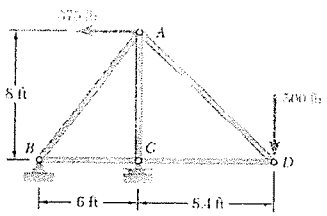


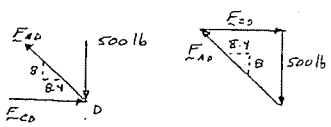
PROBLEM 6.4

Using the method of joints, determine the force in each member of the truss shown. State whether each member is in tension or compression.

SOLUTION

Joint FBDs:

Joint *D*:

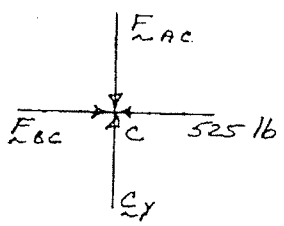


$$\frac{F_{CD}}{8.4} = \frac{F_{AD}}{11.6} = \frac{500 \text{ lb}}{8}$$

$F_{AD} = 725$ lb T ◀

$F_{CD} = 525$ lb C ◀

Joint *C*:

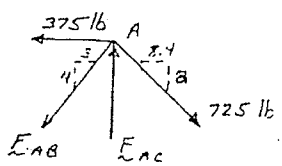


$\rightarrow \Sigma F_x = 0$: $F_{BC} - 525 \text{ lb} = 0$

$F_{BC} = 525$ lb C ◀

This is apparent by inspection, as is $F_{AC} = C_y$.

Joint *A*:

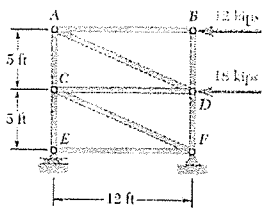


$\rightarrow \Sigma F_x = 0$: $\frac{8.4}{11.6}(725 \text{ lb}) - \frac{3}{5} F_{AB} - 375 \text{ lb} = 0$

$F_{AB} = 250$ lb T ◀

$+\uparrow \Sigma F_y = 0$: $F_{AC} - \frac{4}{5}(250 \text{ lb}) - \frac{8}{11.6}(725 \text{ lb}) = 0$

$F_{AC} = 700$ lb C ◀



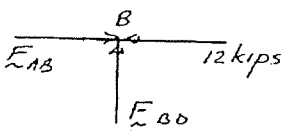
PROBLEM 6.8

Using the method of joints, determine the force in each member of the truss shown. State whether each member is in tension or compression.

SOLUTION

Joint FBDs:

Joint *B*:

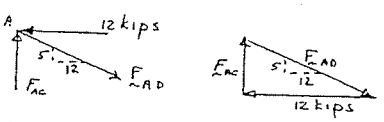


By inspection:

$F_{AB} = 12.00$ kips C ◀

$F_{BD} = 0$ ◀

Joint *A*:

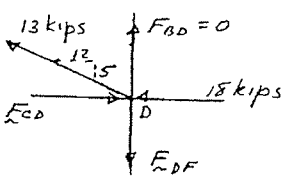


$$\frac{F_{AC}}{5} = \frac{F_{AD}}{13} = \frac{12 \text{ kips}}{12}$$

$F_{AC} = 5.00$ kips C ◀

$F_{AD} = 13.00$ kips T ◀

Joint *D*:



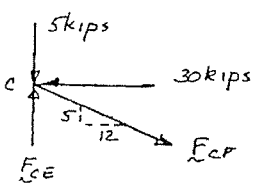
$$\rightarrow \Sigma F_x = 0: \quad F_{CD} - \frac{12}{13}(13 \text{ kips}) - 18 \text{ kips} = 0$$

$F_{CD} = 30.0$ kips C ◀

$$\uparrow \Sigma F_y = 0: \quad \frac{5}{13}(13 \text{ kips}) - F_{DF} = 0$$

$F_{DF} = 5.00$ kips T ◀

Joint *C*:



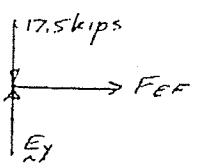
$$\rightarrow \Sigma F_x = 0: \quad 30 \text{ kips} - \frac{12}{13} F_{CF} = 0$$

$F_{CF} = 32.5$ kips T ◀

$$\uparrow \Sigma F_y = 0: \quad F_{CE} - 5 \text{ kips} - \frac{5}{13}(32.5 \text{ kips})$$

$F_{CE} = 17.50$ kips C ◀

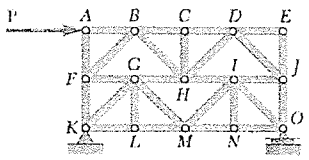
Joint *E*:



by inspection:

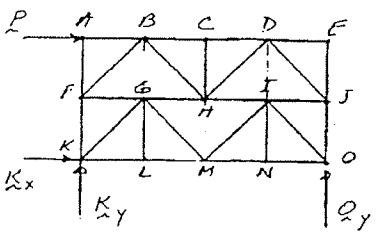
$F_{CF} = 0$ ◀

PROBLEM 6.34



For the given loading, determine the zero-force members in the truss shown.

SOLUTION



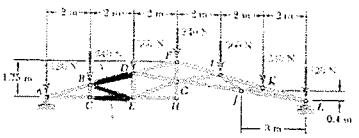
By inspection of joint A: $F_{AF} = 0$ ◀

By inspection of joint C: $F_{CH} = 0$ ◀

By inspection of joint E: $F_{DE} = F_{EI} = 0$ ◀

By inspection of joint L: $F_{GL} = 0$ ◀

By inspection of joint N: $F_{IN} = 0$ ◀

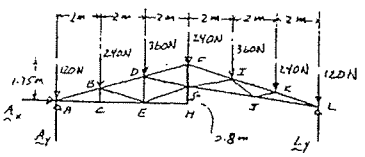


PROBLEM 6.44

A valuted roof truss is loaded as shown. Determine the force in members *BD*, *BE*, and *CE*.

SOLUTION

FBD Truss:



$\rightarrow \Sigma F_x = 0$: $\quad \mathbf{A}_x = 0$

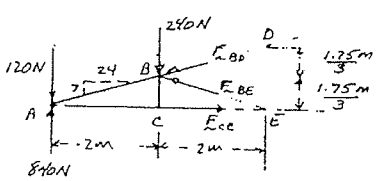
By load symmetry:

$$\mathbf{A}_y = \mathbf{L}_y = 840 \text{ N} \uparrow$$

$\circlearrowleft \Sigma M_E = 0$: $\quad \frac{2}{3}(1.75 \text{ m})\frac{24}{25}F_{BD} + (2 \text{ m})(240 \text{ N}) - (4 \text{ m})(840 \text{ N} - 120 \text{ N}) = 0$

$$F_{BD} = \frac{15000}{7} \text{ N}, \qquad F_{BD} = 2.14 \text{ kN C} \blacktriangleleft$$

FBD Section *ABC*:

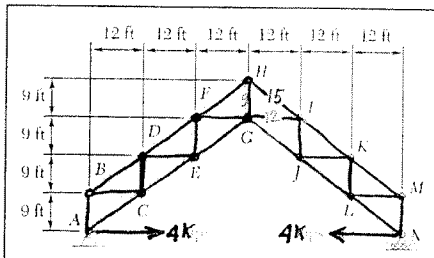


$\circlearrowleft \Sigma M_B = 0$: $\quad \left(\frac{1.75}{3} \text{ m}\right)F_{CE} - (2 \text{ m})(840 \text{ N} - 120 \text{ N}) = 0$

$$F_{CE} = \frac{17280}{7} \text{ N}, \qquad F_{CE} = 2.47 \text{ kN T} \blacktriangleleft$$

$\circlearrowleft \Sigma M_A = 0$: $\quad (4 \text{ m})\left(\frac{7}{25}F_{BE}\right) - (2 \text{ m})(240 \text{ N}) = 0$

$$F_{BE} = \frac{3000}{7} \text{ N}, \qquad F_{BE} = 429 \text{ N C} \blacktriangleleft$$

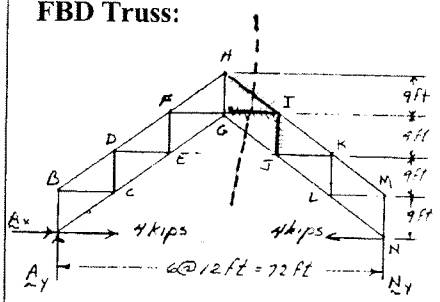


PROBLEM 6.53

A roof truss is loaded as shown. Determine the force in members *GI*, *HI*, and *IJ*.

SOLUTION

FBD Truss:

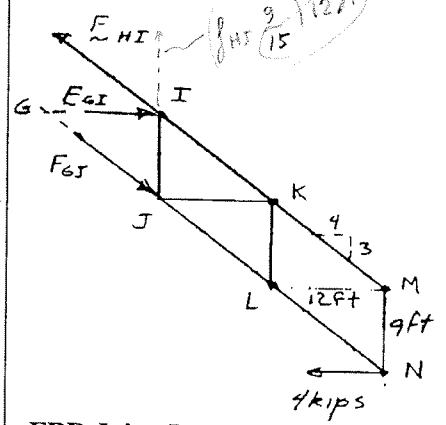


$\rightarrow \Sigma F_x = 0$: $\quad \mathbf{A}_x + 4 \text{ kips} - 4 \text{ kips} = 0$

$$\mathbf{A}_x = 0$$

By symmetry, $\quad \mathbf{A}_y = \mathbf{N}_y = 0$

FBD Section *IJNM*:



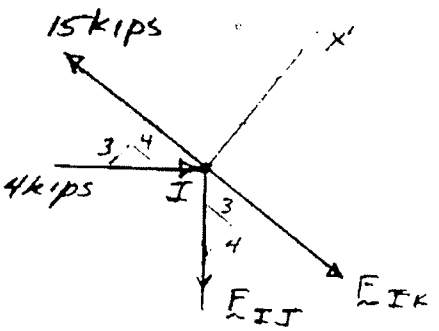
$\circlearrowleft \Sigma M_G = 0$: $\quad -(27 \text{ ft})(4 \text{ kips}) + (9 \text{ ft})\frac{4}{5}F_{HI} = 0$

$$F_{HI} = 15.00 \text{ kips T} \blacktriangleleft$$

$\circlearrowleft \Sigma M_N = 0$: $\quad (9 \text{ ft})\frac{4}{5}(15 \text{ kips}) - (27 \text{ ft})F_{GI} = 0$

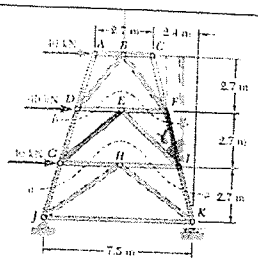
$$F_{GI} = 4.00 \text{ kips C} \blacktriangleleft$$

FBD Joint *I*:



$\nearrow \Sigma F_x = 0$: $\quad \frac{3}{5}(4 \text{ kips}) - \frac{4}{5}F_{IJ} = 0$

$$F_{IJ} = 3.00 \text{ kips T} \blacktriangleleft$$



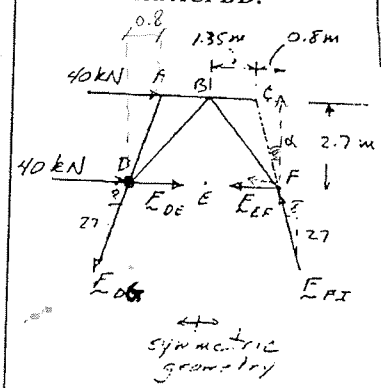
PROBLEM 6.63

Determine the force in members *FI* and *EG* of the truss shown. (*Hint*: Use section *bb*.)

SOLUTION

$FC = \sqrt{(2.7)^2 + (0.8)^2} = 2.82 = \sqrt{7.93}$

FBD Section *ACFBD*:



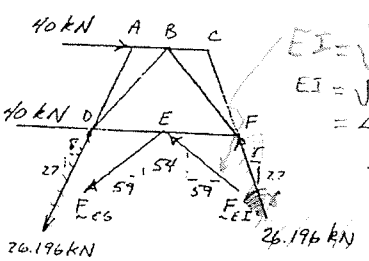
$\zeta \Sigma M_D = 0$: $(4.3\text{ m})\frac{2.7}{\sqrt{7.93}}F_{FI} - (2.7\text{ m})(40\text{ kN}) = 0$

$F_{FI} = 26.196\text{ kN},$ $\quad F_{FI} = 26.2\text{ kN C}$ ◀

$\uparrow \Sigma F_y = 0$: $\frac{2.7}{\sqrt{7.93}}(26.196\text{ kN} - F_{DG}) = 0$

$F_{DG} = 26.196\text{ kN T}$

FBD Section *ACFD*:



$EI = \sqrt{(2.7)^2 + (2.95)^2}$

$EI = \sqrt{7.29 + 8.70} = 4$

$\uparrow \Sigma F_y = 0$: $\frac{2.7}{\sqrt{7.93}}(26.196\text{ kN} - 26.196\text{ kN})$

$+\frac{54}{\sqrt{6397}}(F_{EI} - F_{EG}) = 0, \quad F_{EI} = F_{EG}$

$\rightarrow \Sigma F_x = 0$: $-2\frac{59}{\sqrt{6397}}(F_{EG}) + 2(40\text{ kN})$

$-\frac{8}{\sqrt{793}}(26.196\text{ kN} + 26.196\text{ kN}) = 0$

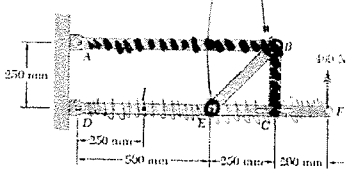
$F_{EG} = 44.136\text{ kN},$ $\quad F_{EG} = 44.1\text{ kN T}$ ◀

$(F_{EI})_y = (F_{EI})\left[\cos\theta = \frac{2.7}{4}\right]$

Hinges

PROBLEM 6.78

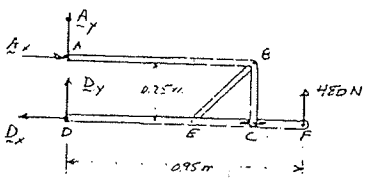
OK



For the frame and loading shown, determine the components of all forces acting on member *DECF*.

SOLUTION

FBD Frame:



$$\circlearrowleft \Sigma M_A = 0: \quad (0.25\text{ m})D_x - (0.95\text{ m})(480\text{ N}) = 0$$

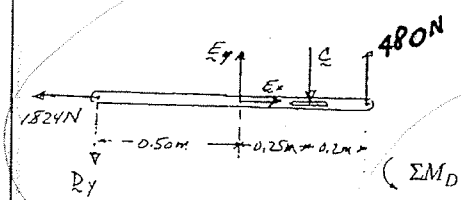
$$\mathbf{D}_x = 1824\text{ N} \leftarrow \blacktriangleleft$$

FBD member *DF*:

Note that *BE* is a two-force member, $E_x = E_y$ (because 45°)

$$\rightarrow \Sigma F_x = 0: \quad -1824\text{ N} + E_x = 0, \qquad \mathbf{E}_x = 1824\text{ N} \rightarrow \blacktriangleleft$$

so $\mathbf{E}_y = 1824\text{ N} \uparrow \blacktriangleleft$

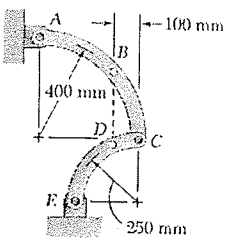


$$\circlearrowleft \Sigma M_D = 0: \quad (0.50\text{ m})(1824\text{ N}) - (0.75\text{ m})C + (0.95\text{ m})(480\text{ N}) = 0$$

$$\mathbf{C} = 1824\text{ N} \downarrow \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0: \quad -D_y + 1824\text{ N} - 1824\text{ N} + 480\text{ N} = 0$$

$$\mathbf{D}_y = 480\text{ N} \downarrow \blacktriangleleft$$



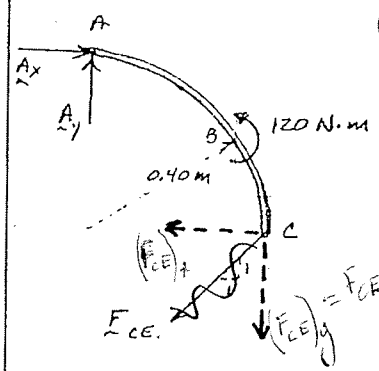
PROBLEM 6.87 (OK)

Determine the components of the reactions at A and E when a counterclockwise couple of magnitude 120 N·m is applied to the frame (*a*) at B, (*b*) at D.

SOLUTION

(*a*) **FBD *AC*:**

Note: *CE* is a two-force member



$$\left(+\right) \Sigma M_A = 0: \quad 120 \text{ N·m} - (0.4 \text{ m})\left(\frac{2}{\sqrt{2}} F_{CE}\right) = 0,$$

$$F_{CE} = 150\sqrt{2} \text{ N}$$

$$\rightarrow \Sigma F_x = 0: \quad A_x - 150.0 \text{ N} = 0, \qquad \mathbf{A}_x = 150.0 \text{ N} \rightarrow$$

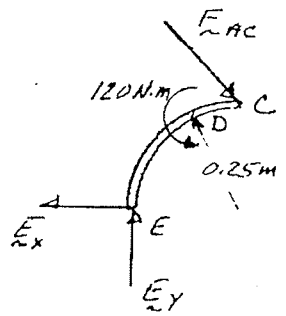
$$\uparrow \Sigma F_y = 0: \quad A_y - 150.0 \text{ N} = 0, \qquad \mathbf{A}_y = 150.0 \text{ N} \uparrow$$

$$\mathbf{E}_x = 150.0 \text{ N} \leftarrow$$

$$\mathbf{E}_y = 150.0 \text{ N} \downarrow$$

(*b*) **FBD *CE*:**

Note: *AC* is a two-force member



$$\left(+\right) \Sigma M_E = 0: \quad -(0.25 \text{ m})\left(\frac{2}{\sqrt{2}} F_{AC}\right) + 120 \text{ N·m} = 0$$

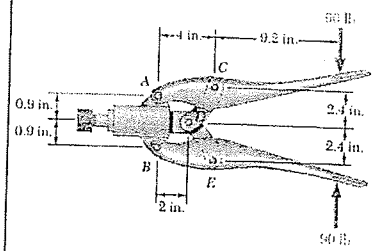
$$F_{AC} = 240\sqrt{2} \text{ N},$$

$$\rightarrow \Sigma F_x = 0: \quad 240 \text{ N} - E_x = 0, \qquad \mathbf{E}_x = 240 \text{ N} \leftarrow$$

$$\uparrow \Sigma F_y = 0: \quad E_y - 240 \text{ N} = 0, \qquad \mathbf{E}_y = 240 \text{ N} \uparrow$$

$$\mathbf{A}_x = 240 \text{ N} \rightarrow$$

$$\mathbf{A}_y = 240 \text{ N} \downarrow$$

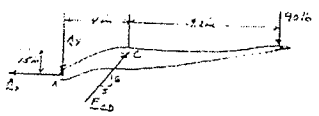


PROBLEM 6.139

A hand-operated hydraulic cylinder has been designed for use where space is severely limited. Determine the magnitude of the force exerted on the piston at D when two 90-lb forces are applied as shown.

SOLUTION

FBD top handle:



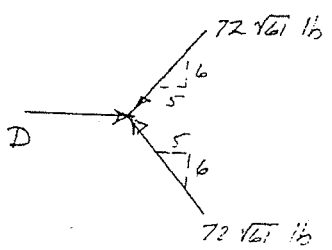
Note CD and DE are two-force members

$$\left(\Sigma M_A = 0: \quad (4\text{ in.})\frac{6}{\sqrt{61}}F_{CD} - (1.5\text{ in.})\frac{5}{\sqrt{61}}F_{CD} - (13.2\text{ in.})(90\text{ lb}) = 0\right.$$

$$F_{CD} = 72\sqrt{61}\text{ lb}$$

By symmetry: $F_{DE} = F_{CD} = 72\sqrt{61}\text{ lb}$

FBD Joint D:



$$\rightarrow \Sigma F_x = 0: \quad D - 2\frac{5}{\sqrt{61}}\left(72\sqrt{61}\text{ lb}\right) = 0, \qquad D = 720\text{ lb} \blacktriangleleft$$