha$

$F_{GF} = \dfrac{F_{DF}\cos\alpha}{\cos\theta}$

$F_{GF} = \dfrac{(3.36kN)\cos 26.57°}{\cos 45°}$

$\boxed{= 4.25\ kN}$

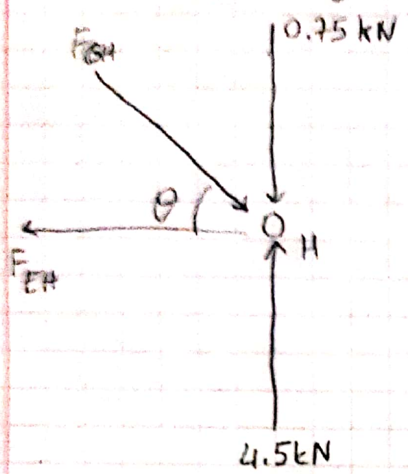
Balance the forces in the vertical direction.

$$F_{EF} + (1.75\,kN) = F_{DF}\sin\alpha + F_{GF}\sin\theta$$

$$F_{EF} + (1.75\,kN) = (3.36\,kN)\sin 26.57^\circ + (4.25\,kN)\sin 45^\circ$$

$$\boxed{F_{EF} = 2.75\,kN}$$

Free body diagram of H



Balance vertical forces

$$(0.75\,kN) + F_{GH}\sin\theta = (4.5)\,kN$$

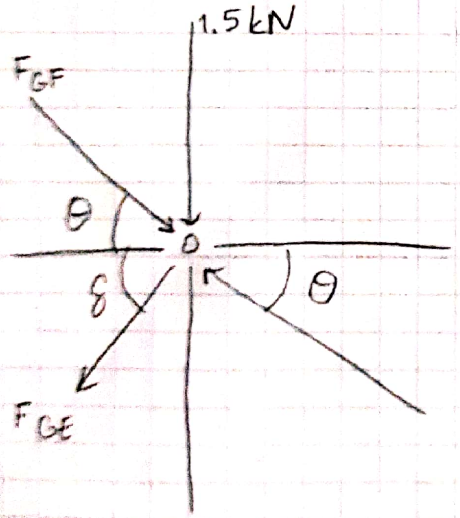
$$F_{GH} = \frac{3.75}{\sin 45^\circ} = \boxed{5.30\,kN}$$

Balance the horizontal forces

$$F_{EH} = F_{GH}\cos\theta$$

$$F_{EH} = 5.30\,kN\cos 45^\circ = \boxed{3.75\,kN}$$

Free body diagram of G



balance horizontal forces

$$F_{GE}\cos\delta + F_{GH}\cos\theta = F_{GF}\cos\theta$$

$$F_{GE} = \frac{(F_{GH} - F_{GF})\cos\theta}{\cos\delta}$$

$$= \frac{(5.3 - 4.25)\cos 45^\circ}{\cos 45^\circ}$$

$$\boxed{= 1.05\,kN}$$

Q2 Apply moment equilibrium about Joint A to find the reaction force at support F.

$$\Sigma M_A = 0$$

$$40(1.5) + 30(1.5+1.5) + 40(2) - F_y(2+2) = 0$$

$$F_y = 57.5 \text{ kN}$$

Apply force equilibrium along vertical direction

$$\Sigma F_y = 0$$

$$A_y + F_y - 40 - 50 = 0$$

$$A_y + 57.5 - 40 - 50 = 0$$

$$A_y = 32.5 \text{ kN}$$

$$\Sigma F_x = 0$$

$$A_x - 40 - 30 = 0$$

$$A_x = 70 \text{ kN}$$

Apply moment equilibrium about Joint E.

$$\Sigma M_E = 0.$$

$$-57.5(2) + F_{GH}(1.5) = 0$$

$$F_{GH} = 76.7 \text{ kN (T)}$$

for Joint H.

$$\Sigma M_H = 0$$

$$-57.5(2+2) + 40(2) - F_{ED}(1.5) = 0$$

$$F_{ED} = -100 \text{ kN (C)}$$

$$\Sigma F_y = 0$$

$$57.5 - F_{EH}\left(\frac{3}{\sqrt{3^2+4^2}}\right) - 40 = 0$$

$$F_{EH} = 29.2 \text{ kN (T)}$$

Q3

In the first figure (left one)

A B is zero force member

There is no zero force member for the second figure