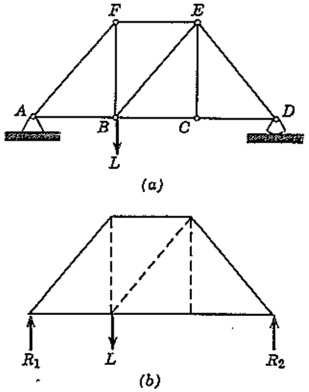


Figure 4/5

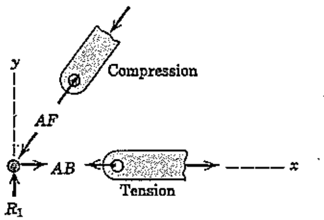


Figure 4/6

given, and reference will be made to the simple truss shown in Fig. 4/5*a* for each of the two methods. The free-body diagram of the truss as a whole is shown in Fig. 4/5*b*. The external reactions are usually determined by computation from the equilibrium equations applied to the truss as a whole before proceeding with the force analysis of the remainder of the truss.

4/3 METHOD OF JOINTS.

This method for finding the forces in the members of a simple truss consists of satisfying the conditions of equilibrium for the forces acting on the connecting pin of each joint. The method therefore deals with the equilibrium of concurrent forces, and only two independent equilibrium equations are involved. We begin the analysis with any joint where at least one known load exists and where not more than two unknown forces are present. Solution may be started with the pin at the left end, and its free-body diagram is shown in Fig. 4/6. With the joints indicated by letters, we may designate the force in each member by the two letters defining the ends of the member. The proper directions of the forces should be evident for this simple case by inspection. The free-body diagrams of portions of members AF and AB are also shown to indicate clearly the mechanism of the action and reaction. The member AB actually makes contact on the left side of the pin, although the force AB is drawn from the right side and is shown acting away from the pin. Thus, if we consistently draw the force arrows on the *same* side of the pin as the member, then tension (such as AB) will always be indicated by an arrow *away* from the pin, and compression (such as AF) will always be indicated by an arrow *toward* the pin. The magnitude of AF is obtained from the equation $\Sigma F_y = 0$ and AB is then found from $\Sigma F_x = 0$.

Joint F must be analyzed next, since it now contains only two unknowns, EF and BF. Joints B, C, E, and D are subsequently analyzed in that order. The free-body diagram of each joint and its corresponding force polygon which represents graphically the two equilibrium conditions $\Sigma F_x = 0$ and $\Sigma F_y = 0$ are shown in Fig. 4/7. The numbers indicate the order in which the joints are analyzed. We note that, when joint D is finally reached, the computed reaction R_2 must be in equilibrium with the forces in members CD and ED, determined previously from the two neighboring joints. This requirement will provide a check on the correctness of our work. We should also note that isolation of joint C quickly discloses the fact that the force in CE is zero when the equation $\Sigma F_y = 0$ is applied. The force in this member would not be zero, of course, if an external vertical load were applied at C.

It is often convenient to indicate the tension T and compression C of the various members directly on the original truss diagram by drawing arrows away from the pins for tension and toward the pins

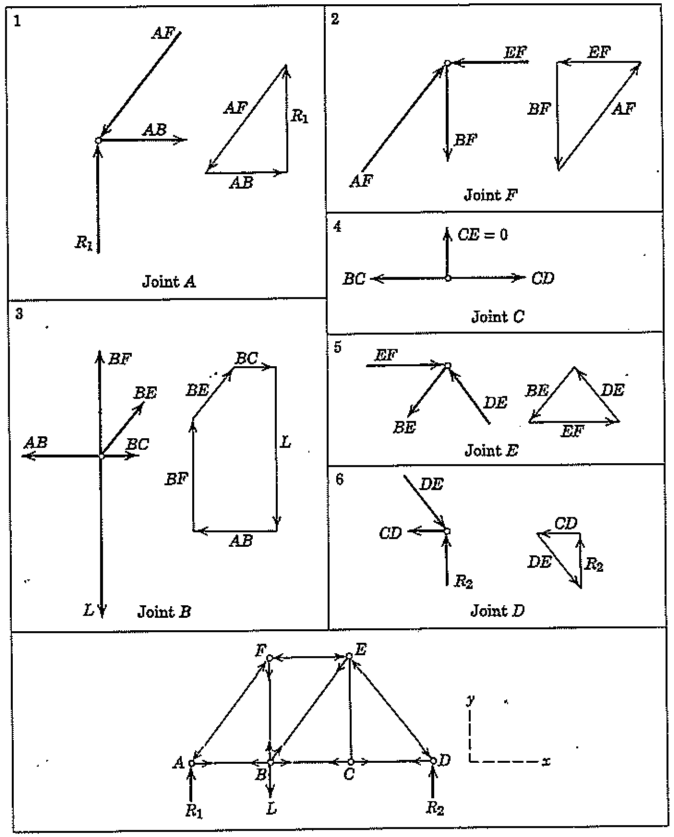


Figure 4/7

for compression. This designation is illustrated at the bottom of Fig. 4/7.

In some instances it is not possible to assign initially the correct direction of one or both of the unknown forces acting on a given pin. In this event we may make an arbitrary assignment. A negative value from the computation indicates that the assumed direction is incorrect.

If a simple truss has more external supports than are necessary to ensure a stable equilibrium configuration, the truss as a whole is statically indeterminate, and the extra supports constitute *external* redundancy. If the truss has more internal members than are necessary to prevent collapse, then the extra members constitute *internal* redundancy and the truss is statically indeterminate. For a truss that is statically determinate externally, there is a definite relation between the number of its members and the number of its joints necessary for internal stability without redundancy. Since we can specify the equilibrium of each joint by two scalar force equations, there are in all $2j$ such equations for a simple truss with j joints. For the entire truss composed of m two-force members with a maximum of three unknown support reactions, there are in all $m + 3$ unknowns. Thus, for a simple plane truss composed of triangular elements, the equation $m + 3 = 2j$ will be satisfied if the truss is statically determinate internally.

This relation is a necessary condition for stability but it is not a sufficient condition, since one or more of the m members can be arranged in such a way as not to contribute to a stable configuration of the entire truss. If $m + 3 > 2j$, there are more members than there are independent equations, and the truss is statically indeterminate internally with redundant members present. If $m + 3 < 2j$, there is a deficiency of internal members, and the truss is unstable and will collapse under load.

The force polygon for each joint, shown in Fig. 4/7, may be constructed graphically to obtain the unknown forces in the members as an alternative to or as a check on the algebraic calculations using the force equations of equilibrium. If a consistent sequence around each joint, clockwise, for example, has been used for the addition of the forces, we may superpose these force polygons on one another to form a composite graphical figure known as the *Maxwell diagram.** The force and its sense may be obtained directly from the diagram. The student who is interested in structures may wish to experiment with this construction and to consult other books dealing more completely with structural analysis for a more detailed description of the Maxwell diagram.

Special conditions. We draw attention to several special conditions which occur frequently in the analysis of simple trusses. When two collinear members are under compression, as indicated in Fig. 4/8*a*, it is necessary to add a third member to maintain alignment of the two members and prevent buckling. We see very quickly from a force summation in the y-direction that the force F_3 in the third member must be zero and from the x-direction that $F_1 = F_2$. This conclusion holds regardless of the angle θ and, of course, holds if the collinear members are in tension. If an external force with a compo-

*The method was published by James Clerk Maxwell in 1864.

nent in the y-direction were applied to the joint, then, of course, F_3 would no longer be zero.

When two noncollinear members are joined as shown in Fig. 4/8*b*, then in the absence of an externally applied load at this joint, the forces in both members must be zero as we see from the two force summations.

When two pairs of collinear members are joined as shown in Fig. 4/8*c*, the forces in each pair must be equal and opposite. This conclusion follows from the force summations indicated in the figure.

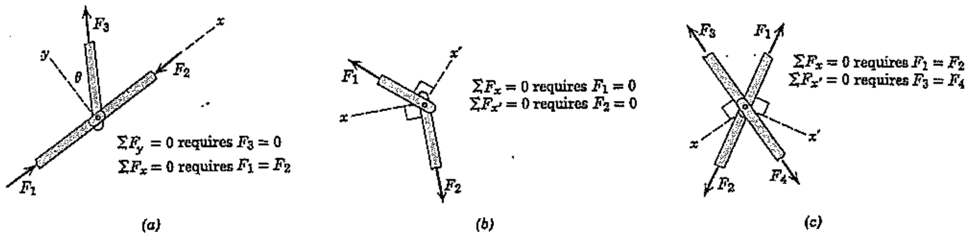


Figure 4/8

Truss panels are frequently cross-braced as shown in Fig. 4/9*a*. Such a panel is statically indeterminate if each brace is capable of supporting either tension or compression. However, when the braces are flexible members incapable of supporting compression, as are cables, then only the tension member acts and the other member is disregarded. It is usually evident from the asymmetry of the loading how the panel will deflect. If the deflection is as indicated in Fig. 4/9*b*, then member *AB* should be retained and *CD* disregarded. When this choice cannot be made by inspection, we may make an arbitrary selection of the member to be retained. If the assumed tension turns out to be positive upon calculation, then the choice was correct. If the assumed tension force turns out to be negative, then the opposite member must be retained and the calculation redone.

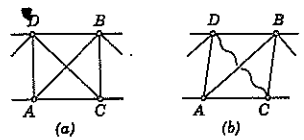


Figure 4/9

The simultaneous solution of the equations for two unknown forces at a joint may be avoided by a careful choice of reference axes. Thus for the joint indicated schematically in Fig. 4/10 where L is known and F_1 and F_2 are unknown, a force summation in the x-direction eliminates reference to F_1 and a force summation in the x'-direction eliminates reference to F_2. When the angles involved are not easily found, then a simultaneous solution of the equations using one set of reference directions for both unknowns may be preferable.

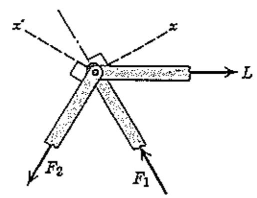
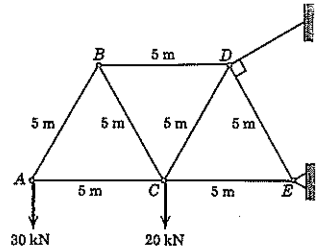


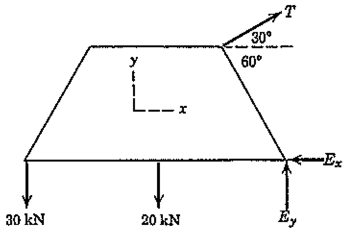
Figure 4/10

Sample Problem 4/1

Compute the force in each member of the loaded cantilever truss by the method of joints.



Solution. If it were not desired to calculate the external reactions at D and E, the analysis for a cantilever truss could begin with the joint at the loaded end. However, this truss will be analyzed completely, so the first step will be to compute the external forces at D and E from the free-body diagram of the truss as a whole. The equations of equilibrium give



$[\Sigma M_E = 0]$ $\quad 5T - 20(5) - 30(10) = 0 \qquad T = 80.0$ kN

$[\Sigma F_x = 0]$ $\quad 80.0 \cos 30° - E_x = 0 \qquad E_x = 69.3$ kN

$[\Sigma F_y = 0]$ $\quad 80.0 \sin 30° + E_y - 20 - 30 = 0 \qquad E_y = 10.0$ kN

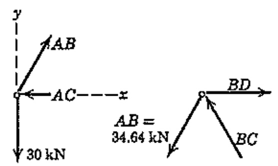
Next we draw free-body diagrams showing the forces acting on each of the connecting pins. The correctness of the assigned directions of the forces is verified when each joint is considered in sequence. There should be no question about the correct direction of the forces on joint A. Equilibrium requires

$[\Sigma F_y = 0]$ $\quad 0.866AB - 30 = 0 \qquad AB = 34.64$ kN T *Ans.*

$[\Sigma F_x = 0]$ $\quad AC - 0.5(34.64) = 0 \qquad AC = 17.32$ kN C *Ans.*

① where T stands for tension and C stands for compression.

Joint B must be analyzed next, since there are more than two unknown forces on joint C. The force BC must provide an upward component, in which case BD must balance the force to the left. Again the forces are obtained from



Joint A Joint B

$[\Sigma F_y = 0]$ $\quad 0.866BC - 0.866(34.64) = 0 \qquad BC = 34.64$ kN C *Ans.*

$[\Sigma F_x = 0]$ $\quad BD - 2(0.5)(34.64) = 0 \qquad BD = 34.64$ kN T *Ans.*

Joint C now contains only two unknowns, and these are found in the same way as before:

$[\Sigma F_y = 0]$ $\quad 0.866CD - 0.866(34.64) - 20 = 0$

$CD = 57.74$ kN T *Ans.*

$[\Sigma F_x = 0]$ $\quad CE - 17.32 - 0.5(34.64) - 0.5(57.74) = 0$

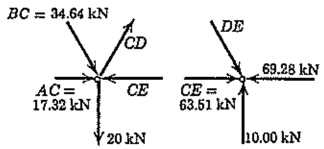
$CE = 63.51$ kN C *Ans.*

Finally, from joint E there results

$[\Sigma F_y = 0]$ $\quad 0.866DE = 10.00 \qquad DE = 11.55$ kN *Ans.*

and the equation $\Sigma F_x = 0$ checks.

① Note that we draw the force arrow on the same side of the joint as the member which exerts the force. In this way tension (arrow away from the joint) is distinguished from compression (arrow toward the joint).

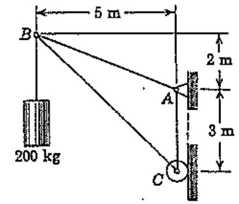


Joint C Joint E

PROBLEMS

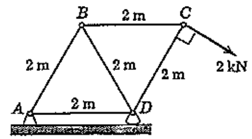
(Solve the following problems by the method of joints. Neglect the weights of the members compared with the forces they support unless otherwise indicated.)

4/1 Calculate the force in each member of the loaded truss.
Ans. $AB = 3.52$ kN T
$BC = 4.62$ kN C
$AC = 3.27$ kN T



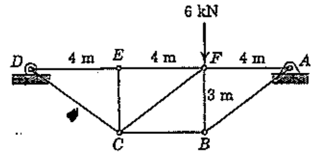
Problem 4/1

4/2 Calculate the force in each member of the truss.



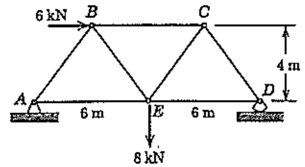
Problem 4/2

4/3 Calculate the force in member CF of the loaded truss. *Ans.* $CF = 3.33$ kN C



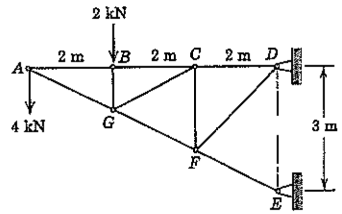
Problem 4/3

4/4 Calculate the force in each member of the loaded truss. All triangles are isosceles.



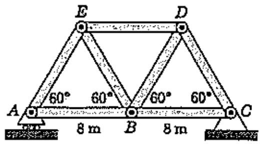
Problem 4/4

4/5 Calculate the forces in members CG and CF for the truss shown.
Ans. $CG = 2.24$ kN T
$CF = 1.00$ kN C



Problem 4/5

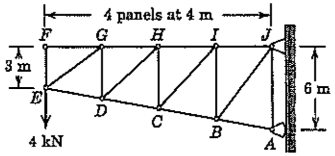
4/6 If the 2-kN force acting on the truss of Prob. 4/5 were removed, identify by inspection those members in which the forces are zero. On the other hand, if the 2-kN force were applied at G instead of B, would there be any zero-force members?



Problem 4/7

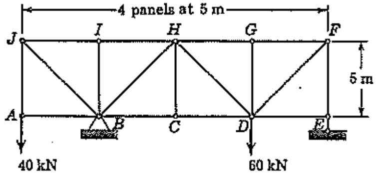
4/7 Each member of the truss is a uniform 8-m bar with a mass of 200 kg. Calculate the average tension or compression in each member due to the weights of the members.

Ans. $AE = CD = 5.66$ kN C
$AB = BC = 2.83$ kN T
$BE = BD = 2.27$ kN T
$DE = 3.96$ kN C



Problem 4/8

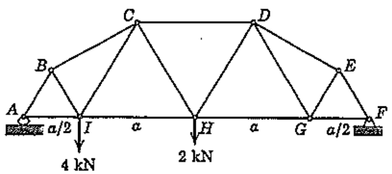
4/8 Calculate the forces in members FG, EG, and GD for the loaded cantilever truss.



Problem 4/9

4/9 Calculate the forces in members JB and BH for the loaded truss.

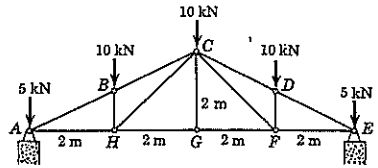
Ans. $JB = 56.6$ kN C
$BH = 47.1$ kN C



Problem 4/10

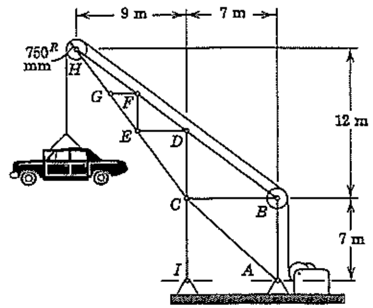
4/10 Determine the forces in members BI, CI, and HI for the loaded truss. All angles are 30°, 60°, or 90°.

4/11 A snow load transfers the forces shown to the upper joints of a Pratt roof truss. Neglect any horizontal reactions at the supports and compute the forces in members BH, BC, and CH.



Problem 4/11

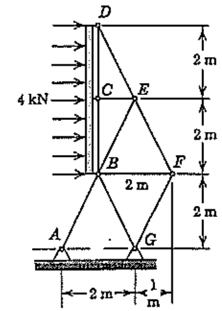
4/12 Calculate the forces induced in members GH and ED for the crane truss when it lifts an 1800-kg car.



Problem 4/12

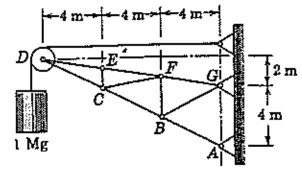
4/13 The signboard truss is designed to support a horizontal wind load of 4 kN. A separate analysis shows that $\frac{5}{8}$ of this force is transmitted to the center connection at C and the rest is equally divided between D and B. Calculate the forces in members BE and BC.

Ans. $BE = 2.80$ kN T, $BC = 1.5$ kN T

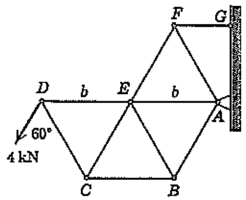


Problem 4/13

4/14 Calculate the forces in members CF, BF, BG, and FG for the simple crane truss.



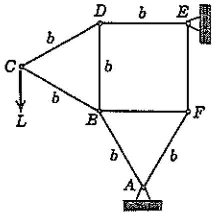
Problem 4/14



Problem 4/15

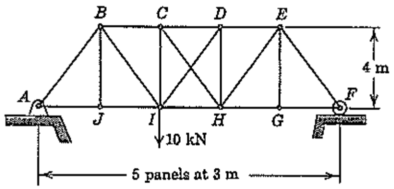
4/15 Calculate the forces in all members of the loaded truss supported by the horizontal link FG and the hinge at A. All interior angles are 60°.

Ans. $AB = CB = DC = 4$ kN C
$BE = CE = DE = 4$ kN T, $AE = 0$
$EF = 8$ kN T, $AF = 8$ kN C



Problem 4/16

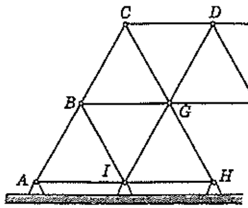
4/16 Show that the truss is statically determinate and determine the forces in members BD and BF in terms of the applied load L.



Problem 4/17

4/17 Calculate the forces in members AB, BJ, BI, and CI. Members CH and DI are cables that are capable of supporting tension only.

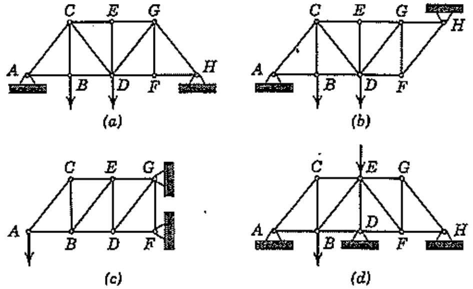
Ans. $AB = 7.5$ kN C, $BJ = CI = 0$, $BI = 7.5$ kN T



Problem 4/18

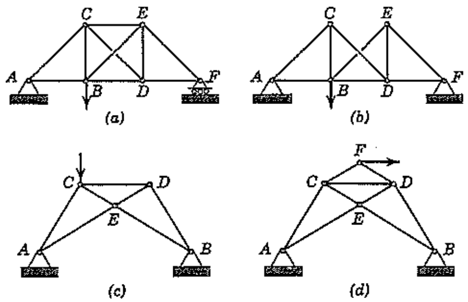
4/18 By inspection designate those members of the truss that cause the structure to be statically indeterminate.

4/19 Each of the loaded trusses has supporting constraints which are statically indeterminate. List all members of each truss whose forces are not affected by the indeterminacy of the supports and that may be computed directly by using only the equations of equilibrium. Assume that the loading and dimensions of the trusses are known.



Problem 4/19

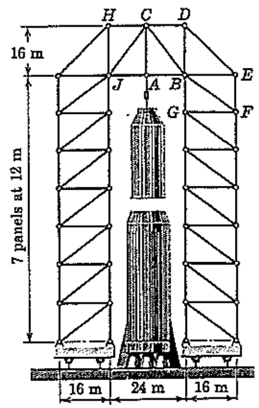
4/20 Verify the fact that each of the trusses contains one or more elements of redundancy, and propose two separate changes, either one of which would remove the redundancy and produce complete statical determinacy. All members can support compression as well as tension.



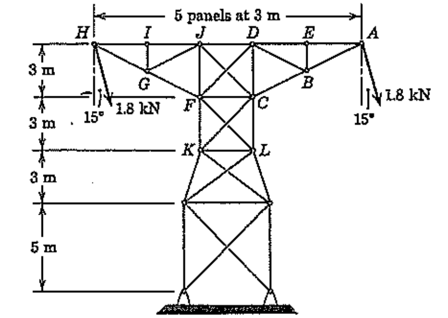
Problem 4/20

4/21 The movable gantry is used to erect and prepare a 500-Mg rocket for firing. The primary structure of the gantry is approximated by the symmetrical plane truss shown, which is statically indeterminate. As the gantry is positioning a 60-Mg section of the rocket suspended from A, strain gage measurements indicate a compressive force of 50 kN in member AB and a tensile force of 120 kN in member CD due to the 60-Mg load. Calculate the corresponding forces in members BF and EF.

Ans. $BF = 188.4$ kN C, $EF = 120$ kN T



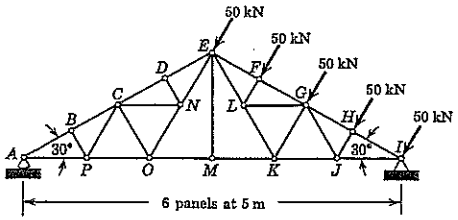
Problem 4/21



Problem 4/22

▶4/22 The tower for a transmission line is modeled by the truss shown. The crossed members in the center sections of the truss may be assumed capable of supporting tension only. For the loads of 1.8 kN applied in the vertical plane, compute the forces induced in members AB, DB, and CD.

Ans. $AB = 3.89$ kN C, $DB = 0$, $CD = 0.93$ kN C



Problem 4/23

▶4/23 Find the forces in members EF, KL, and GL for the Fink truss shown. (*Hint:* Note that the forces in BP, PC, DN, etc., are zero.)

Ans. $EF = 202$ kN C
$KL = 100$ kN T
$GL = 50.0$ kN T

4/4 METHOD OF SECTIONS.

In the previous article on the analysis of plane trusses by the method of joints we took advantage of only two of the three equilibrium equations, since the procedures involve concurrent forces at each joint. We may 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 nonconcurrent system of forces. This *method of sections* has the basic advantage that the force in almost any desired member may be found directly from an analysis of 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 note that, in general, not more than three members whose forces are unknown may be cut, since there are only three available equilibrium relations which are independent.

The method of sections will now be illustrated for the truss in Fig. 4/5, which was used in the explanation of the previous method. The truss is shown again in Fig. 4/11*a* for ready reference. The external reactions are first computed as before, considering the truss as a whole. Now let us determine the force in the member BE for example. An imaginary section, indicated by the dotted line, is passed through the truss, cutting it into two parts, Fig. 4/11*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 that was exerted on it by the member cut away. These forces, either tensile or compressive, will always be in the directions of the respective members for simple trusses composed of two-force members. The left-hand 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 may 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 makes it compressive, since it acts toward the cut section of member EF. The load L is greater than the reaction R_1, so

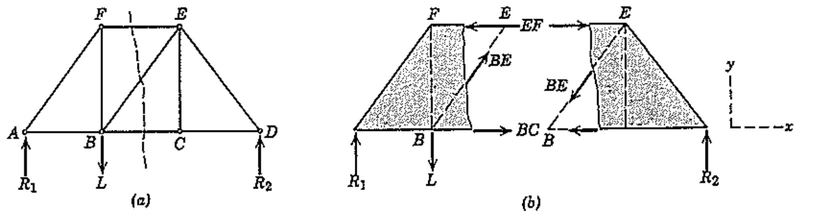


Figure 4/11

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 R_1 and L in mind 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 may 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. 4/11b, 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 may easily be seen from the balance of moments about points B and E.

We may use either section of a truss for the calculations, but the one involving the smaller number of forces will usually yield the simpler solution.

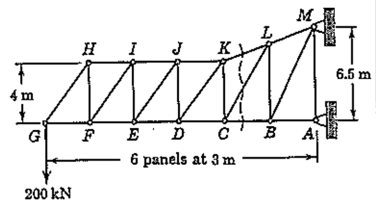
It is essential to understand that in the method of sections an entire portion of the truss is considered a single body in equilibrium. Thus the forces in members internal to the section are not involved in the analysis of the section as a whole. In order to clarify the free body and the forces acting externally on it, the section is preferably passed through the members and not the joints.

The moment equations are used to great advantage in the method of sections, and a moment center, either on or off the section, through which as many forces pass as possible should be chosen. It is not always possible to assign an unknown force in the proper sense when the free-body diagram of a section is initially drawn. With an arbitrary assignment made, a positive answer will verify the assumed sense and a negative result will indicate that the force is in the sense opposite to that assumed. Any system of notation desired may be used, although usually it is found convenient to letter the joints and designate a member and its force by the two letters defining the ends of the member.

An alternative notation preferred by some is to assign all unknown forces arbitrarily as positive in the tension direction (away from the section) and let the algebraic sign of the answer distinguish between tension and compression. Thus a plus sign would signify tension and a minus sign compression. On the other hand the advantage of assigning forces in their correct sense on the free-body diagram of a section wherever possible is that it emphasizes the physical action of the forces more directly and is preferred in this treatment.

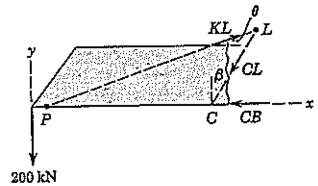
Sample Problem 4/2

Calculate the forces induced in members KL, CL, and CB by the 200-kN load on the cantilever truss.



Solution. Although the vertical components of the reactions at A and M are statically indeterminate with the two fixed supports, all members other than AM are statically determinate. We may pass a section directly through members KL, CL, and CB and analyze the portion of the truss to the left of this section as a statically determinate rigid body. ①

The free-body diagram of the portion of the truss to the left of the section is shown. A moment sum about L quickly verifies the assignment of CB as compression, and a moment sum about C quickly discloses that KL is in tension. The direction of CL is not quite so obvious until we observe that KL and CB intersect at a point P to the right of G. A moment sum about P eliminates reference to KL and CB and shows that CL must be compressive to balance the moment of the 200-kN force about P. With these considerations in mind the solution becomes straightforward, as we now see how to solve for each of the three unknowns independently of the other two.



② Summing moments about L requires the moment arm $BL = 4 + (6.5 - 4)/2 = 5.25$ m. Thus

$$[\Sigma M_L = 0] \qquad 200(5)(3) - CB(5.25) = 0 \qquad CB = 571 \text{ kN } C \qquad \textit{Ans.}$$

Next we take moments about C which requires a calculation of $\cos\theta$. From the given dimensions we see $\theta = \tan^{-1}(5/12)$ so that $\cos\theta = 12/13$. Therefore

$$[\Sigma M_C = 0] \qquad 200(4)(3) - \tfrac{12}{13}KL(4) = 0 \qquad KL = 650 \text{ kN } T \qquad \textit{Ans.}$$

Finally we may find CL by a moment sum about P whose distance from C is given by $PC/4 = 6/(6.5 - 4)$ or $PC = 9.60$ m. We also need β which is given by $\beta = \tan^{-1}(\overline{CB}/\overline{BL}) = \tan^{-1}(3/5.25) = 29.7°$ and $\cos\beta = 0.868$. We now have

③ $$[\Sigma M_P = 0] \qquad 200(12 - 9.60) - CL(0.868)(9.60) = 0$$

$$CL = 57.6 \text{ kN } C \qquad \textit{Ans.}$$

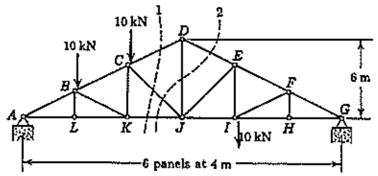
① We note that analysis by the method of joints would necessitate working with eight joints in order to calculate the three forces in question. Thus the method of sections offers a considerable advantage in this case.

② We could have started with moments about C or P just as well.

③ We could also have determined CL by a force summation in either the x- or y-direction.

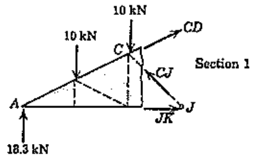
Sample Problem 4/3

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



Solution. It is not possible to pass a section through DJ without cutting four members whose forces are unknown. Although three of these cut by section 2 are concurrent at J and therefore the moment equation about J could be used to obtain DE, the force in DJ cannot be obtained from the remaining two equilibrium principles. It is necessary to consider first the adjacent section 1 before considering section 2.

The free-body diagram for section 1 is drawn and includes the reaction of 18.3 kN at A, which is previously calculated from the equilibrium of the truss as a whole. In assigning the proper directions for the forces acting on the three cut members we see that a balance of moments about A eliminates the effects of CD and JK and clearly requires that CJ be up and to the left. A balance of moments about C eliminates the effect of the three forces concurrent at C and indicates that JK must be to the right to supply sufficient counterclockwise moment. Again it should be fairly obvious that the lower chord is under tension because of the bending tendency of the truss. Although it should also be apparent that the top chord is under compression, for purposes of illustration the force in CD
① will be arbitrarily assigned as tension.



By the analysis of section 1, CJ is obtained from

$$[\Sigma M_A = 0] \qquad 0.707CJ(12) - 10(4) - 10(8) = 0 \qquad CJ = 14.1 \text{ kN } C$$

In this equation the moment of CJ is calculated by considering its horizontal and vertical components acting at point J. Equilibrium of moments about J requires

$$[\Sigma M_J = 0] \qquad 0.894CD(6) + 18.3(12) - 10(4) - 10(8) = 0$$

$$CD = -18.6 \text{ kN}$$

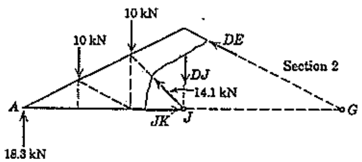
The moment of CD about J is calculated here by considering its two
② components as acting through D. The minus sign indicates that CD was assigned in the wrong direction.

Hence $\qquad CD = 18.6 \text{ kN } C \qquad$ *Ans.*

From the free-body diagram of section 2, which now includes the known value of CJ, a balance of moments about G is seen to eliminate DE and JK. Thus

$$[\Sigma M_G = 0] \qquad 12DJ + 10(16) + 10(20) - 18.3(24) - 14.1(0.707)(12) = 0$$

$$DJ = 16.6 \text{ kN } T \qquad \textit{Ans.}$$



Again the moment of CJ is determined from its components considered to be acting at J. The answer for DJ is positive, so that the assumed tensile direction is correct. An analysis of the joint D alone also verifies this conclusion.

In choosing a section it is always important to match the number of
③ unknowns with the number of independent equilibrium equations which may be applied.

① There is no harm in assigning one or more of the forces in the wrong direction as long as the calculations are consistent with the assumption. A negative answer will show the need for reversing the direction of the force.

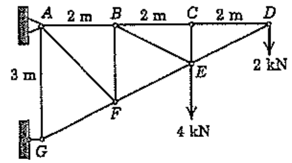
② If desired, the direction of CD may be changed on the free-body diagram and the algebraic sign of CD reversed in the calculations, or else the work may be left as it stands with a note stating the proper direction.

③ Observe that a section through members CD, DJ, and DE could be taken that would cut only three unknown members. However, since the forces in these three members are all concurrent at D, a moment equation about D would yield no information about them. The remaining two force equations would not be sufficient to solve for the three unknowns.

PROBLEMS

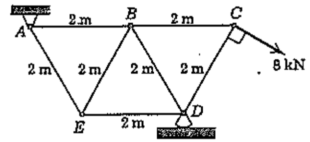
(Solve the following problems by the method of sections. Neglect the weight of the members compared with the forces they support.)

4/24 Calculate the forces in members AB, BF, and EF in the loaded truss.
Ans. $AB = 8$ kN T, $BF = 2$ kN C, $EF = 4\sqrt{5}$ kN C



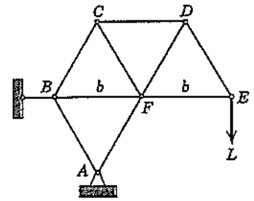
Problem 4/24

4/25 Calculate the forces in members ED and EB in the loaded truss composed of equilateral triangles.



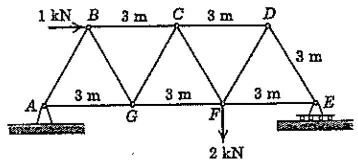
Problem 4/25

4/26 Determine the force in member CF in terms of the applied load L. All interior angles are 60°.
Ans. $CF = 2L/\sqrt{3}$, C

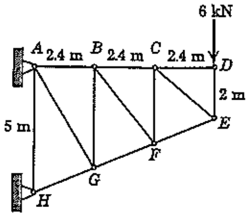


Problem 4/26

4/27 Calculate the forces in members CD, BC, and CG in the loaded truss composed of equilateral triangles.

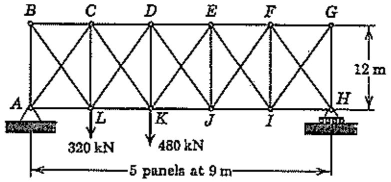


Problem 4/27



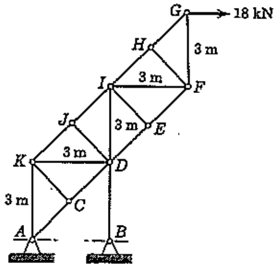
Problem 4/28

4/28 Calculate the force in members AB, BG, and GF. Solve for each force from an equilibrium equation which contains that force as the only unknown.
Ans. $AB = 7.2$ kN T, $BG = 3$ kN C, $GF = 7.8$ kN C



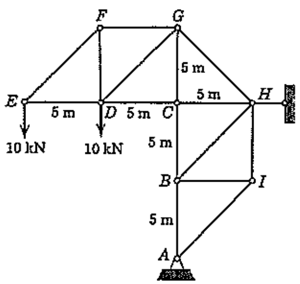
Problem 4/29

4/29 Assume that the cross braces in the bridge truss are flexible members incapable of supporting compression. Calculate the force in member DE for the loading condition shown.



Problem 4/30

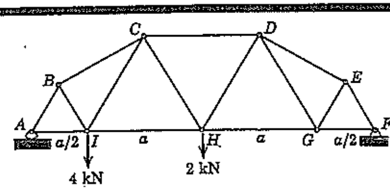
4/30 Calculate the forces in members DI, DE, and EI for the loaded truss shown.
Ans. $DI = 18$ kN C, $DE = 25.5$ kN C, $EI = 0$



Problem 4/31

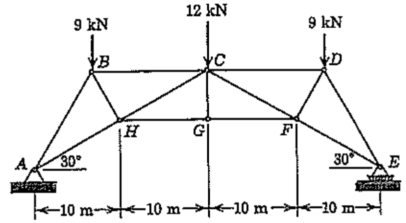
4/31 Calculate the forces in members CH, CB, and GH for the cantilevered truss. Solve for each force from a moment equation which contains that force as the only unknown.

4/32 Compute the forces in members BC, CI, and HI for the truss of Prob. 4/10 repeated here. Solve for each force from an equilibrium equation which contains that force as the only unknown.
Ans. $BC = 4.33$ kN C, $CI = 2.12$ kN T, $HI = 2.69$ kN T



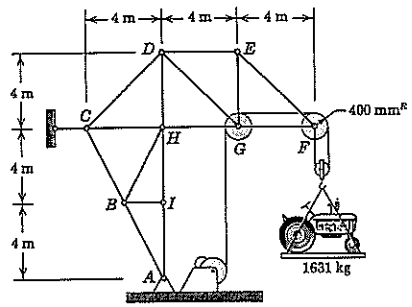
Problem 4/32

4/33 The roof truss is composed of 30°–60° right triangles and is loaded as shown. Compute the forces in members BH and HG.



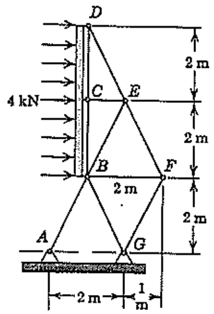
Problem 4/33

4/34 A crane is modeled by the simple truss shown. Compute the forces in members DE, DG, and HG under the load of the tractor, which has a mass of 1631 kg.
Ans. $DE = 16$ kN T, $DG = 33.9$ kN T, $HG = 40$ kN C



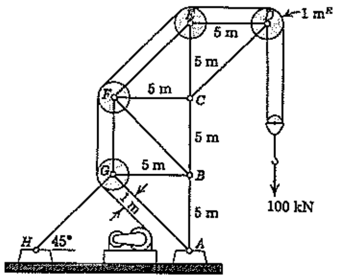
Problem 4/34

4/35 Compute the forces in members CH, CD, and HI for the crane truss of Prob. 4/34.



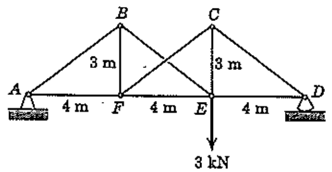
Problem 4/36

4/36 Solve for the forces in members *BG* and *BF* of the signboard truss of Prob. 4/13 repeated here. The resultant of the 4-kN wind load passes through *C*.
Ans. $BG = 2\sqrt{5}$ kN *C*, $BF = 4$ kN *T*



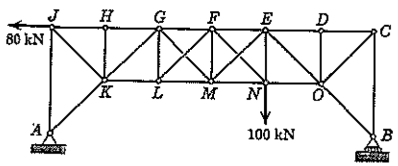
Problem 4/37

4/37 Calculate the forces in members *FC* and *FB* due to the 100-kN load on the crane truss.



Problem 4/38

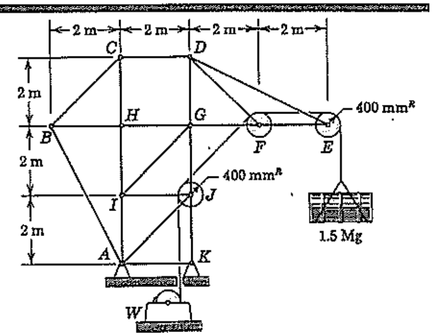
4/38 Each of the members *BE* and *FC* is capable of supporting compression as well as tension. Compute the forces in members *CF*, *BE*, and *EF*.
Ans. $BE = 1.667$ kN *C*, $FC = 3.33$ kN *C*
$EF = 4$ kN *T*



Problem 4/39

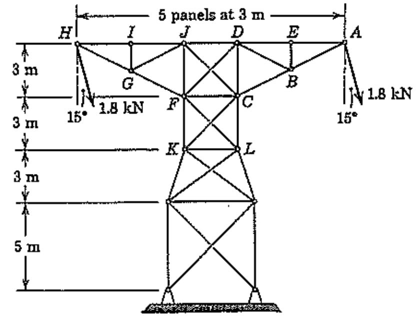
4/39 The truss shown is composed of 45° right triangles. The crossed members in the center two panels are slender tie rods incapable of supporting compression. Retain the two rods which are under tension and compute the magnitudes of their tensions. Also find the force in member *MN*.

4/40 The crane truss is secured to the fixed supports at *A* and *K*, and its winch *W* is locked in position while supporting the 1.5-Mg tank. Identify any statically indeterminate members and calculate the force in member *HG*.
Ans. $HG = 59.8$ kN *C*



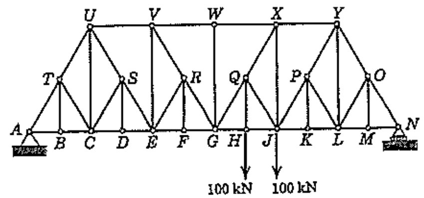
Problem 4/40

4/41 The transmission-line truss of Prob. 4/22 is shown again here. Assume that the crossed members are capable of supporting tension only and compute the force in member *FC* under the action of the loading shown.



Problem 4/41

4/42 Find the force in member *JQ* for the Baltimore truss where all angles are 30°, 60°, 90°, or 120°.
Ans. $JQ = 57.7$ kN *C*



Problem 4/42