

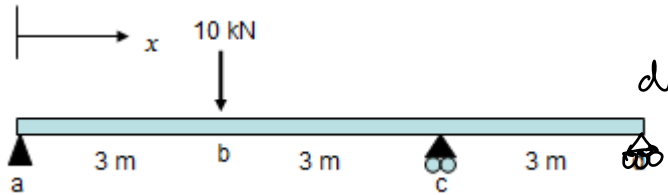
EXAMPLES

5.1: Force method (Beams & Frames)

Example-Beam

Example 1: Use the force method to determine the reactions as well as shear and moment

diagrams. Use “geometric methods” and “integration tables” to compute $\int_0^L m M dx$



Check degree of indeterminacy: $SI =$

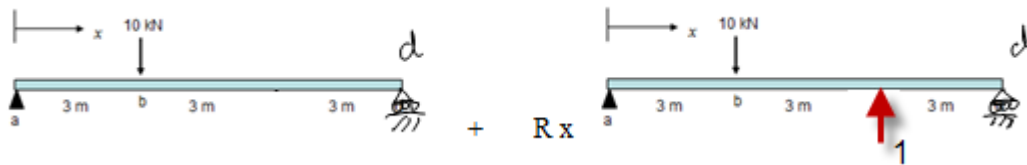
Since $SI =$ \rightarrow we must identify redundant (s)

... use “force method” to solve for member forces ...

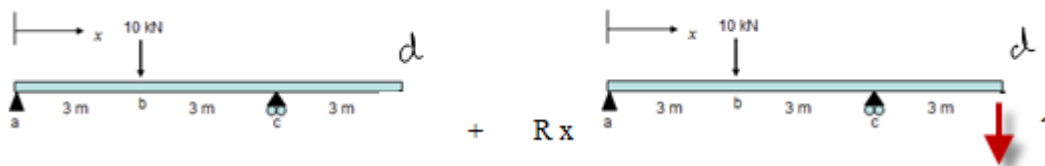
Use superposition to create a primary + redundant structure

Important: can't choose a redundant that will cause structure to be unstable

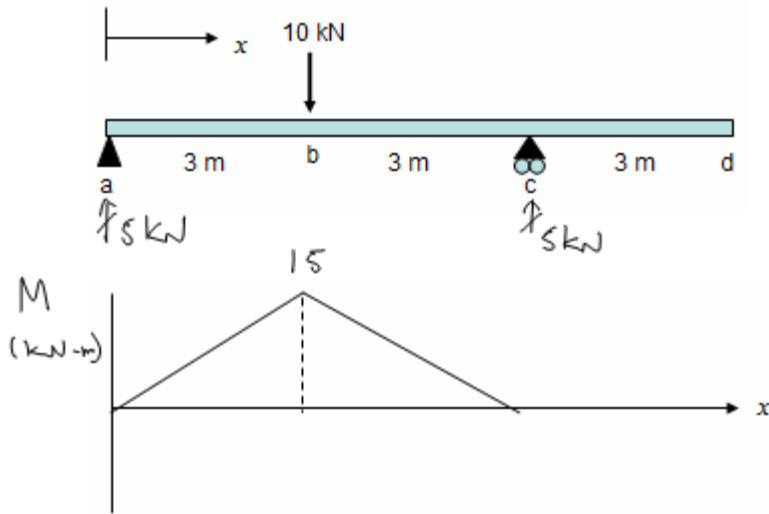
option 1



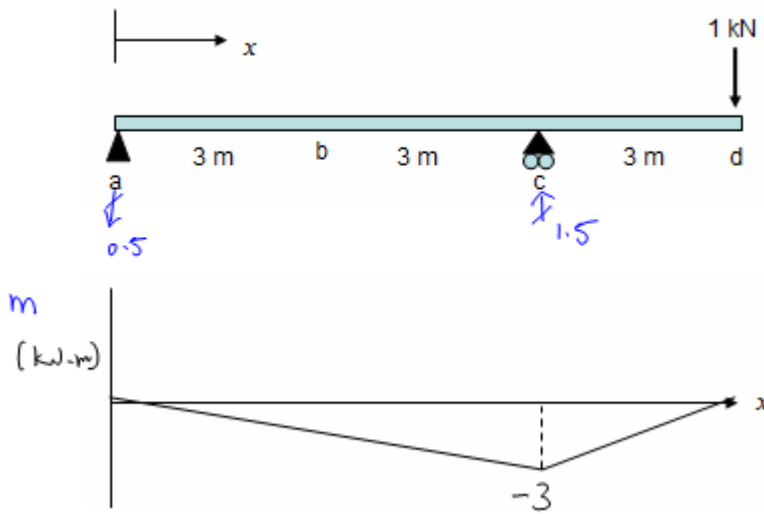
option 2



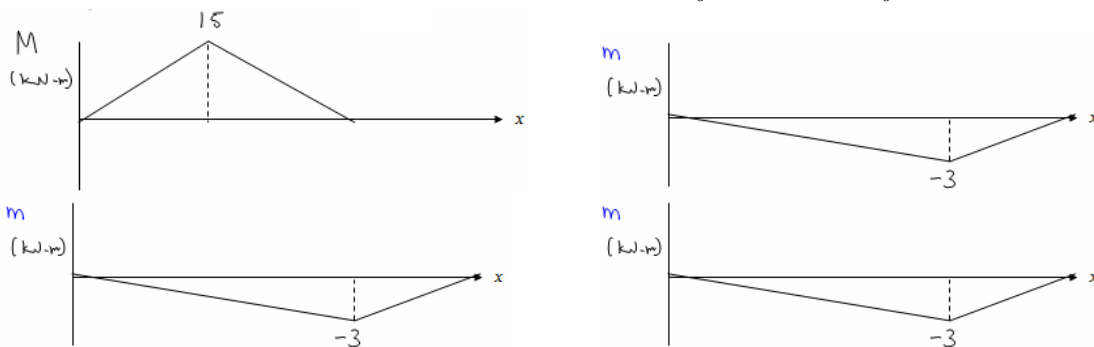
Subject determinate structure to external forces → get M_0

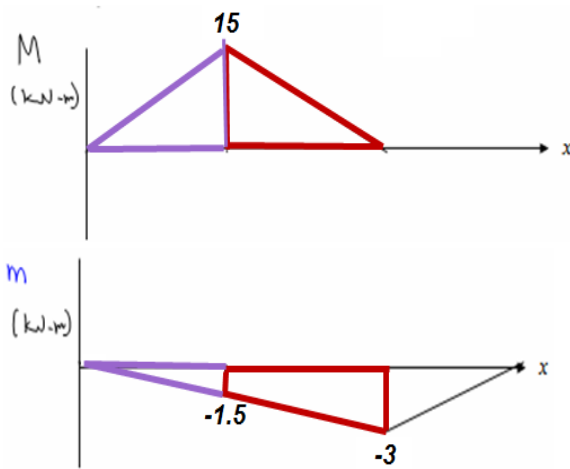


Subject to redundant force "R" in direction of unknown reaction → get m



Using geometric method or integration table to compute $\int_0^L \frac{mM_0}{EI} dx$ and $\int_0^L \frac{mm}{EI} dx$



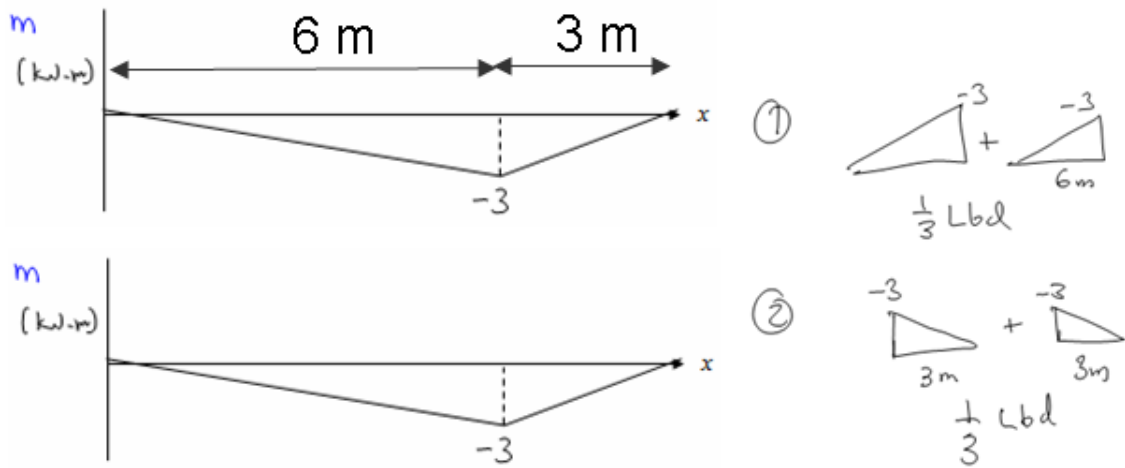


① $b = 15 \quad d = -1.5$

$\frac{1}{3} L b d$

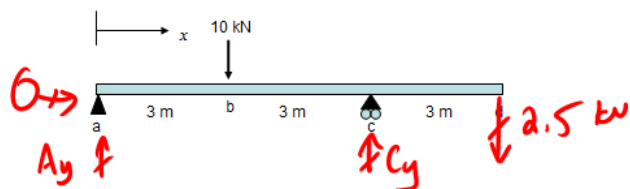
② $\frac{L a}{6} (2c + d)$

Area	$(A)_i$	$(h)_i$	$(A)_i * (h)_i$	Alternative: table
1			Try as an exercise	= -22.5
2			Try as an exercise	= -45.0
				-67.5



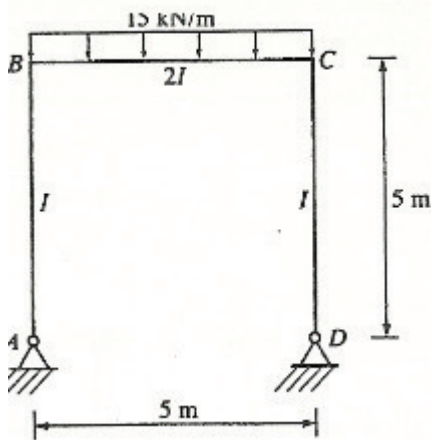
Area	$(A)_i$	$(h)_i$	$(A)_i * (h)_i$	Alternative: table
1	Try as an exercise			= 18
2	Try as an exercise			= 9
				27

Solve for remaining reactions and draw V and M ...



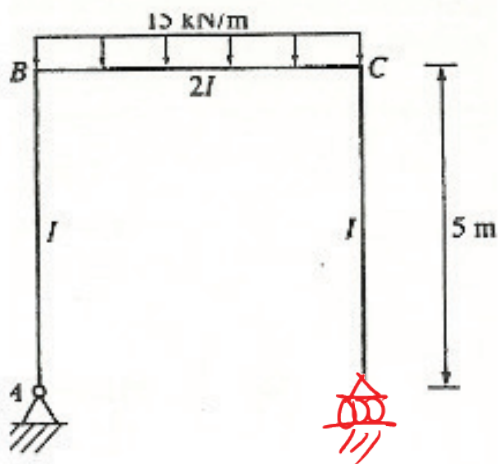
Example-Frame**Example**

Use the force method to determine the reactions as well as shear and moment diagrams.

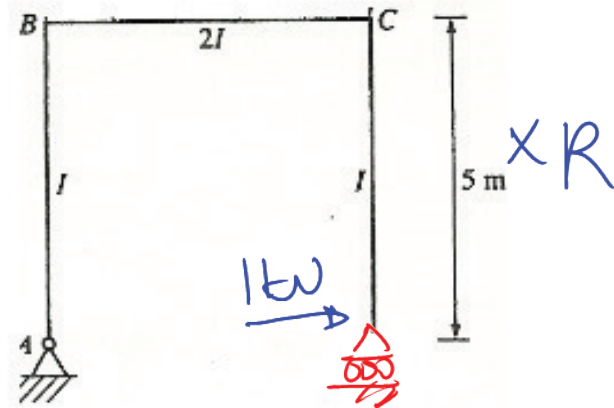


$$SI = 1$$

Check degree of indeterminacy: $SI = 1$, choose 1 redundant

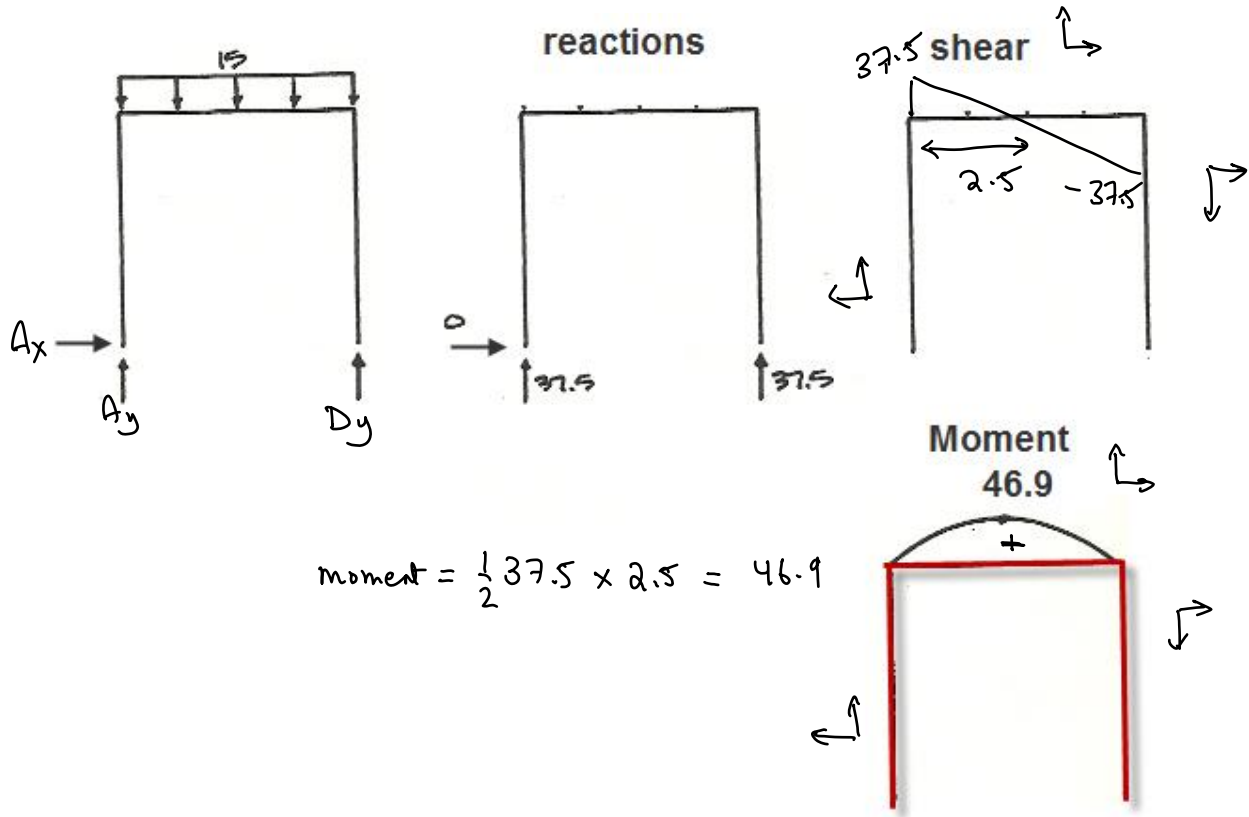


PRIMARY

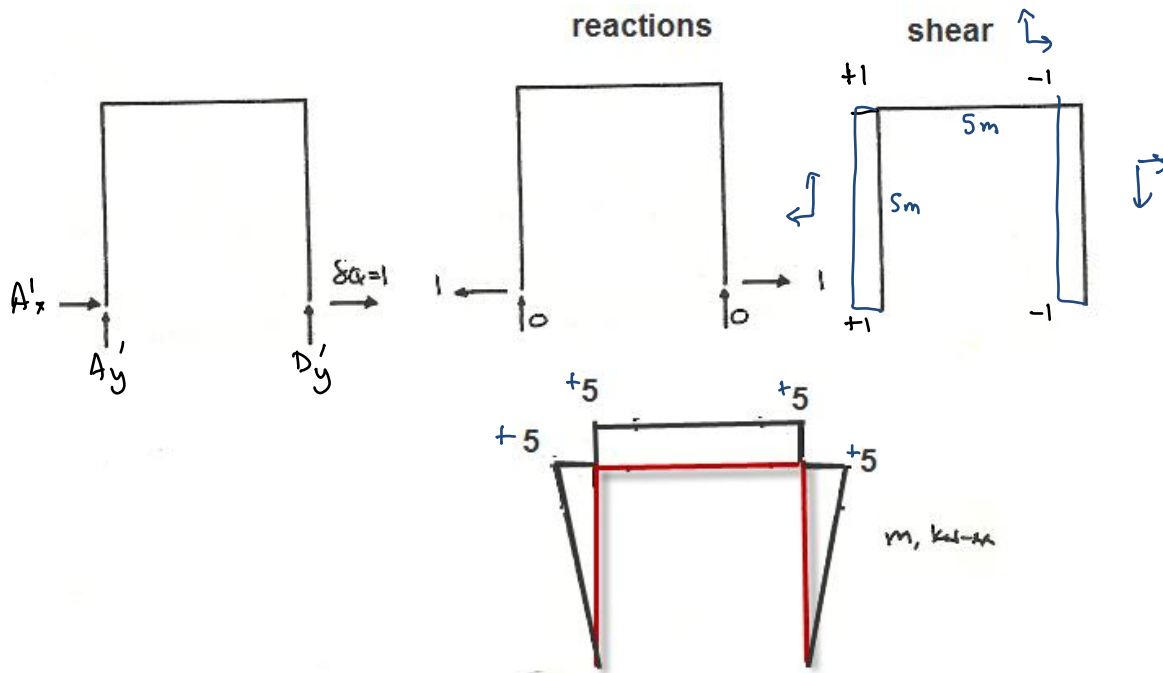


REDUNDANT

Subject determinate structure to external forces \rightarrow get M_0



Subject to redundant force "R" in direction of unknown reaction \rightarrow get m

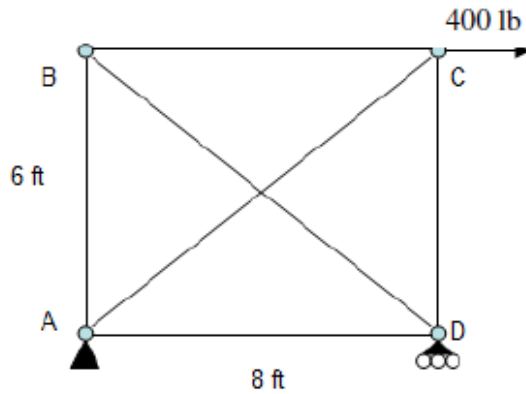


Using geometric method or integration table to compute $\int_0^L \frac{mM_o}{EI} dx$ and $\int_0^L \frac{mm}{EI} dx$

EXAMPLES 6.1: Force method (Trusses)

Example #1 (Hibbeler, p. 422)

Determine the force in each member of the truss shown below. EA is constant for all members.



Check degree of indeterminacy: $SI = (b + r) - 2j =$

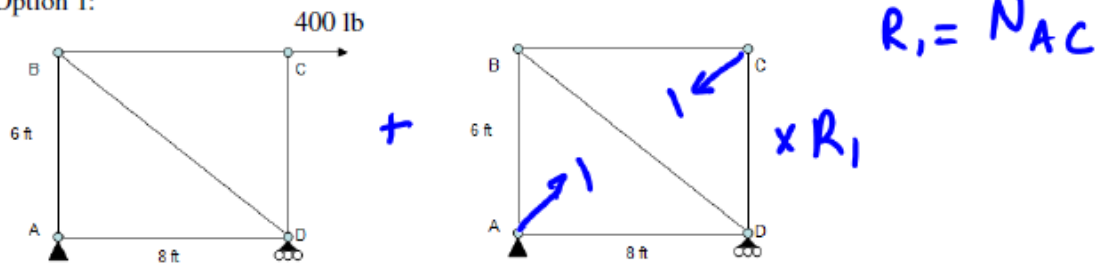
Since $SI =$ \rightarrow we must identify redundant (s)

... use "force method" to solve for member forces ...

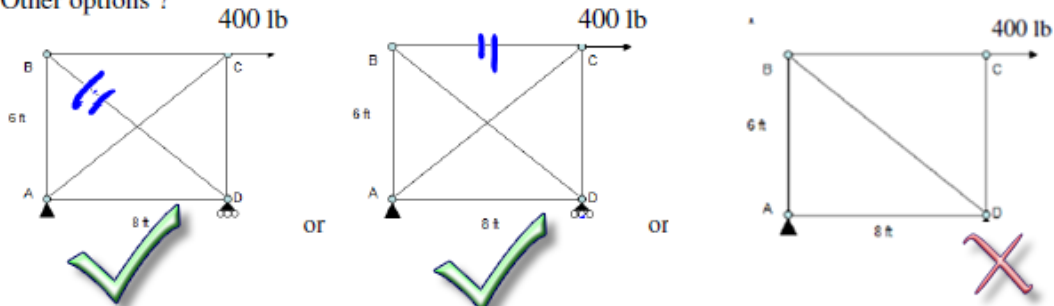
Use superposition to create a primary + redundant structure

Important: can't choose a redundant that will cause structure to be unstable

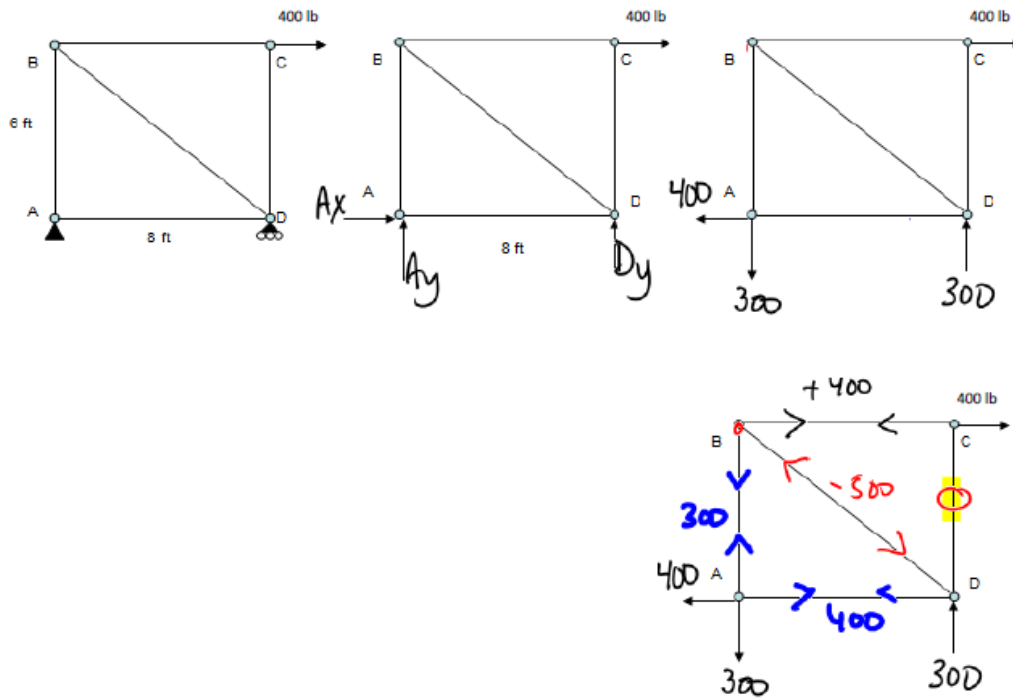
Option 1:



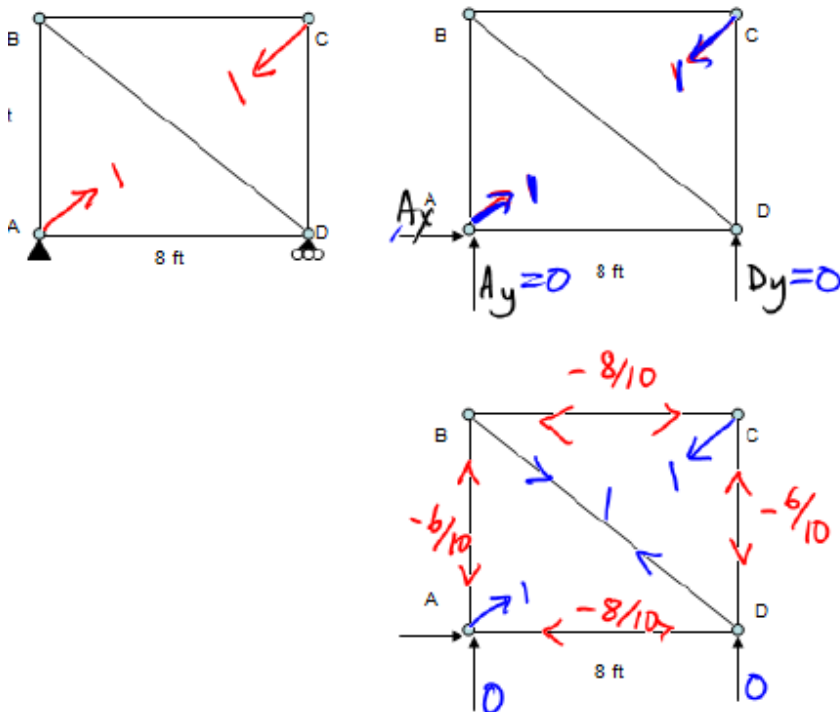
Other options ?



Solve for member forces in $P_0 \rightarrow$ get N_{0i}



Solve for member forces in $p_1 \rightarrow$ get n_i



Member	L	N_{0i}	n_i	$N_{0i} n_i L$	$n_i n_i L$
	(ft)	(lbs)	(lbs)	(lb ² -ft)	(lb ² -ft)
AB	6	300	-0.6	-1080	2.16
BC	8	400	-0.8	-2560	5.12
CD	6	0	-0.6	0	2.16
AD	8	400	-0.8	-2560	5.12
AC	10	0	1	0	10
BD	10	-500	1	-5000	10
			Σ		

Write the compatibility equation:

$$\Delta_{total} = \Delta_R + \Delta_x$$

$$\Delta_{total} = \Delta_R + R \times f_R$$

Evaluate the compatibility equation

$$1 \times \Delta_R = \sum n_i \frac{N_{0i} L_i}{AE}$$

$$1 \times f_R = \sum n_i \frac{n_i L_i}{AE}$$

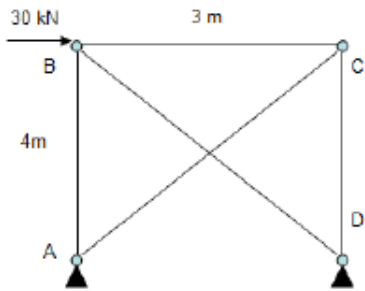
Solve the compatibility equation: $\Delta_{total} = \Delta_R + R \times f_R$

Get member forces ... either by equilibrium or using $N_i = N_{oi} + R \times n_i$

Member	N_{oi}	n_i	$N_i = N_{oi} + R \times n_i$	C/T?
AB	300	-0.6	106	T
BC	400	-0.8	141	
CD	0	-0.6	194	C
AD	400	-0.8	141	T
AC	0	1	325	T
BD	-500	1	-176	C

Example #2

Determine the force in each member of the truss shown below. The cross-sectional area, A of all members is $= 500 \text{ mm}^2$, and $E = 200 \text{ GPa}$.



Check degree of indeterminacy: $SI = (b + r) - 2j = 1$

Since $SI = 1 \rightarrow$ we must identify 1 redundant(s)

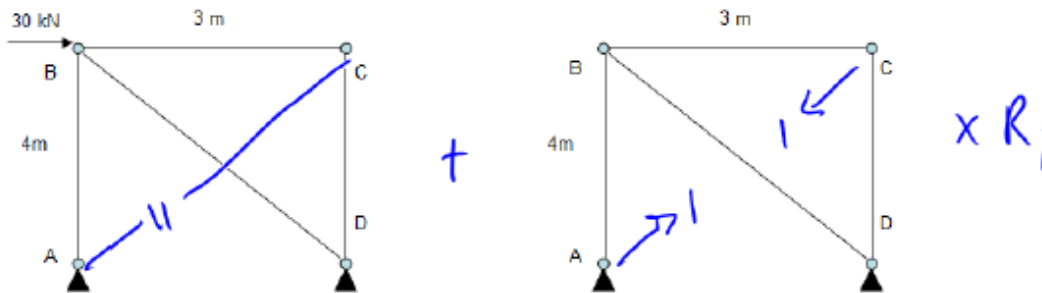
$\rightarrow R_1$

... use "force method" to solve for member forces ...

Use superposition to create a primary + redundant structure

Important: can't choose a redundant that will cause structure to be unstable

Option #1 :



Option #2 :

