METHOD OF SECTIONS

Learning Objectives

1). To employ the *method of sections* to evaluate the axial force carried by selected members in a truss.
2). To do an *engineering estimate* of the load in select members of a truss.

Procedure

1). Draw a FBD of the *entire truss* showing the *reaction forces* at the supports and the *external loads*. Write the equilibrium equations and solve for as many unknowns as possible.
2). Locate the force members to be evaluated. Identify whether any of these forces can be determined by observation (e.g., zero-force members).
3). Identify section to be used and draw a FBD of the section including any support reactions, external loads and internal forces of sectioned members. Remember, the cutting plane must cut through the members of interest. Also the cutting plane need not be straight, it may be curved.
4). Write the equilibrium equations for one of the two sections. The equations for either half of the section will yield the same member forces.
5). Three equilibrium equations are available, so up to three unknowns can be solved with a single section.
6). At times more than one section may be necessary.

Method of Sections

Example 1

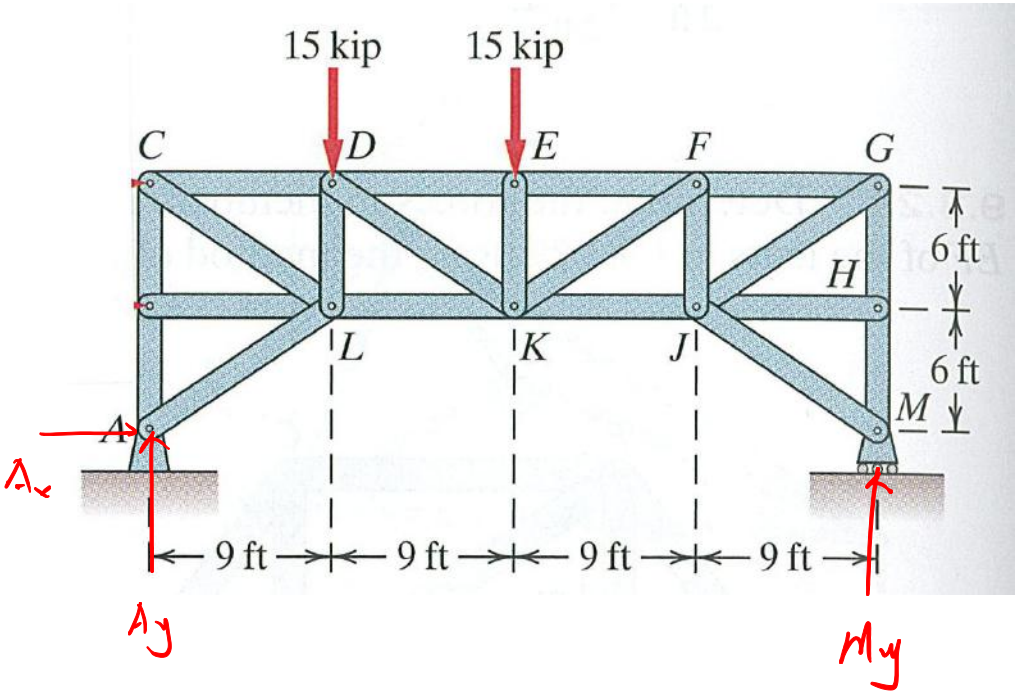
Given: Truss A-M is supported by a pin support at joint A and a roller support at joint M. The truss is loaded with two 15kip forces as shown. (Note: 1kip = 1,000lbs.)

Find:

a) Determine the reaction forces at supports A and M.

b) By inspection, identify all zero-force members in the truss. What else can you determine about the truss by inspection?

c) Using the method of sections, determine the loads in members DE, KL, and DK. State whether each of these members are in tension or compression.

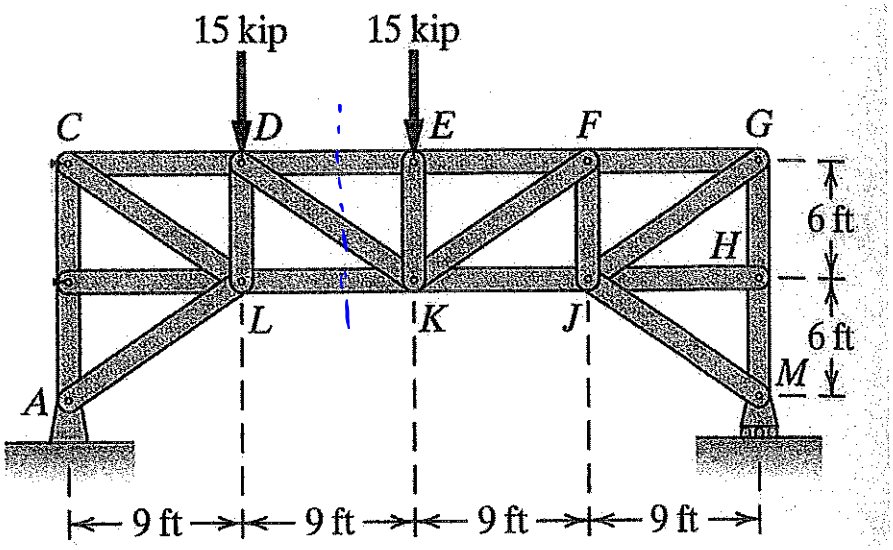


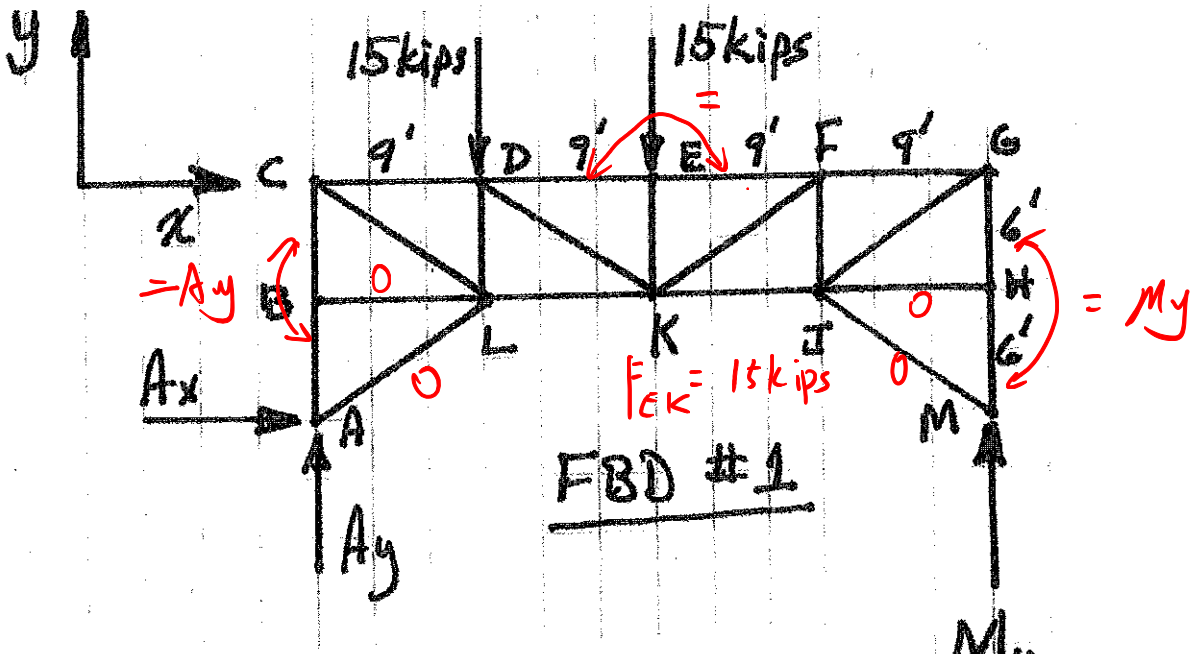
a) $\Sigma M_A = 0$: $-15(9) - 15(18) + M_y(36) = 0$

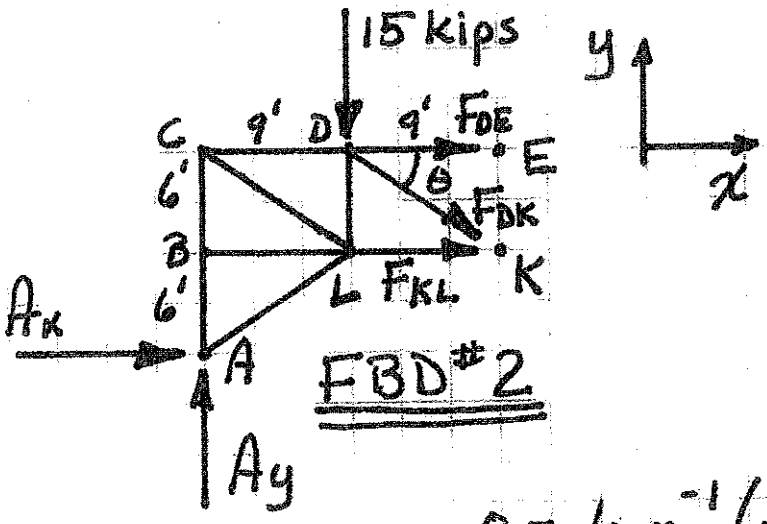
$\Rightarrow M_y = 11.25$ kips

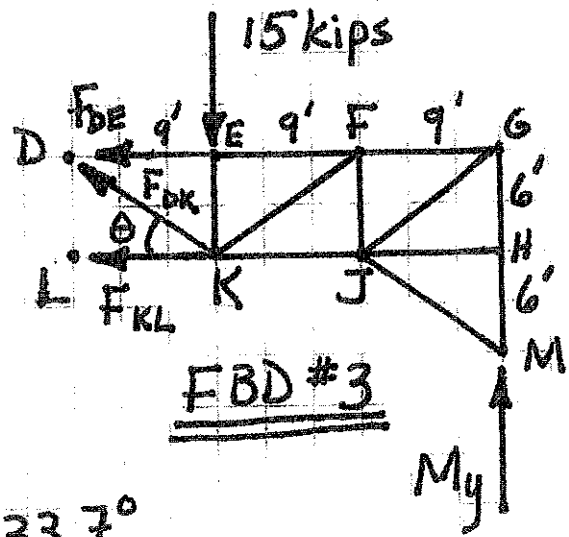
$\Sigma F_x = 0$: $A_x = 0$

$\Sigma F_y = 0$: $A_y - 15 - 15 + M_y = 0 \Rightarrow A_y = 18.75$ kips









$$\theta = \tan^{-1}\left(\frac{6}{9}\right) = 33.7^\circ$$

( ) From FBD #2 :

$\Sigma M_K = 0$: $-F_{DE}(6) + 15(9) + A_x(6) - A_y(18) = 0$

$\Rightarrow F_{DE} = -33.75$ kips (Compression)

$\Sigma M_D = 0$: $F_{KL}(6) + A_x(12) - A_y(9) = 0$

$\Rightarrow F_{KL} = 28.13$ kips (Tension)

$\Sigma F_y = 0$: $A_y - 15 - F_{DK}\sin\theta = 0$

$\Rightarrow F_{DK} = 6.67$ kips (Tension)

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6. From FBD #3

$\Sigma M_K = 0$: $F_{DE}(6) + M_y(18) = 0$

$\Rightarrow F_{DE} = -33.75$ kips (Compression)

$\Sigma M_D = 0$: $-F_{KL}(6) - 15(9) + M_y(27) = 0$

$\Rightarrow F_{KL} = 28.13$ kips. (Tension)

$\Sigma F_y = 0$: $F_{DK}\sin\theta - 15 - M_y = 0$

$\Rightarrow F_{DK} = 6.76$ kips (Tension)

Method of Sections

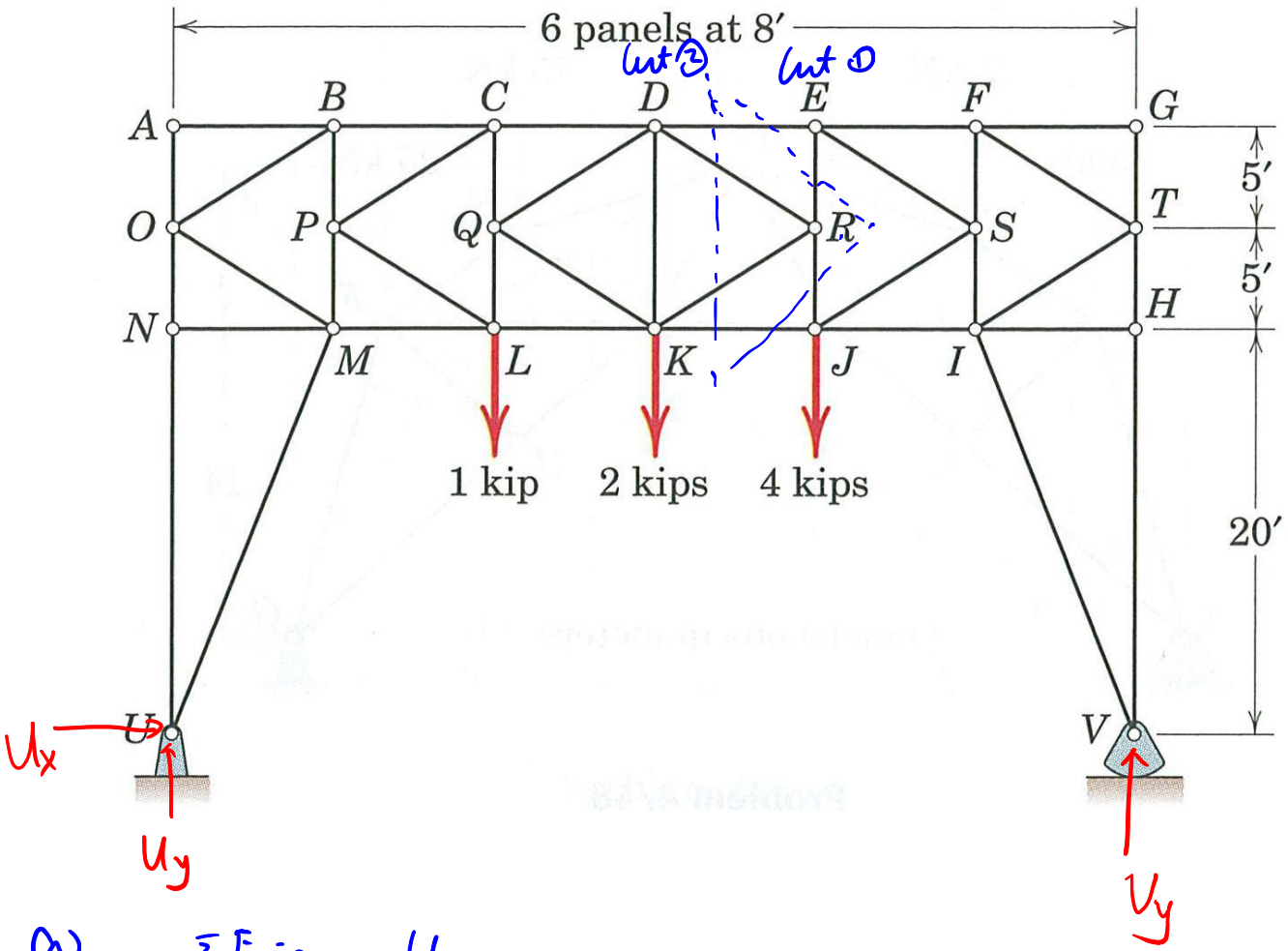
Example 2

Given: The overhead sign truss shown is a K-truss which is supported by a pin joint at U and a rocker support at V. The truss is loaded with these forces as shown and is in static equilibrium.

Find:

a) Determine the reactions at supports U and V.

b) Determine the loads in members DE, DR, KR, and JK. State whether each member is in tension or compression.



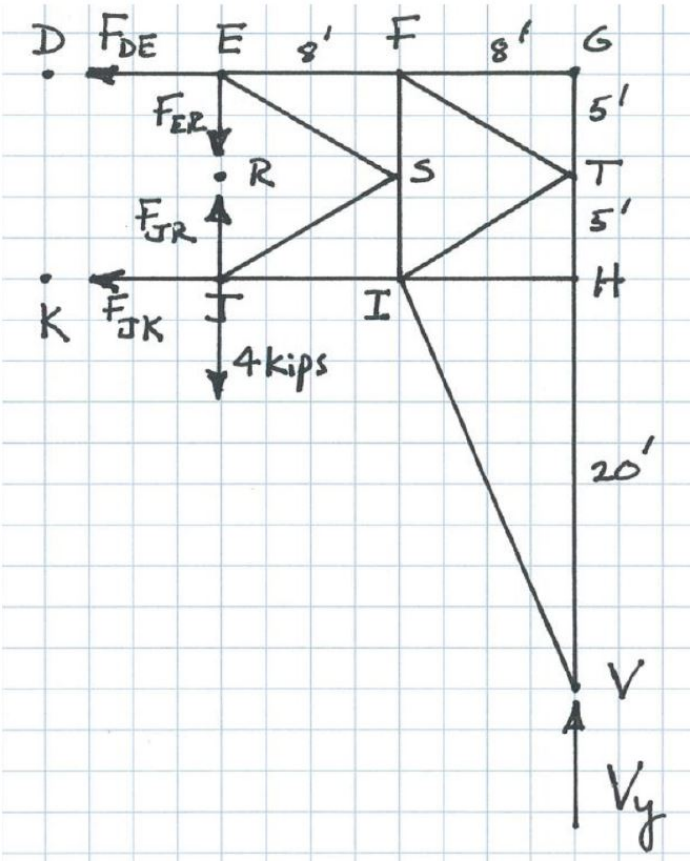
a) $\Sigma F_x = 0$: $U_x = 0$

$\Sigma M_U = 0$: $-1(16) - 2(24) - 4(32) + V_y(48) = 0$

$\Rightarrow V_y = 4$ kips

$\Sigma F_y = 0$: $\Rightarrow U_y = 3$ kips

b) Cut ①:



$\Sigma M_E = 0$: $-F_{JK}(10) + V_y(16) = 0$

$\Rightarrow F_{JK} = 6.4$ kips

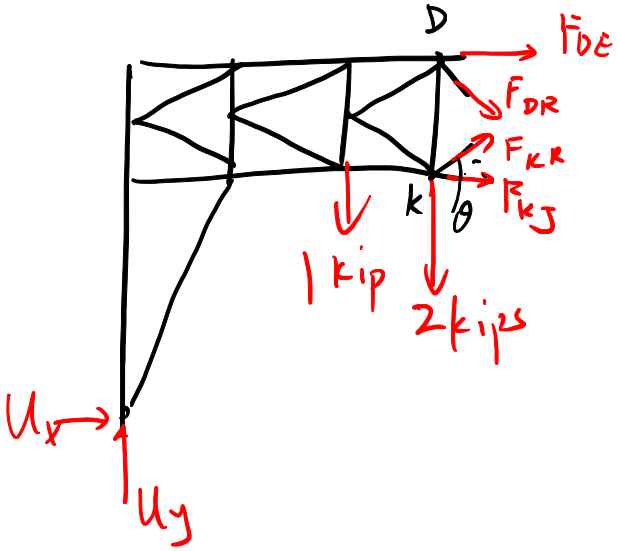
(Tension)

$\Sigma M_J = 0$: $F_{DE}(10) - V_y(16) = 0$

$\Rightarrow F_{DE} = -6.4$ kips

(Compression)

Cut ②:



$\Sigma M_D = 0$:

$(F_{KR}\cos\theta + F_{KJ})(10)$

$+ 1(8) - U_y(24)$

$+ U_x(20) = 0$

$\Rightarrow F_{KR} = 0$

$\Sigma M_K = 0$:

$-(F_{DE} + F_{DR}\cos\theta)(10) + 1(8) - U_y(24) + U_x(20) = 0$

$\Rightarrow F_{DR} = 0$

Trusses – Method of Sections

Example 3

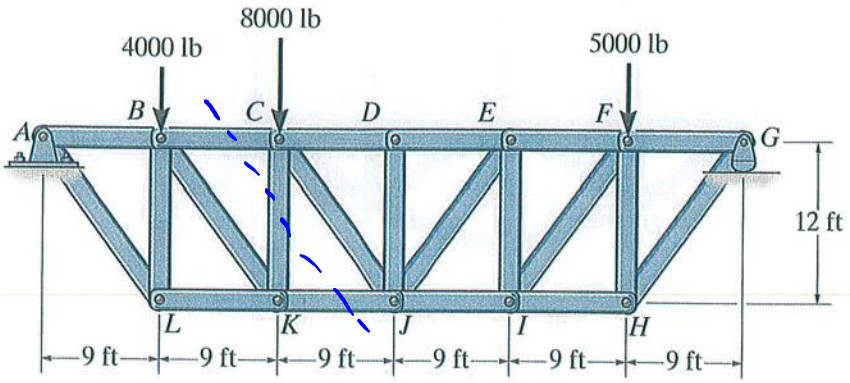
Given: Truss A-L is loaded with three forces as shown and is held in static equilibrium using a pin support at A and a roller support at G.

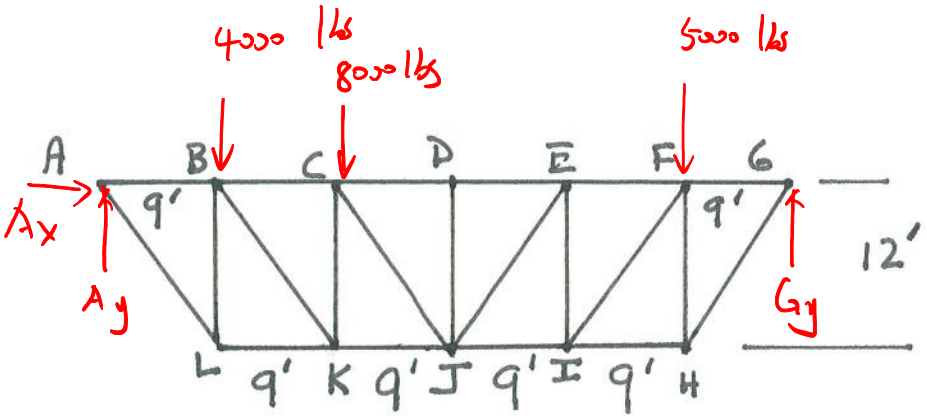
Find:

a) Sketch the overall FBD and determine the reaction forces at A and G.

b) Using the method of sections, determine the loads in members BC, CK, and JK and whether each is in tension or compression.

c) Identify all zero-force members in the truss.





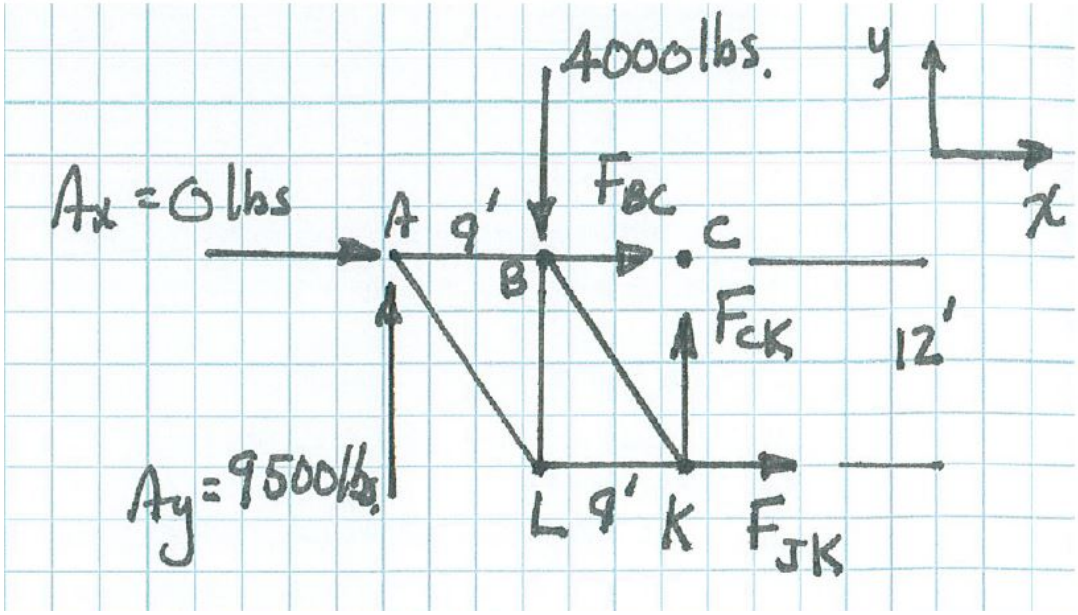
a) $\Sigma M_A = 0$: $\quad -4000(9) - 8000(18) - 5000(45) + G_y(54) = 0$

$\Rightarrow G_y = 7500$ lbs

$\Sigma F_x = 0$: $\quad A_x = 0$

$\Sigma F_y = 0$: $\quad A_y + G_y - 4000 - 8000 - 5000 = 0$

$\Rightarrow A_y = 9500$ lbs



b) $\Sigma M_K = 0$: $-F_{BL}(12) + 4000(9) - 9500(18) = 0$

$\Rightarrow F_{BL} = -11250$ lbs (Compression)

$\Sigma F_x = 0$: $F_{JK} + F_{BL} = 0$

$\Rightarrow F_{BL} = 11250$ lbs (Tension)

$\Sigma F_y = 0$: $A_y - 4000 + F_{CK} = 0$

$\Rightarrow F_{CK} = -5500$ lbs (Compression)

c) Zero force Member: DJ.

Method of Sections
Group Quiz

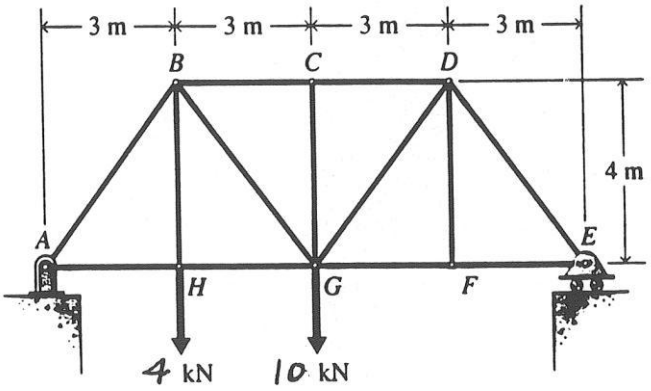
Group #: _____ Group Members: 1) _____
(Present Only)

Date: _____ Period: _____ 2) _____

3) _____

4) _____

Given: The bridge truss is loaded as shown.



Find:

a) Determine the reaction forces at A and E.
b) Identify any zero-force members.
c) Do an engineering estimate of whether members CD, DG and FG are in compression or tension.
d) Using the method of sections, determine the load carried in members CD, DG, and FG.

Solution:

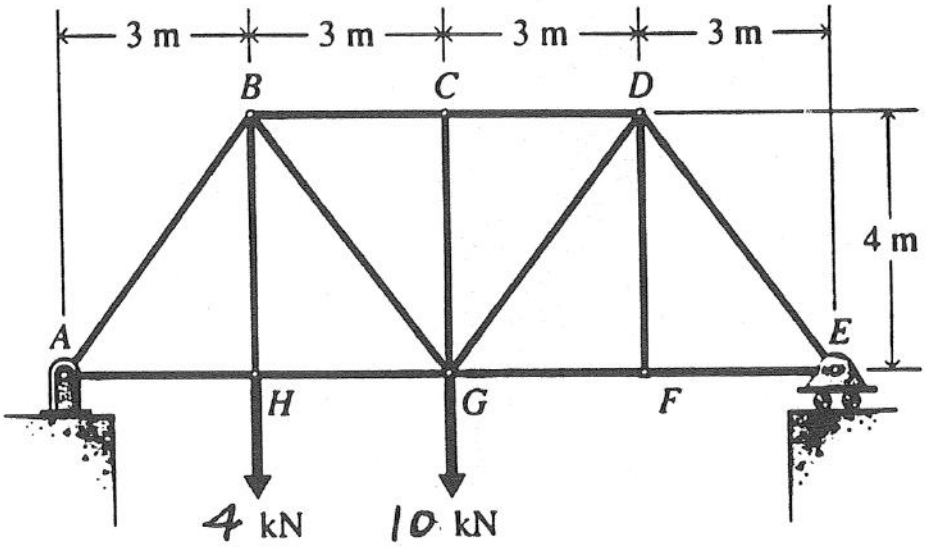


Fig. P7-48

ME 270 - Basic Mechanics I - Group Quiz

Name/Group #: _____ Group Members: 1) _____ 2) _____

Date: _____ Period: _____ 3) _____ 4) _____

Given: The bridge truss is loaded as shown.

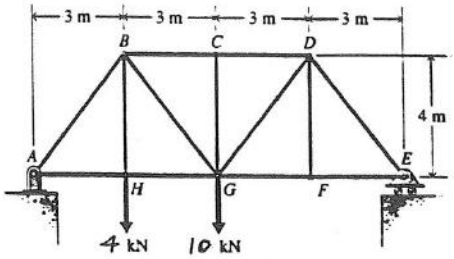


Fig. P7-48

Find:

(a) Determine the reaction forces at A and E.

(b) Identify any zero-force members.

(c) Do an engineering estimate of whether members CD, DG and FG are in compression or tension.

(d) Using the method of sections, determine the load carried in members CD, DG and FG.

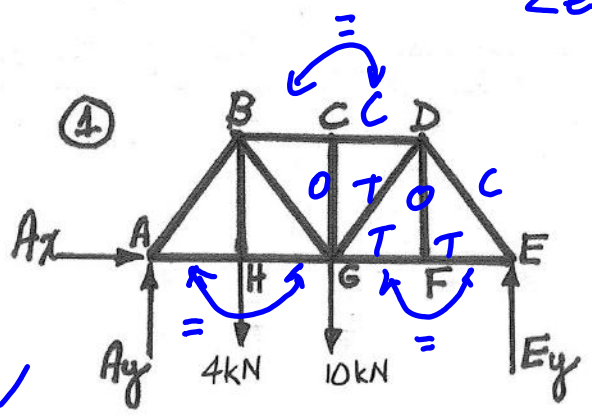
Solution:

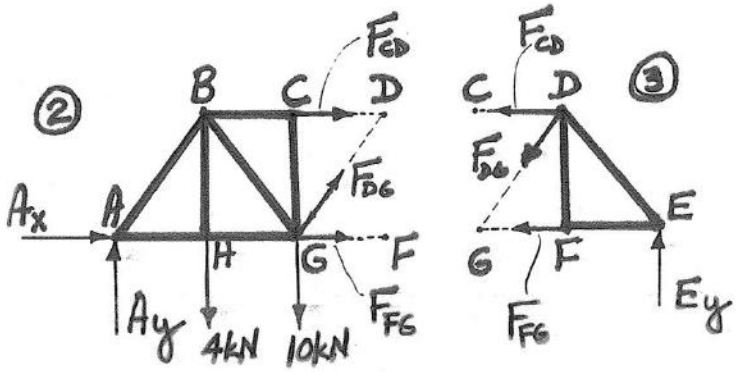
Zero-force member: CG, DF

$A_x = 0$ kN

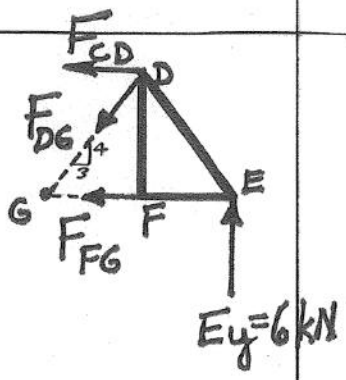
$A_y = 8$ kN

$E_y = 6$ kN





Using FBD ③,



(d) $\Sigma M_G = 0 = 6E_y + 4(F_{CD})$

$\therefore \boxed{F_{CD} = -9\,kN \text{ or } 9kN\ \textcircled{C}}$

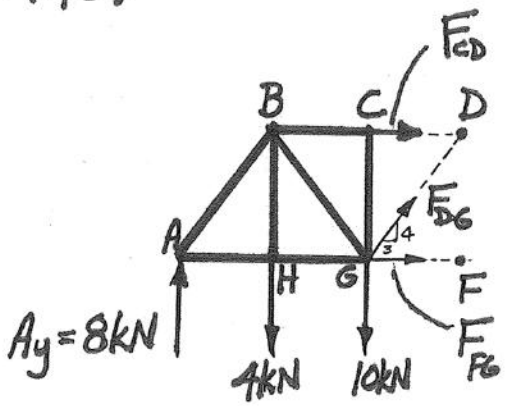
$\Sigma F_y = 0 = E_y - \frac{4}{5}F_{DG}$

$\therefore \boxed{F_{DG} = 7.5kN\ \textcircled{T}}$

$\Sigma M_D = 0 = 3(E_y) - 4(F_{FG})$

$\therefore \boxed{F_{FG} = 4.5kN\ \textcircled{T}}$

Using FBD ②,



$\Sigma M_G = 0 = -6(8) + 3(4) - 4(F_{CD})$

$\boxed{F_{CD} = -9\,kN \text{ or } 9kN\ \textcircled{C}}$

$\Sigma M_D = 0 = -9(8) + 6(4) + 3(10) + 4(F_{FG})$

$\therefore \boxed{F_{FG} = 4.5kN\ \textcircled{T}}$

$\Sigma F_y = 0 = 8 - 4 - 10 + \frac{4}{5}F_{DG}$

$\therefore \boxed{F_{DG} = 7.5kN\ \textcircled{T}}$

(a) From FBD (1),

$\Sigma M_A = -3(4) - 6(10) + 12(E_y)$

$\boxed{E_y = 6\ kN}$

$\Sigma F_x = 0 = A_x \Rightarrow \boxed{A_x = 0\ kN}$

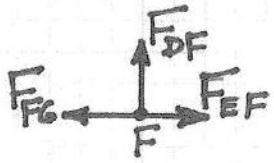
$\Sigma F_y = 0 = A_y - 4 - 10 + E_y \Rightarrow \boxed{A_y = 8\ kN}$

(b) Zero-Force Members: F_{DF}, F_{CG}

Joint F

$\Sigma F_y = 0 = F_{DF}$

$\therefore \boxed{F_{DF} = 0\ kN}$

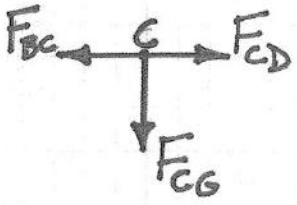


Also note: $\Sigma F_y = 0 = -F_{FG} + F_{EF} \Rightarrow \boxed{F_{FG} = F_{EF}}$

Joint C

$\Sigma F_y = 0 = F_{CG}$

$\therefore \boxed{F_{CG} = 0\ kN}$



Also note: $\Sigma F_y = 0 = -F_{BC} + F_{CD} \Rightarrow \boxed{F_{BC} = F_{CD}}$

(c) F_{CD} = Compression F_{DG} = Tension

F_{FG} = Tension