Lesson 6: Truss Analysis - Determinate Trusses

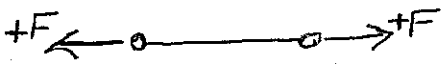
Reading: Text Chapter 4

A. Characteristics of trusses

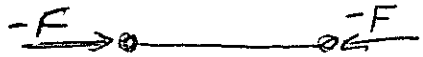
1. Bars are straight & carry only axial load
2. Members are connected by frictionless pins
3. Loads are applied only at joints

→ Sign Convention

- Positive axial force is tension (T)



- Negative axial force is compression (C)



B. Stability & Determinacy in Trusses

- We loose ΣM for individual bars in truss analysis, Now only 2 Eqns. of Equilibrium per joint:

IF ALL Elements are triangular:

Define: r = # of truss reactions
b = # of bars
n = # of joints

Stable, determinant: if $r+b=2n$
unstable if $r+b<2n$
Stable, indeterminate: if $r+b>2n$

degree of indeterminacy $= r+b-2n$

- Remember rules of parallel and concurrent force systems apply to trusses.
- Trusses with non-triangular elements are more complicated, see homework problem.

C. ANALYSIS: METHOD OF JOINTS

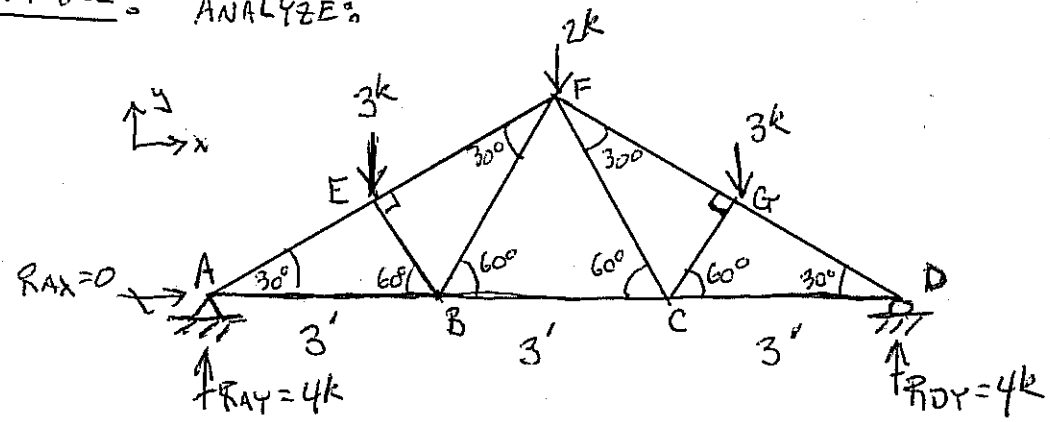
Systematic analysis by balancing forces at every joint.

- Draw FBD for joints with unknown loads
  - Each joint yields 2 eqns. of equilibrium

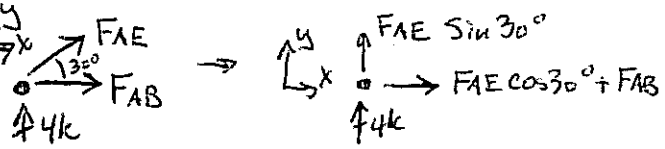
$$\Sigma F_x = 0, \quad \Sigma F_y = 0$$

  - Decompose sloped bar forces into horizontal and vertical components
  - Draw unknown forces in tension, incorrect assumption yields negative result

EXAMPLE: ANALYZE:



JOINT A



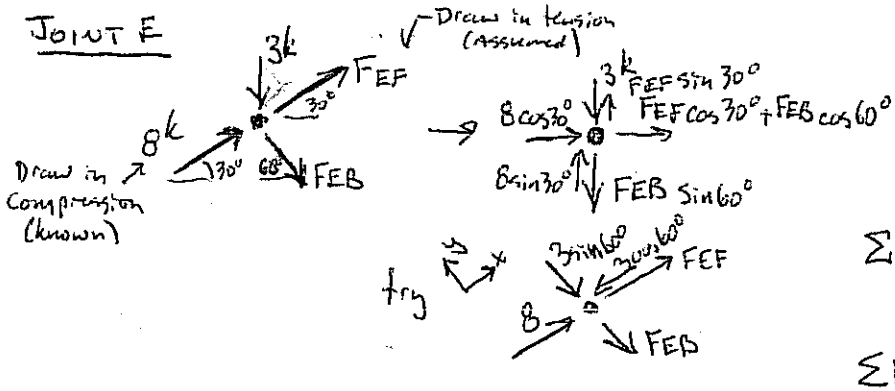
$\Sigma F_y = 0]\ F_{AE}\sin 30° + 4k = 0$

$F_{AE} = -8^k$ COMP.

$\Sigma F_x = 0]\ F_{AE}\cos 30° + F_{AB} = 0$

$F_{AB} = 6.93^k$ TENS.

JOINT E



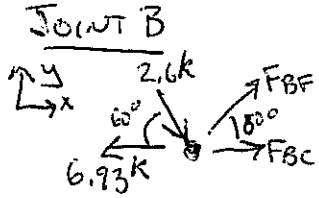
$\Sigma F_y = 0]\ -3\sin 60° - F_{EB} = 0$

$F_{EB} = -2.6^k$ COMP.

$\Sigma F_x = 0]\ 8 - 3\cos 60° + F_{EF} = 0$

$F_{EF} = 6.5^k$ COMP.

JOINT B



$\Sigma F_y = 0]\ -2.6\sin 60° + F_{BF}\sin 60° = 0$

$F_{BF} = 2.6^k$ TENS.

$\Sigma F_x = 0]\ -6.3 + 2.6\cos 60° + F_{BF}\cos 60° + F_{BC} = 0$

$F_{BC} = 4.3^k$ TENS.

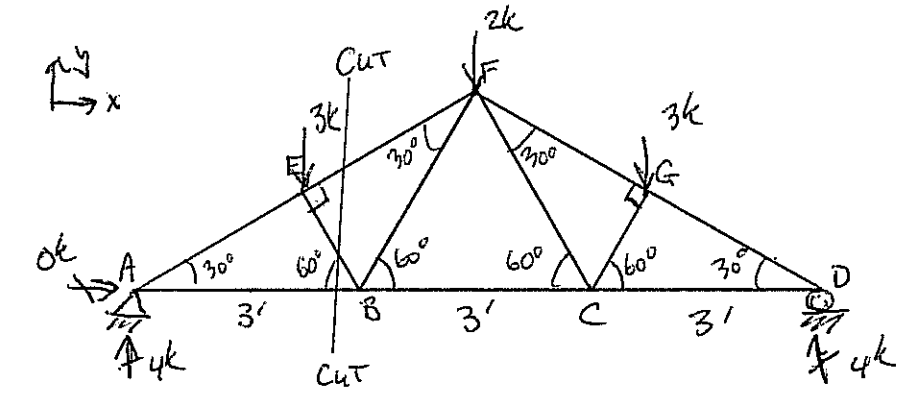
NOTE: Exploit symmetry. DONE!

D. Analysis: Method of Sections

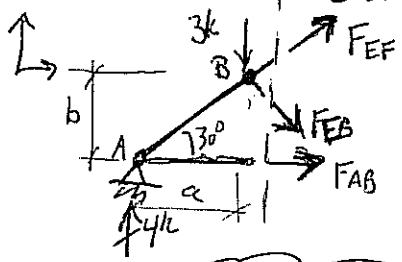
Cut a truss by passing imaginary plane through members. "Throw away" part of structure

- Useful for determining specific member forces
- Resulting force system is not concurrent,
  - therefore 3 eqns of equilibrium:
    $\Sigma F_x = 0]$, $\Sigma F_y = 0]$, $\Sigma M = 0]$
  - Works best when cut intersects 3 members

Example: Find forces in Members EF, EB, and AB



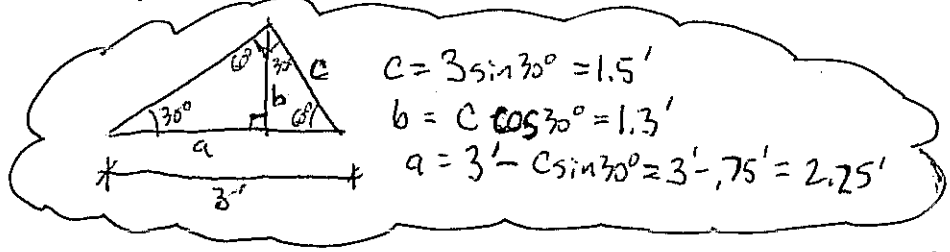
Cut structure where indicated.



$\Sigma F_x = 0]$ $F_{EF}\cos 30° + F_{EB}\cos 60° + F_{AB} = 0$

$\Sigma F_y = 0]$ $F_{EF}\sin 30° - F_{EB}\sin 60° - 3^k + 4^k = 0$

(4) $\Sigma M_A = 0]$ $-3a - (F_{EB}\sin 60°)a - (F_{EB}\cos 60°)b = 0$



$c = 3\sin 30° = 1.5'$

$b = c\cos 30° = 1.3'$

$a = 3' - c\sin 30° = 3' - .75' = 2.25'$

3 simultaneous eqns. to find 3 unknowns.

$F_{EB}(a\sin 60° + b\cos 60°) = 3a \rightarrow F_{EB} = -2.6^k$ Comp.

$\sin 30° F_{EF} = -3.25 \rightarrow F_{EF} = -6.5^k$ Comp.

$F_{AB} = 6.5^k \cos 30° + 2.6^k \cos 60° \rightarrow F_{AB} = 6.93^k$ Tens.