Given: Force-couple system I shown below left is made up of four forces $F_1$, $F_2$, $F_3$ and $F$ acting at points A, B, C and D, respectively, in addition to a couple $M$. Force $F$ and couple $M$ are known to have magnitudes of 200 lb and 900 ft-lb, respectively.

Force-couple system II shown below right is made up of a force $R$ at B and a couple $M_B$, with $R$ and $M_B$ having known magnitudes of 300 lb and 600 ft-lb, respectively.

Find: If System II is to be the equivalent force-couple of System I, what are the magnitudes of the forces $F_1$, $F_2$ and $F_3$?

For System I:

\[
\begin{align*}
\sum F_x & = F - F_1 = 200 - F_1 \\
\sum F_y & = F_3 - F_2 \\
\sum M_B & = 2F_1 + 4F_3 + 2F - M \\
& = 2F_1 + 4F_3 + 2(200) - 900 = 2F_1 + 4F_3 - 500
\end{align*}
\]
For System II:

\[
(\sum F_x)_{II} = R \cos 53.13^\circ = (300)(0.6) = 180 \\
(\sum F_y)_{II} = R \sin 53.13^\circ = (300)(0.8) = 240 \\
(\sum M_B)_{II} = M_B = 600
\]

Making System I equivalent to System II

\[
(\sum F_x)_I = (\sum F_x)_{II} \implies 200 - F_1 = 180 \implies F_1 = 20 \text{ lb}
\]

\[
(\sum M_B)_I = (\sum M_B)_{II} \implies 2F_1 + 4F_3 - 500 = 600 \implies \\
F_3 = \frac{1100 - 2F_1}{4} = \frac{1100 - 2(20)}{4} = 265 \text{ lb}
\]

\[
(\sum F_y)_I = (\sum F_y)_{II} \implies F_3 - F_2 = 240 \implies F_2 = F_3 - 240 = 25 \text{ lb}
\]
Given: Pole OE is supported by a ball-and-socket joint at O and cables AC and BE. A downward vertical force $F$ acts at end E. Consider the weight of the pole to be negligible and the ball-and-socket joint at D to be frictionless.

Find:

a) Complete the free body diagram of the pole given below right.

b) Resolve the forces of cables AC and BE on the pole in terms of their unknown magnitudes and known unit vectors.

c) If $F = 1000$ lb, find the tension in cables AC and BE.

Forces on pole due to cables:

\[
\begin{align*}
F_{AC} &= F_{AC} \frac{r_{A/C}}{|r_{A/C}|} = F_{AC} \left( \frac{3i - 1.5j + 4k}{\sqrt{3^2 + 1.5^2 + 4^2}} \right) = F_{AC} (0.5747i - 0.2873j + 0.7663k) \\
F_{BE} &= F_{BE} \frac{r_{B/E}}{|r_{B/E}|} = F_{BE} \left( \frac{-3i - 3j + 2k}{\sqrt{3^2 + 3^2 + 2^2}} \right) = F_{BE} (-0.6396i - 0.6396j + 0.4264k)
\end{align*}
\]

Using FBD above:
\[ \sum M_O = l_{C/O} \times F_{AC} + l_{E/O} \times F_{BE} + l_{E/O} \times (-F_k) = 0 \]

where

\[ l_{C/O} \times F_{AC} = \begin{bmatrix} i & j & k \\ 0 & 1.5 & 0 \\ 0.5747F_{AC} & -0.2873F_{AC} & 0.7663F_{AC} \end{bmatrix} = 1.1495F_{AC} i - 0.8621F_{AC} k \]

\[ l_{E/O} \times F_{BE} = \begin{bmatrix} i & j & k \\ 0 & 3 & 0 \\ -0.6396F_{BE} & -0.6396F_{BE} & 0.4264F_{BE} \end{bmatrix} = 1.2792F_{BE} i + 1.9188F_{BE} k \]

\[ l_{E/O} \times F_{BE} = \begin{bmatrix} i & j & k \\ 0 & 3 & 0 \\ 0 & -1000 \end{bmatrix} = -3000i \]

Therefore,

\[(1.1495F_{AC} + 1.2792F_{BE} - 3000)i + (-0.8621F_{AC} + 1.9188F_{BE})k = 0\]

Balancing coefficients:

\[ i : \quad 1.1495F_{AC} + 1.2792F_{BE} - 3000 = 0 \]

\[ k : \quad -0.8621F_{AC} + 1.9188F_{BE} = 0 \quad \Rightarrow \quad F_{BE} = \frac{0.8621}{1.9188}F_{AC} = 0.4493F_{AC} \]

Therefore,

\[ 1.1495F_{AC} + 1.2792(0.4493F_{AC}) - 3000 = 0 \quad \Rightarrow \]

\[ F_{AC} = \frac{3000}{1.1495 + (1.2792)(0.4493)} = 1740 \text{ lb} \]

\[ F_{BE} = 0.4493F_{AC} = (0.4493)(1740) = 772.8 \text{ lb} \]
Given: The truss shown below supports the applied loads at joints A, G and I.

Find: Determine the load carried by members DE, DK and DJ. State whether these members are in tension or in compression.

Note: A free body diagram must accompany each equilibrium equation used in your analysis.

Make cut through DE, DK and JK, as shown above, and keep left hand side of the cut:

\[ \sum M_K = (6)(10) + (12)(10) + (4)(20) - (4)F_{DE} = 0 \quad \Rightarrow \quad F_{DE} = 65 \text{ kN (tension)} \]

\[ \sum F_y = -10 - 10 - F_{DK} \sin 53.13^\circ = 0 \quad \Rightarrow \quad F_{DK} = -25 \text{ kN (compression)} \]

FBD of pin D:

\[ \sum F_y = -F_{DJ} - F_{DK} \sin 53.13^\circ = 0 \quad \Rightarrow \quad F_{DJ} = -F_{DK} \sin 53.13^\circ = -(-25)(0.8) = 20 \text{ kN (tension)} \]