Problem 6.2

6.1 through 6.18 Using the method of joints, determine the force in each member of the truss shown. State whether each member is in tension or compression.

**AB** = \( \sqrt{3^2 + 1.25^2} = 3.25 \text{ m} \)
**BC** = \( \sqrt{3^2 + 4^2} = 5 \text{ m} \)

**REACTIONS:**

\( \Sigma M_A = 0 \)
\((84 \text{ kN})(3m) + C(5.25m) = 0 \)
\( C = 48 \text{ kN} \)

\( \Sigma F_x = 0; \ A_x - C = 0 \)
\( A_x = 48 \text{ kN} \)

\( \Sigma F_y = 0; \ A_y = 84 \text{ kN} \)
\( A_y = 84 \text{ kN} \)

**JOINT A:**

\( F_{AB} \)

\( \Sigma F_x = 0; \ 48 \text{ kN} - \frac{12}{13} F_{AB} = 0 \)
\( F_{AB} = +52 \text{ kN} \)

\( \Sigma F_y = 0; \ 84 \text{ kN} - \frac{5}{13} (52 \text{ kN}) - F_{AC} = 0 \)
\( F_{AC} = +64 \text{ kN} \)

**JOINT C:**

\( F_{AC} \)

\( \Sigma F_x = 0; \ \frac{3}{5} F_{AC} = \frac{48 \text{ kN}}{3} \)
\( F_{AC} = 80 \text{ kN} \)

\( \Sigma F_y = 0; \ C = 48 \text{ kN} \)
6.1 through 6.18 Using the method of joints, determine the force in each member of the truss shown. State whether each member is in tension or compression.

**Joint C:**
- \( E_{CA} \)
- \( E_{CD} \)
- \( E_{CD} = \frac{2 \, kN}{5} = \frac{E_{CA}}{13} = \frac{F_{ED}}{12} \)
- \( F_{CA} = 5.20 \, kN \) T
- \( F_{CD} = 4.80 \, kN \) C

**Joint A:**
- \( F_{AB} \)
- \( F_{AB} = \frac{2 \, kN}{13} \)
- \( F_{AD} = +4.80 \, kN \)
- \( F_{AD} = 4.80 \, kN \) T

**Joint B:**
- \( F_{BD} \)
- \( F_{BD} = \frac{2 \, kN}{13} \)
- \( F_{BD} = 5.20 \, kN \) C
6.1 through 6.18 Using the method of joints, determine the force in each member of the truss shown. State whether each member is in tension or compression.

**Entire Truss**

\[ \sum M_A = 0: \quad C(0.9\text{ m}) - (6\text{kN})(1.2\text{ m}) - (6\text{kN})(2.4\text{ m}) = 0 \]

\[ C = 16\text{kN} \quad C \rightarrow \text{ tension} \]

\[ \sum F_y = 0: \quad A_y - 6\text{kN} - 3\text{kN} = 0 \quad A_y = 9\text{kN} \]

\[ \sum F_x = 0: \quad A_x + 16\text{kN} = 0 \quad A_x = -16\text{kN} \quad A_x \rightarrow \text{ compression} \]

**Joint E:**

\[ F_{BE} = 3\text{kN} \]

\[ F_{DE} = 4\text{kN} \]

\[ F_{BE} = 3\text{kN} \quad F_{DE} = 4\text{kN} \]

**Joint B:**

\[ \sum F_y = 0: \quad \frac{4}{5}(5\text{kN}) - F_{AB} = 0 \quad F_{AB} = 4\text{kN} \quad F_{AB} \rightarrow \text{ tension} \]

\[ \sum F_x = 0: \quad -6\text{kN} - \frac{3}{5}(5\text{kN}) - F_{BD} = 0 \quad F_{BD} = 9\text{kN} \quad F_{BD} \rightarrow \text{ compression} \]

**Joint D:**

\[ F_{AD} = 9\text{kN} \]

\[ F_{BD} = 4\text{kN} \]

\[ F_{AD} = 15\text{kN} \quad F_{AD} \rightarrow \text{ tension} \]

\[ \sum F_y = 0: \quad -9\text{kN} + \frac{3}{5}F_{AD} = 0 \quad F_{AD} = 15\text{kN} \quad F_{AD} \rightarrow \text{ tension} \]

\[ \sum F_x = 0: \quad -4\text{kN} - \frac{4}{5}(15\text{kN}) - F_{CO} = 0 \quad F_{CO} = 16\text{kN} \quad F_{CO} \rightarrow \text{ compression} \]
6.25 Determine the force in members BD and CD of the truss shown.

**Reactions:** (From Free Body of Entire Truss)
\[ A = 27 \text{ kips} \uparrow \]
\[ H = 4.5 \text{ kips} \uparrow \]

\[ A = 27 \text{ kips} \]

**Member BD:**
\[ +) \Sigma M_C = 0: \quad -(27 \text{ kips})(10 \text{ ft}) - F_{BD}(7.5 \text{ ft}) = 0 \]
\[ F_{BD} = -36 \text{ kips} \quad F_{BD} = 36 \text{ kips} \downarrow \]

**Member CD:**
\[ +) \Sigma F_y = 0: \quad 27 \text{ kips} + \frac{3}{5} F_{CD} = 0 \]
\[ F_{CD} = -45 \text{ kips} \quad F_{CD} = 45 \text{ kips} \downarrow \]

6.26 Determine the force in members DF and DG of the truss shown.

**Reactions:** (From Free Body of Entire Truss)
\[ A = 27 \text{ kips} \uparrow \]
\[ H = 4.5 \text{ kips} \uparrow \]

**Member DF:**
\[ +) \Sigma M_C = 0: \quad (45 \text{ kips})(10 \text{ ft}) + F_{DF}(7.5 \text{ ft}) = 0 \]
\[ F_{DF} = -60 \text{ kips} \quad F_{DF} = 60 \text{ kips} \downarrow \]

**Member DG:**
\[ +) \Sigma F_y = 0: \quad 45 \text{ kips} - 30 \text{ kips} + \frac{3}{5} F_{DG} = 0 \]
\[ F_{DG} = -15 \text{ kips} \quad F_{DG} = 15 \text{ kips} \downarrow \]
6.27 Determine the force in members $FG$ and $FH$ of the truss shown when $P = 35 \text{kN}$.

MEMBER $FG$:

$$+\sum M_A = 0:$$

$$-P(4\text{ m}) - P(8\text{ m}) - P(12\text{ m}) - F_{FG}(12\text{ m}) = 0$$

$$F_{FG} = -2P$$

For $P = 35\text{kN}$, $F_{FG} = -70\text{kN}$

MEMBER $FH$:

$$+\sum M_C = 0:$$

$$P(12\text{ m}) + P(8\text{ m}) + P(4\text{ m}) - F_{FH}(3.5\text{ m}) = 0$$

$$F_{FH} = \frac{24}{3.5}P$$

For $P = 35\text{kN}$, $F_{FH} = \frac{24}{3.5}(35\text{kN}) = +240\text{kN}$

6.28 Determine the force in members $EF$ and $EG$ of the truss shown when $P = 35 \text{kN}$.

MEMBER $EF$:

$$+\sum M_A = 0:$$

$$-P(4\text{ m}) - P(8\text{ m}) + (F_{EF} \sin 20.26^\circ)(12\text{ m}) = 0$$

$$F_{EF} = 1.9846P$$

For $P = 35\text{kN}$, $F_{EF} = 1.9846(35) = +69.4\text{kN}$

MEMBER $EG$:

$$+\sum M_E = 0:$$

$$P(12\text{ m}) + P(8\text{ m}) + P(4\text{ m}) + \frac{24}{26}F_{EG}(3.5\text{ m}) = 0$$

$$F_{EG} = -7.143P$$

For $P = 35\text{kN}$, $F_{EG} = -7.143(35) = -250\text{kN}$
6.33 Determine the force in members BD and DE of the truss shown.

\[ \text{MEMBER BD:} \]
\[ +\sum M_e = 0: \]
\[ - (15 KN)(6 m) - (15 KN)(3 m) + \frac{4}{5} F_{BD}(4.5 m) = 0 \]
\[ F_{BD} = 37.5 KN \]
\[ F_{BD} = 37.5 KN T \]

\[ \text{MEMBER DE:} \]
\[ +\sum M_e = 0: \]
\[ (15 KN)(3 m) + (15 KN)(6 m) - F_{ED}(6 m) = 0 \]
\[ F_{ED} = -22.5 KN \]
\[ F_{ED} = 22.5 KN T \]

6.34 Determine the force in members FH and DH of the truss shown.

\[ \text{MEMBER FH (Section b-b)}: \]
\[ +\sum M = 0: \]
\[ -(15 KN)(3 m) + \frac{4}{5} F_{FH}(4.5 m) = 0 \]
\[ F_{FH} = 12.5 KN \]
\[ F_{FH} = 12.5 KN T \]

\[ \text{MEMBER DH (Section a-a)}: \]
\[ +\sum M = 0: \]
\[ (15 KN)(12 m) - (15 KN)(9 m) + F_{DH}(4.5 m) = 0 \]
\[ F_{DH} = 10 KN \]
\[ F_{DH} = 90 KN T \]
Problem 6.49

6.49 through 6.51 Determine the force in member BD and the components of the reaction at C.

Free Body: ABC

\[ \sum M_C = 0: \quad (350N)(0.100m) + \frac{3}{5} F_{BD}(0.050m) = 0 \]
\[ F_{BD} = -1750N \quad F = 1750N \quad C \uparrow \]

\[ \sum F_x = 0: \quad -\frac{4}{5} F_{BD} + C_x = 0 \]
\[ -\frac{4}{5}(-1750N) + C_x = 0 \]
\[ C_x = 1400N \quad C_x = 1400N \downarrow \]

\[ \sum M_B = 0: \quad (350N)(0.100m) + C_y(0.050m) = 0 \]
\[ C_y = -700N \quad C_y = 700N \downarrow \]

6.49 through 6.51 Determine the force in member BD and the components of the reaction at C.

Free Body: ABC

\[ \sum M_C = 0: \quad (90lb)(12in.)/3 F_{BD}(4.5in.) = 0 \]
\[ F_{BD} + 300lb \quad F_{BD} = 300lb \uparrow \]

\[ \sum F_y = 0: \quad -\frac{3}{5} F_{BD} + C_y = 0 \]
\[ -\frac{3}{5}(300lb) + C_y = 0 \]
\[ C_y = 180lb \quad C_y = 180lb \uparrow \]

\[ \sum M_B = 0: \quad (90lb)(7.5in.) + C_x(4.5in.) = 0 \]
\[ C_x = -150lb \quad C_x = 150lb \downarrow \]
Problem 6.52

6.52 Determine the components of all forces acting on member A B C D of the assembly shown.

**Free Body: Entire Assembly**

\[ \sum M_B = 0: \quad D(6 \text{ in.}) - (120 \text{ lb})(4 \text{ in.}) = C \quad D = 80 \text{ lb} \uparrow \]

\[ \sum F_x = 0: \quad B_x + 120 \text{ lb} = 0 \quad B_x = 120 \text{ lb} \rightarrow \]

\[ \sum F_y = 0: \quad B_y + 80 \text{ lb} = 0 \quad B_y = 80 \text{ lb} \downarrow \]

**Free Body: Member A B C D**

\[ \sum M_A = 0: \quad (80 \text{ lb})(10 \text{ in.}) - (120 \text{ lb})(2 \text{ in.}) - (80 \text{ lb})(4 \text{ in.}) - C(8 \text{ in.}) = 0 \]

\[ C = +30 \text{ lb} \quad C = 30 \text{ lb} \downarrow \]

\[ \sum F_x = 0: \quad A_x - 120 \text{ lb} = 0 \quad A_x = 120 \text{ lb} \rightarrow \]

\[ \sum F_y = 0: \quad A_y - 80 \text{ lb} + 80 \text{ lb} - 30 \text{ lb} = 0 \quad A_y = 30 \text{ lb} \uparrow \]
Problem 6.60

Determine the components of the force exerted at B on member BE (a) if the 200-lb load is applied as shown, (b) if the 200-lb load is moved along its line of action and is applied at point F.

(a)

**Reactions**

\[ A_y = E_y = 100\, \text{lb} \uparrow \]

**Member BE:**

\[ B_x = 100\, \text{lb} \downarrow \]
\[ E_x = 250\, \text{lb} \rightarrow \]

\[ +\sum F_y = 0: -E_y + 100\, \text{lb} = 0 \]
\[ +\sum M_F = 0: -B_x(4\, \text{in}) + 200(5\, \text{in}) = 0 \]

(b)

**Reactions**

\[ A_y = E_y = 100\, \text{lb} \uparrow \]

**Member BE:**

\[ B_x = 100\, \text{lb} \uparrow \]
\[ E_x = 0 \]

\[ +\sum F_y = 0: B_x - 200\, \text{lb} + 100\, \text{lb} = 0 \]
\[ +\sum M_E = 0: -B_x(4\, \text{in}) + 200(5\, \text{in}) = 0 \]

**Comment:** The answers are not the same in parts (a) and (b).

We observe that the principle of transmissibility is valid only if a force is moved along its line of action and attached to another point on the same rigid body.
6.85 Two 300-N forces are applied to the handles of the pliers as shown. Determine (a) the magnitude of the forces exerted on the rod, (b) the force exerted by the pin at A on portion AB of the pliers.

(a) \( \sum M_A = 0 \):
\[ -300 \times 0.25 + Q \times 0.03 = 0 \]
\[ Q = 2500 \text{ N} \]

(b) \( \sum F_x = 0 \):
\[ A_x - (2500 \cos 60^\circ) = 0 \]
\[ A_x = 1250 \text{ N} \]
\[ A := \begin{cases} A_x = 1250 \text{ N} \end{cases} \]

\[ \sum F_y = 0 \):
\[ -300 + (2500 \sin 60^\circ) = 0 \]
\[ A_y = 2465 \text{ N} \]
\[ A := \begin{cases} A_y = 2465 \text{ N} \end{cases} \]

\[ A := \begin{cases} 2465 \text{ N} \end{cases} \]

A = 2760 \text{ N} \angle 63.1^\circ