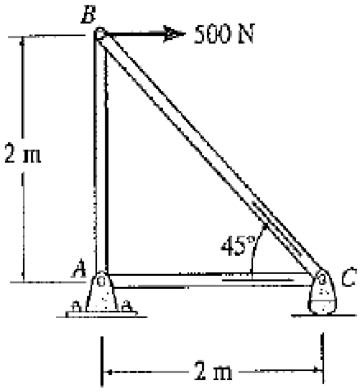
EX 16

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

Sol



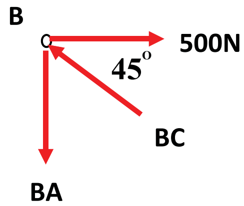
Free-body diagram of the pin at B

$\Sigma F_X = 0$

$500 - BC \sin 45^{\circ} = 0 \Longrightarrow BC = 707.1\ N\ \ C$

$\Sigma F_Y = 0$

$BC \cos 45^{\circ} - BA = 0 \Longrightarrow BA = 500N\ \ T$



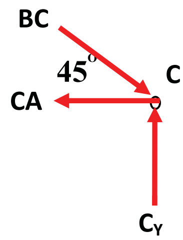
Free-body diagram of the pin at C

$\Sigma F_X = 0$

$-CA + 707.1 \cos 45^{\circ} = 0 \Longrightarrow CA = 500\ N\ \ T$

$\Sigma F_Y = 0$

$C_Y - 707.1 \sin 45^{\circ} = 0 \Longrightarrow C_Y = 500N$



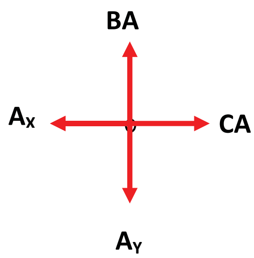
Free-body diagram of the pin at A

$\Sigma F_X = 0$

$500 - A_X = 0 \Longrightarrow A_X = 500\ N$

$\Sigma F_Y = 0$

$500 - A_Y = 0 \Longrightarrow A_Y = 500N$



Method of Sections:

When analyzing plane trusses by the method of joints, we need only two of the three equilibrium equations because the procedures involve concurrent forces at each joint, we can take advantage of the third or moment equation of equilibrium by selecting an entire section of the truss for the free body in equilibrium under the action of a no concurrent system of force, this method of sections has the basic advantage that the force in almost any desired member may be found directly from an analysis if a section which has cut that member. Thus, it is not necessary to proceed with the calculation from joint to joint until the member in question has been reached. In choosing a section of the truss, we not that, in general, not more than three members whose forces are unknown should be cut, since there are only three available independent equilibrium relations.

Illustration of the Method:

The method of sections will now be illustrated for the truss in Fig. below. The reactions are first computed as with the method of joints, by considering the truss as a whole.

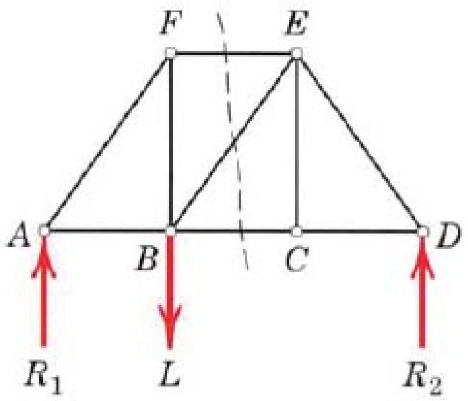
Let us determine the force in the member BE, for example. An imaginary section, indicated by the dashed line, is passed through the truss, cutting it in two parts, Fig. b. this section has cut three members whose forces are initially unknown. In order for the portion of the truss on each side of the section to remain in equilibrium, it is necessary to apply to each cut member the force which was exerted on it by the member cut away. For simple trusses composed of two-force member, these forces, either tensile or compressive, will always be in the directions of the respective members. The left0hand section is in equilibrium under the action of the applied load L, the end reaction R_1, and the three forces exerted on the cut members by the right-hand section which has been removed.

We can usually draw the forces with their proper senses by a visual approximation of the equilibrium requirements. Thus, in balancing the moments about point B for the left-hand section, the force EF is clearly to the left, which toward the cut section of member EF, the load L is greater than the reaction R_1, so

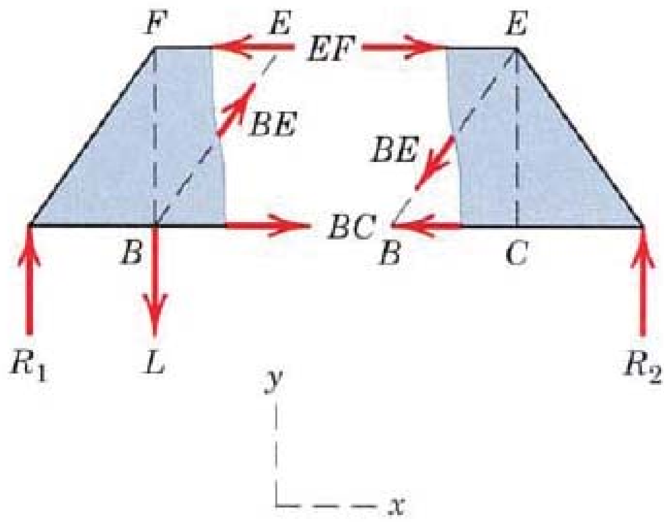
that the force BE must be up and to the right to supply the needed upward component for vertical equilibrium. Force BE is therefore tensile, since it acts away from the cut section.

With the approximate magnitudes of R1 and L in mid we see that the balance of moments about point E requires that BC be to the right. A casual glance at the truss should lead to the same conclusion when it is realized that the lower horizontal member will stretch under the tension caused by bending. The equation of moments about joint B eliminates three forces from the relation, and EF can be determined directly. The force BE is calculated from the equilibrium equation for the y-direction. Finally, we determine BC by balancing moments about point E. In this way each of the three unknowns has been determined independently of the other two.

The right-hand section of the truss, fig. b, is in equilibrium under the action of R_2 and the same three forces in the cut members applied in the directions opposite to those for the left section. The proper sense for the horizontal forces can easily be seen from the balance of moments about points B and E.



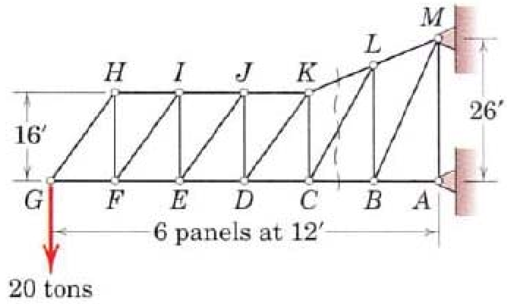
(a)



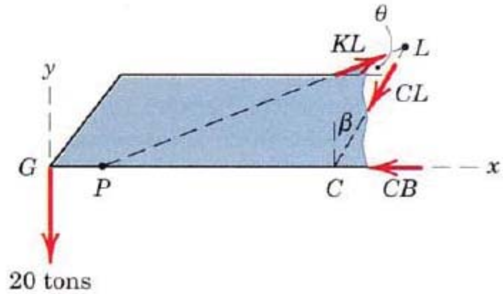
(b)

EX 17

Calculate the forces induces in members KL, CL, and CB by the 20-ton load on the cantilever truss.



Sol



By taking moments about L

$\overline{BL} = 16 + (26 - 16)/2 = 21$ ft

$\Sigma M_L = 0$

$20 \times 5 \times 12 - CB \times 21 = 0 \Longrightarrow CB = 57.1$ tons C

By taking moments about C

$\theta = \tan^{-1}(10/24) = 22.6^{o}$

$\Sigma M_C = 0$

$20 \times 4 \times 12 - KL \times \cos 22.6^{o} \times 16 = 0 \Longrightarrow KL = 65$ tons T

By taking the summation of the forces

$\beta = \tan^{-1}(12/21) = 29.744^{o}$

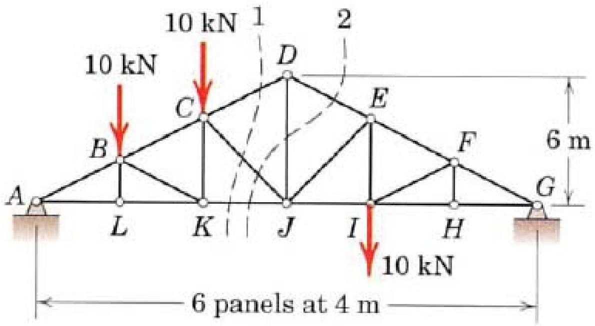
$\Sigma F_Y = 0$

$KL \sin 22.6^{o} - CL \cos 29.744^{o} - 20 = 0$

$CL \cos 29.744^{o} = 4.98 \Longrightarrow CL = 5.74$ tons C

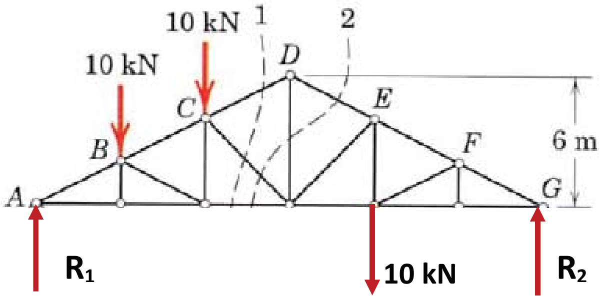
EX 18

Calculate the force in member DH of the Howe roof truss illustrated. Neglect any horizontal components of force at the supports.



Sol

From the fee-body diagram of the whole body.



$\Sigma M_G = 0$

$10 \times 20 + 10 \times 16 + 10 \times 8 - R_1 \times 24 = 0$

$R_1 = 18.33$ kN

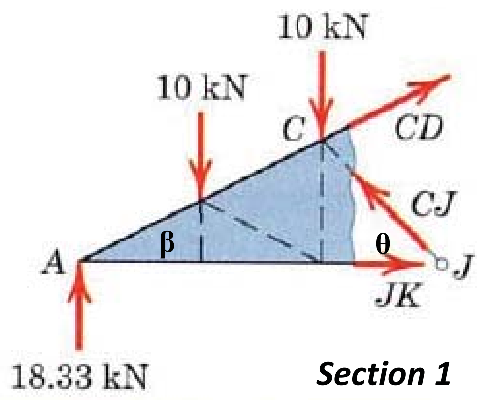
$\Sigma F_Y = 0$

$R_2 + 18.33 - 10 - 10 - 10 = 0$

$R_2 = 11.67$ kN

From the fee-body diagram of section 1

By taking moments about A



$\frac{6}{12} = \frac{CK}{8} \Longrightarrow CK = 4$ m

$\theta = \tan^{-1}(4/4) = 45^\circ$

$\Sigma M_A = 0$

$CJ \sin 45^\circ \times 12 - 10 \times 4 - 10 \times 8 = 0 \Longrightarrow CJ = 14.14$ kN C

By taking moments about J

$\beta = \tan^{-1}(6/12) = 26.56^{o}$

$\Sigma M_J = 0$

$10 \times 4 + 10 \times 8 - CD \cos 26.56^{o} \times 6 - 18.33 \times 12 = 0$

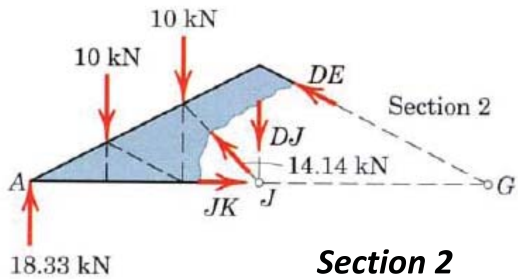
$5.366\ CD = -99.96$

The moment of CD about J is calculated here By considering its tow components as acting through D. the minus sign indicates that cd was assigned in the wrong direction.

Hence CD = 18.63 kN C

From the fee-body diagram of section 2

By taking moments about G



Section 2

$\Sigma M_G = 0$

$DJ \times 12 + 10 \times 16 + 10 \times 20 - 18.33 \times 24 - CJ \sin 45^{o} \times 12 = 0$

DJ = 16.67 kN T

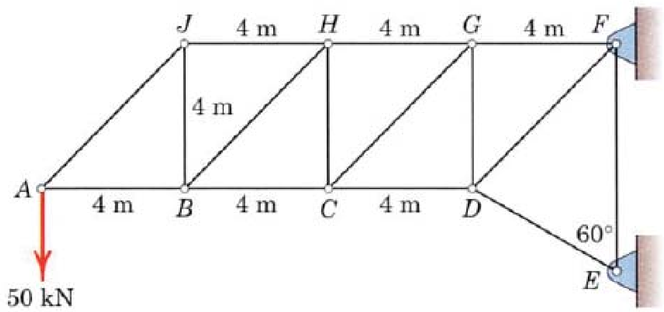
H.W

1. Determine the force in member GH and CG for the truss loaded and supported as shown. Does the statically indeterminacy of the supports affect your calculation? Why? . [J. L. Merim (4-31)]

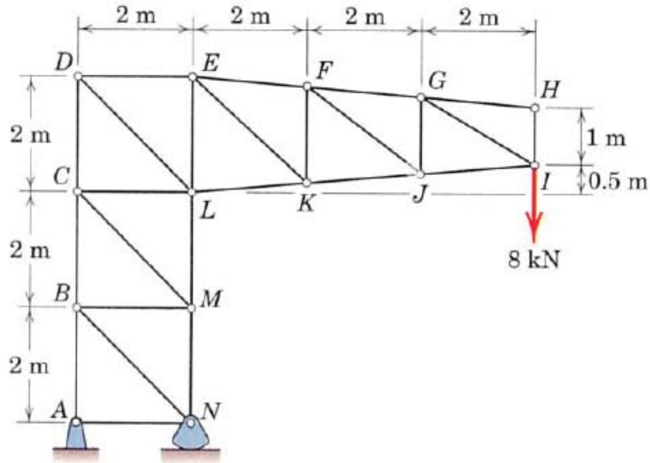
Ans. CG = 70.7 kN T

GH = 100 kN T

No

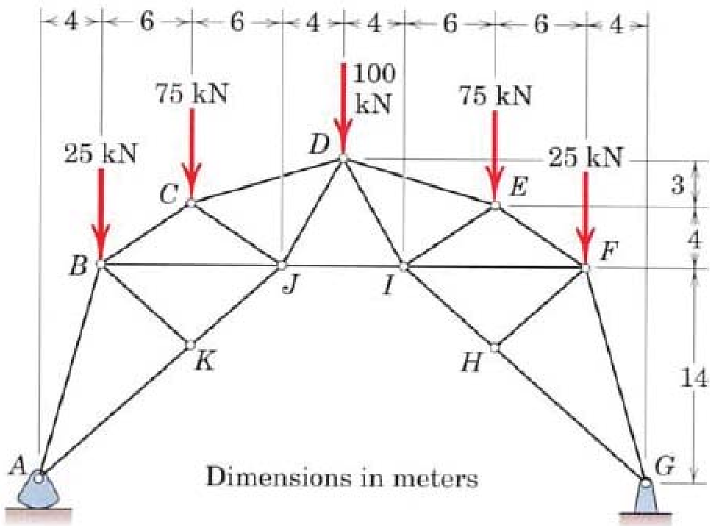


2. Determine the force in members DE and DL. . [J. L. Merim (4-34)]



Ans. DE = 24 kN T
DL = 33.9 kN C

3. Determine the forces in members DE, EI, FI, and HI of the arched roof truss. [J. L. Merim (4-47)]



Ans.
DE = 297 kN C
EI = 26.4 kN T
FI = 205 kN T
Hi = 75.9 kN T