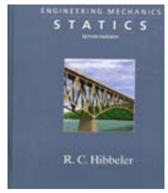
PEARSON Prentice Hall **Engineering Mechanics: Statics** Tenth Edition

CHAPTER

STRUCTURAL ANALYSIS

UMBC

•College of Engineering •Department of Mechanical Engineering



6b

by

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SPRING 2007

ENES 110 – Statics

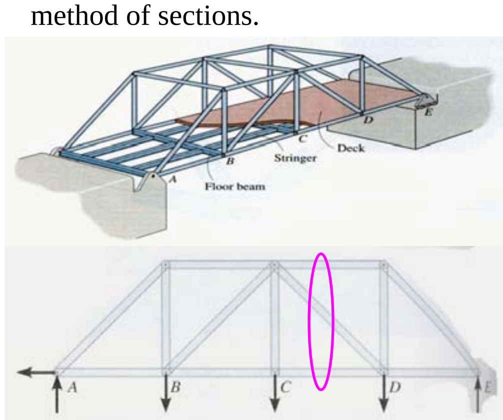
Department of Mechanical Engineering

University of Maryland, Baltimore County

Trusses – The Method of Sections (Section 6.4)

Lecture's Objectives:

Students will be able to determine forces in truss members using the method of sections.



In-Class Activities:

- Submit Homework #7
- Reading quiz
- Applications
- Method of sections
- Concept quiz
- Problem solving (Ex. 2)
- Attention quiz

Reading Quiz

1. In the method of sections, generally a "cut" passes through no more than _____ members in which the forces are unknown.

A) 1 B) 2

C) 3 D) 4

2. If a simple truss member carries a tensile force of *T* along its length, then the internal force in the member is ______ .

A) tensile with magnitude of *T*/2

B) compressive with magnitude of *T*/2

C) compressive with magnitude of *T*

D) tensile with magnitude of *T*

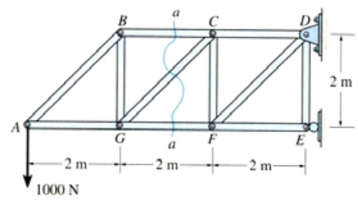
Applications

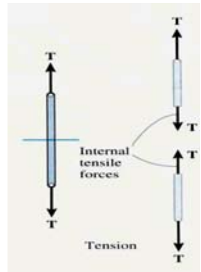
Long trusses are often used to construct bridges.

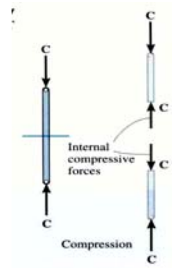
The method of joints requires that many joints be analyzed before we can determine the forces in the middle part of the truss.

Is there another method to determine these forces directly?

The Method of Sections



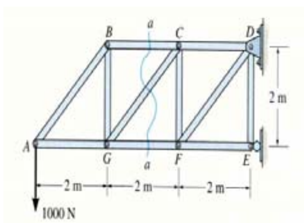


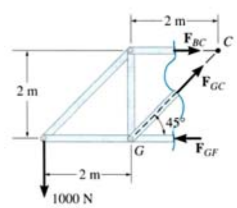


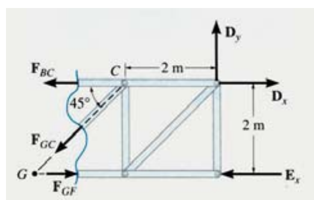
In the method of sections, a truss is divided into two parts by taking an imaginary "cut" (shown here as *a-a*) through the truss.

Since truss members are subjected to only tensile or compressive forces along their length, the internal forces at the cut member will also be either tensile or compressive with the same magnitude. This result is based on the equilibrium principle and Newton's third law.

Steps for Analysis

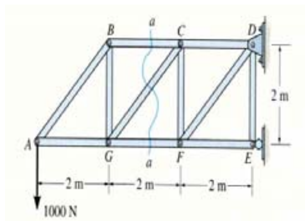


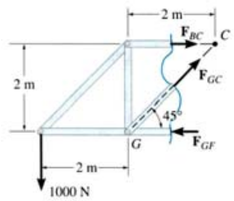


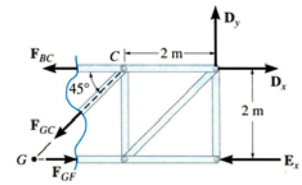


1. Decide how you need to "cut" the truss. This is based on:
   a) where you need to determine forces, and, b) where the total number of unknowns does not exceed three (in general).
2. Decide which side of the cut truss will be easier to work with (minimize the number of reactions you have to find).
3. If required, determine the necessary support reactions by drawing the FBD of the entire truss and applying the EofE.

Steps for Analysis (cont'd)

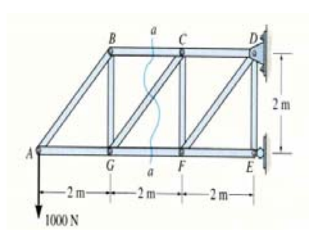


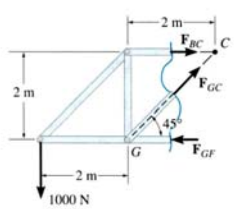


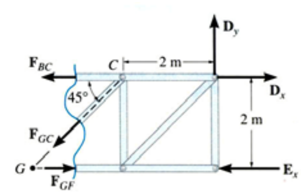


4. Draw the FBD of the selected part of the cut truss. We need to indicate the unknown forces at the cut members. Initially we assume all the members are in tension, as we did when using the method of joints. Upon solving, if the answer is *positive*, the member is in *tension* as per our assumption. If the answer is *negative*, the member must be in *compression*. (Please note that you can also assume forces to be either tension or compression by inspection as was done in the figures above.)

Steps for Analysis (cont'd)

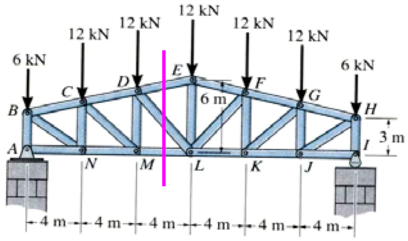






5. Apply the equations of equilibrium (EofE) to the selected cut section of the truss to solve for the unknown member forces. Please note that in most cases it is possible to write one equation to solve for one unknown directly.

Example 1



Given: Loads as shown on the roof truss.

Find: The force in members *DE*, *DL*, and *ML*.

Plan:

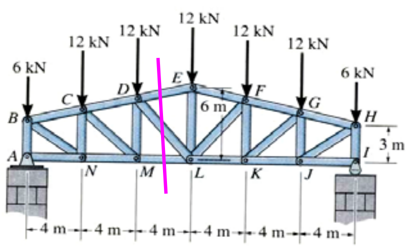
a) Take a cut through the members *DE*, *DL*, and *ML*.

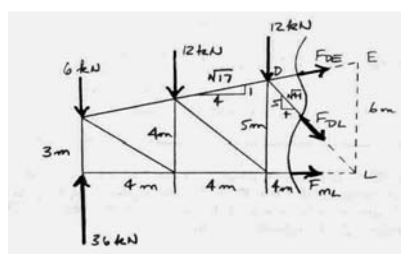
b) Work with the left part of the cut section. Why?

c) Determine the support reaction at *A*. What are they?

d) Apply the EofE to find the forces in *DE*, *DL*, and *ML*.

Example 1 (cont'd)





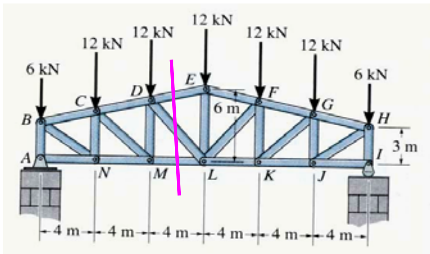
Analyzing the entire truss, we get $\sum F_x = A_x = 0$. By symmetry, the vertical support reactions are

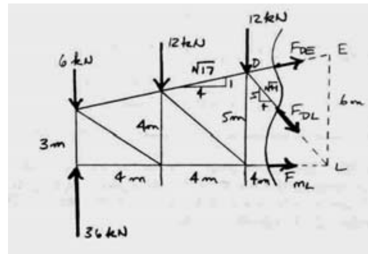
$A_y = I_Y =$ 36 kN

$$\circlearrowright + \sum M_D = -36\,(8) + 6\,(8) + 12\,(4) + F_{ML}\,(5) = 0$$

F_{ML} = 38.4 kN (T)

Example 1 (cont'd)





$+\Sigma M_L = -36\,(12) + 6\,(12) + 12\,(8) + 12\,(4) - F_{DE}\,(4/\sqrt{17})(6) = 0$

$F_{DE} = -37.11$ kN or 37.1 kN (C)

$\rightarrow + \Sigma F_x = 38.4 + (4/\sqrt{17})\,(-37.11) + (4/\sqrt{41})\,F_{DL} = 0$

$F_{DL} = -3.84$ kN or 3.84 kN (C)

Concept Quiz

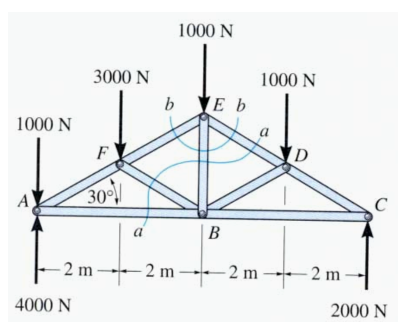
1. Can you determine the force in member *ED* by making the cut at section *a-a*? Explain your answer.

   A) No, there are 4 unknowns.

   B) Yes, using $\Sigma M_D = 0$.

   C) Yes, using $\Sigma M_E = 0$.

   D) Yes, using $\Sigma M_B = 0$.



Concept Quiz (cont'd)

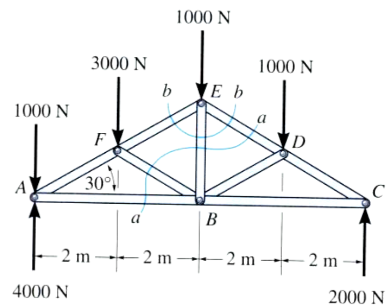
2. If you know F_{ED}, how will you determine F_{EB} ?

   A) By taking section *b-b* and using $\Sigma M_E = 0$

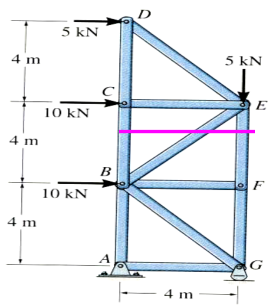
   B) By taking section *b-b*, and using $\Sigma F_x = 0$ and $\Sigma F_y = 0$

   C) By taking section *a-a* and using $\Sigma M_B = 0$

   D) By taking section *a-a* and using $\Sigma M_D = 0$



Example 2



Given: Loading on the truss as shown.

Find: The force in members *BC*, *BE*, and *EF*.

Plan:

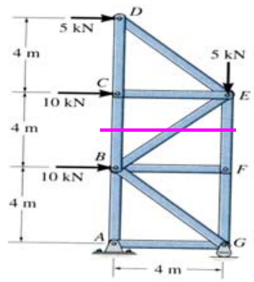
a) Take a cut through the members *BC*, *BE*, and *EF*.

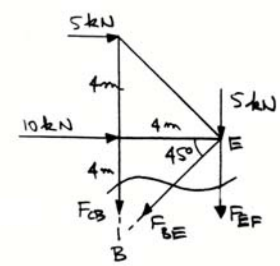
b) Analyze the top section (no support reactions!).

c) Draw the FBD of the top section.

d) Apply the equations of equilibrium such that every equation yields answer to one unknown.

Example 2 (cont'd)





$+\rightarrow \Sigma F_x = 5 + 10 - F_{BE} \cos 45^{o} = 0$

$F_{BE} = 21.2$ kN (T)

$+ \Sigma M_E = -5(4) + F_{CB}(4) = 0$

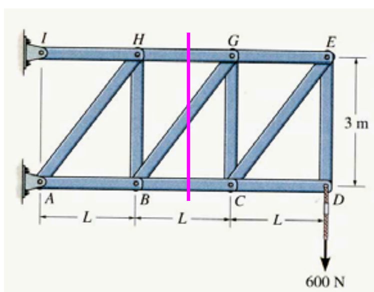
$F_{CB} = 5$ kN (T)

$+ \Sigma M_B = -5(8) - 10(4) - 5(4) - F_{EF}(4) = 0$

$F_{EF} = -25$ kN or 25 kN (C)

Attention Quiz

1. As shown, a cut is made through members *GH*, *BG* and *BC* to determine the forces in them. Which section will you choose for analysis and why?



A) Right, fewer calculations.

B) Left, fewer calculations.

C) Either right or left, same amount of work.

D) None of the above, too many unknowns.

Attention Quiz (cont'd)

2. When determining the force in member *GH* in the previous question, which one equation of equilibrium is best to use?

A) $\Sigma M_H = 0$

B) $\Sigma M_G = 0$

C) $\Sigma M_B = 0$

D) $\Sigma M_C = 0$