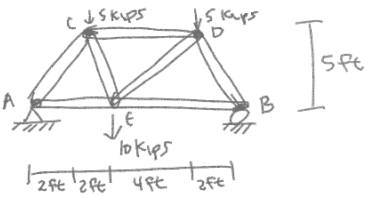
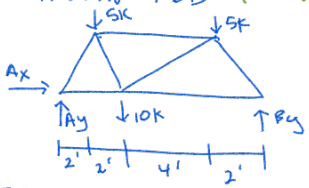
Statics
Trusses
Example #1

Using method of joints and method of sections to solve for the reactions and the force in each member of the following trusses. Indicate whether each member is in tension or compression.

a)



STEP #1: DRAW FBD (THIS IS THE SAME FOR BOTH METHODS)



STEP #2: FIND REACTIONS (THIS IS THE SAME FOR BOTH METHODS)

$\Sigma M_A = 0 \curvearrowright +$

$5K[2ft] + 10K[4ft] + 5K[8ft] - B_y[10ft] = 0$ → TIP: PUT YOUR MOMENT ARMS IN BRACKETS [] RATHER THAN PARENTHESES ( ). THIS WAY, YOU CAN QUICKLY LOOK AT AN EQUATION & KNOW YOU HAVEN'T FORGOTTEN A MOMENT ARM.

$B_y = \frac{5K(2ft) + 10K[4ft] + 5K[8ft]}{10\ ft}$

$= 9$ Kips

$\Sigma F_x = 0 \rightarrow +$

$A_x = 0$

$\Sigma F_y = 0 \uparrow +$

$A_y - 5K - 10K - 5K + B_y = 0$

$A_y - 5K - 10K - 5K + 9K = 0$

$A_y = 5K + 10K + 5K - 9K$

$= 11$ Kips

METHOD OF JOINTS:

- FBD EACH JOINT & SOLVE FOR UNKNOWNS

TIP: START WITH A JOINT THAT HAS THE FEWEST MEMBERS & HAS A KNOWN REACTION.

JOINT A:

→ YOU KNOW HAVE A PARTICLE IN EQUILIBRIUM. SOLVE FOR UNKNOWNS HAVE YOU DONE IN THE PAST

→ DRAW ALL UNKNOWN FORCES IN TENSION (AWAY FROM THE JOINT) THIS WAY, IF YOUR ANSER IS NEGATIVE, THE MEMBER IS IN COMPRESSION

$\Sigma F_y = 0 \uparrow +$

$11K + F_{AC_y} = 0$

$11K + F_{AC}\left(\frac{5}{5.38}\right) = 0$

$F_{AC} = -11\left(\frac{5.38}{5}\right)$

$= -11.8$ Kips

$F_{AC} = 11.8$ Kips (COMPRESSION)

$\Sigma F_x = 0 \rightarrow +$

$F_{AC_x} + F_{AE} + A_x = 0$

$F_{AC}\left(\frac{2}{5.38}\right) + F_{AE} + 0 = 0$

$-11.8K\left(\frac{2}{5.38}\right) + F_{AE} = 0$

$F_{AE} = 11.8K\left(\frac{2}{5.38}\right) = 4.4$ Kips

$F_{AE} = 4.4$ Kips (TENSION)

JOINT B:

$\Sigma F_y = 0 \uparrow +$

$9K + F_{BD_y} = 0$

$9K + F_{BD}\left(\frac{5}{5.38}\right) = 0$

$F_{BD} = -9\left(\frac{5.38}{5}\right) = -9.7K$

$F_{BD} = 9.7$ KIPS (COMPRESSION)

$\Sigma F_x = 0 \xrightarrow{+}$

$-F_{BD_x} - F_{BE} = 0$

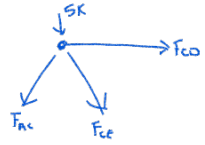
$-F_{BD}\left(\frac{2}{5.38}\right) - F_{BE} = 0$

$-(-9.7 \text{ KIPS})\left(\frac{2}{5.38}\right) - F_{BE} = 0$

$F_{BE} = 9.7 \text{ KIPS}\left(\frac{2}{5.38}\right) = 3.6 \text{ K}$

$F_{BE} = 3.6$ KIPS (TENSION)

JOINT C:



$\Sigma F_y = 0 \uparrow +$

$-5K - F_{AC_y} - F_{CE_y} = 0$

$-5K - F_{AC}\left(\frac{5}{5.38}\right) - F_{CE}\left(\frac{5}{5.38}\right) = 0$

$-5K - (-11.8K)\left(\frac{5}{5.38}\right) - F_{CE}\left(\frac{5}{5.38}\right) = 0$

$F_{CE} = \frac{-5K + 11.8K\left(\frac{5}{5.38}\right)}{5/5.38} = 6.4 \text{ KIPS}$

$F_{CE} = 6.4$ KIPS (TENSION)

$\Sigma F_x = 0 \xrightarrow{+}$

$F_{CD} - F_{AC_x} + F_{CE_x} = 0$

$F_{CD} - F_{AC}\left(\frac{2}{5.38}\right) + F_{CE}\left(\frac{2}{5.38}\right) = 0$

$F_{CD} - (-11.8K)\left(\frac{2}{5.38}\right) + 6.4K\left(\frac{2}{5.38}\right) = 0$

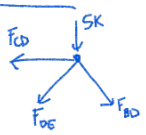
$F_{CD} + 4.4 \text{ KIPS} + 2.4 \text{ KIPS} = 0$

$F_{CD} = -4.4K - 2.4K$

$= -6.8 \text{ KIPS}$

$F_{CD} = 6.8$ KIPS (COMPRESSION)

JOINT D:



$\Sigma F_x = 0 \xrightarrow{+}$

$-F_{CD} - F_{CD_x} + F_{BD_x} = 0$

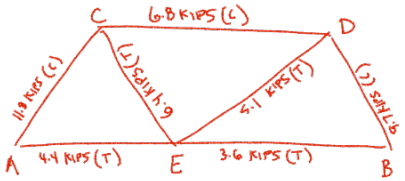
$-F_{CD} - F_{DE}\left(\frac{4}{6.4}\right) + F_{BD}\left(\frac{2}{5.38}\right) = 0$

$-(-6.8K) - F_{DE}\left(\frac{4}{6.4}\right) + (-9.7K)\left(\frac{2}{5.38}\right) = 0$

$6.8K - F_{DE}\left(4/6.4\right) - 3.6K = 0$

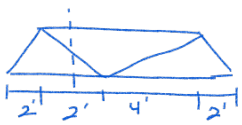
$F_{DE} = \frac{6.8K - 3.6K}{(4/6.4)} = 5.1 \text{ KIPS}$

$F_{DE} = 5.1$ KIPS TENSION



METHOD OF SECTIONS

CUT THE TRUSS AND SOLVE FOR THE FORCES IN THE UNKNOWN MEMBERS



$\Sigma M_C = 0 \curvearrowright +$

$11K[2Ft] - F_{AE}[5Ft] = 0$

$F_{AE} = \frac{22 \text{ K-Ft}}{5Ft} = 4.4 \text{ KIPS}$

$F_{AE} = 4.4$ KIPS (TENSION)

$\Sigma F_y = 0 \uparrow +$

$-5K + 11K - F_{CE_y} = 0$

$-5K + 11K - F_{CE}\left(5/5.38\right) = 0$

$F_{CE} = \frac{-5+11}{5/5.38} = 6.4 \text{ KIPS}$

$F_{CE} = 6.4$ KIPS (TENSION)

$\Sigma F_x = 0 \xrightarrow{+}$

$F_{CD} + F_{CE_x} + F_{AE} = 0$

$F_{CD} + F_{CE}\left(2/5.38\right) + F_{AE} = 0$

$F_{CD} + 6.4K\left(2/5.38\right) + 4.4K = 0$

$F_{CD} = -6.4\left(2/5.38\right) - 4.4K$

$= -6.8 \text{ KIPS}$

$F_{CD} = 6.8$ KIPS (COMPRESSION)

$\Sigma M_D = 0 \curvearrowright +$

$-9K[2Ft] + F_{BE}[5Ft] = 0$

$F_{BE} = \frac{9K[2Ft]}{5Ft} = 3.6 \text{ KIPS}$

$F_{BE} = 3.6$ KIPS (TENSION)

$\Sigma F_y = 0 \uparrow +$

$-5K + 9K - F_{DE_y} = 0$

$4K - F_{DE}\left(5/6.4\right) = 0$

$F_{DE} = 4\left(6.4/5\right) = 5.1 \text{ KIPS}$

$F_{DE} = 5.1$ KIPS (TENSION)

$\Sigma F_x = 0 \xrightarrow{+}$

$F_{AE} + F_{AC}\left(\frac{2}{5.38}\right) = 0$

$4.4K + F_{AC}\left(2/5.38\right) = 0$

$F_{AC} = -4.4K\left(\frac{5.38}{2}\right)$

$= -11.8 \text{ KIPS}$

$F_{AC} = 11.8$ K (COMP.)

$\Sigma F_x = 0 \xrightarrow{+}$

$-F_{BE} - F_{BD_x} = 0$

$-F_{BE} - F_{BD}\left(2/5.38\right) = 0$

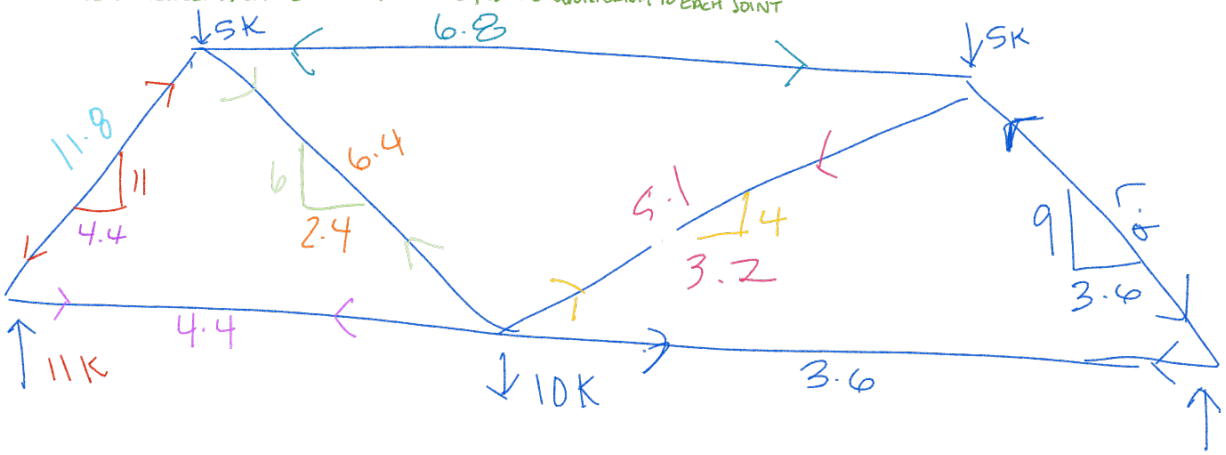
$-3.6 \text{ KIPS} - F_{BD}\left(2/5.38\right) = 0$

$F_{BD} = -3.6K\left(5.38/2\right)$

$F_{BD} = 9.7$K (COMP.)

WANT TO KNOW A QUICK WAY TO CHECK YOUR WORK?

1. DRAW THE TRUSS AS BIG AS POSSIBLE
2. APPLY FORCES AND REACTIONS TO TRUSS
3. USE PRINCIPLES FROM METHOD OF JOINTS TO PROVIDE EQUILIBRIUM TO EACH JOINT



$\frac{5}{2} = \frac{11}{x}$ $x = 4.4$

$\sqrt{4.4^2 + 11^2} = 11.8$

$11.8 - 5 = 6.8$

$\frac{5}{2} = \frac{6}{x}$ $x = 2.4$

$4.4 + 2.4 = 6.8$

$6 - 10 = -4$

$\frac{5}{4} = \frac{4}{x}$ $x = 3.2$

$\frac{5}{2} = \frac{9}{x}$ $x = 3.6K$

$F_{AC} = 11.8$ KIPS (C)

$F_{AE} = 4.4$ KIPS (T)

$F_{BD} = 9.7$ KIPS (C)

$F_{BE} = 3.6$ KIPS (T)

$F_{CD} = 6.8$ KIPS (C)

$F_{CE} = 6.4$ KIPS (T)

$F_{DE} = 5.1$ KIPS (T)