

1. Find Displacements  $\{P\} = [S] \{d\}$
2. Member Forces
3. Reactions

$E = 30 \times 10^3 \text{ ksi}$

1.  $\{P\} = \begin{Bmatrix} P_1 \\ P_2 \end{Bmatrix} = \begin{Bmatrix} -48 \\ 144 \end{Bmatrix} \text{ lbs}$

$[S] \rightarrow$  code # assembly to get  $[S]$  from member  $k_{ij}$ s

member #	code #	$M_1, Q_1$	$M_2, Q_2$
1	3	1	
2	1		2
3	2		4

$$[S] = \begin{matrix} & \begin{matrix} d_1 \\ d_2 \end{matrix} \\ \begin{matrix} 1 \\ 2 \end{matrix} & \begin{bmatrix} k_{22}^1 + k_{11}^2 & k_{12}^2 \\ k_{21}^2 & k_{22}^2 + k_{11}^3 \end{bmatrix} \end{matrix} = \begin{bmatrix} 572917 & -416667 \\ -416667 & 604167 \end{bmatrix}$$

1  $[k]^1 = 3 \begin{bmatrix} k_{11}^1 & k_{12}^1 \\ k_{21}^1 & k_{22}^1 \end{bmatrix}$

$$[k] = \frac{EA}{L} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} = \begin{bmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{bmatrix}$$

2  $[k]^2 = 1 \begin{bmatrix} k_{11}^2 & k_{12}^2 \\ k_{21}^2 & k_{22}^2 \end{bmatrix}$

3  $[k]^3 = 2 \begin{bmatrix} k_{11}^3 & k_{12}^3 \\ k_{21}^3 & k_{22}^3 \end{bmatrix}$

	E	A	L	$\frac{EA}{L}$
1	30e6	0.25	48	156250
2	30e6	0.5	36	416667
3	30e6	0.15	24	187500
	psi	in <sup>2</sup>	in.	lbs/in

\* consistent units \*

$$\{P\} = [S] \{d\}$$

$$\{d\} = [S]^{-1} \{P\}$$

$$\begin{Bmatrix} -48 \\ 144 \end{Bmatrix} = \begin{bmatrix} 572917 & -416667 \\ -416667 & 604167 \end{bmatrix} \begin{Bmatrix} d_1 \\ d_2 \end{Bmatrix}$$

$$\begin{Bmatrix} d_1 \\ d_2 \end{Bmatrix} = \begin{Bmatrix} 1.7968 \\ 3.6226 \end{Bmatrix} \times 10^{-4} \text{ in.}$$

Solution step



Post-processing

2. Member Forces

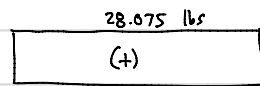
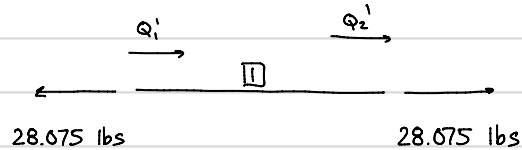


$$\{Q\} = [k] \{u\}$$

$$\begin{Bmatrix} Q_1 \\ Q_2 \end{Bmatrix} = \begin{bmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \end{Bmatrix}$$

□  $\begin{Bmatrix} Q_1' \\ Q_2' \end{Bmatrix} = 156250 \text{ lbs/in} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{Bmatrix} u_1' \\ u_2' \end{Bmatrix}$  support B.C. compatibility !!  
 $u_1' \rightarrow 0$   
 $u_2' \rightarrow d_1 = 1.7968 \times 10^{-4} \text{ in.}$

$$\begin{Bmatrix} Q_1' \\ Q_2' \end{Bmatrix} = \begin{Bmatrix} -28.075 \\ 28.075 \end{Bmatrix} \text{ lbs}$$



axial force diagram



axial force

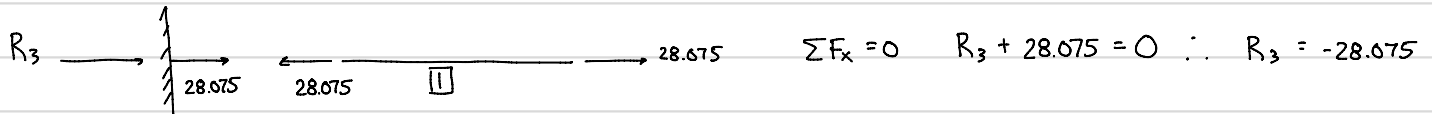
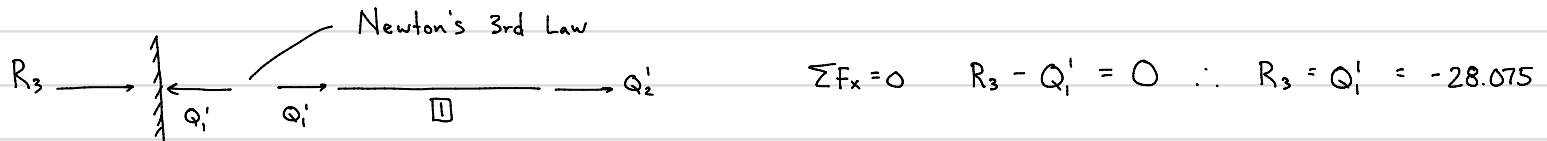
Same process for □, □

$$\begin{Bmatrix} Q_1^2 \\ Q_2^2 \end{Bmatrix} = \begin{Bmatrix} -76.075 \\ 76.075 \end{Bmatrix} \text{ lbs tension}$$

$$\begin{Bmatrix} Q_1^3 \\ Q_2^3 \end{Bmatrix} = \begin{Bmatrix} 67.925 \\ -67.925 \end{Bmatrix} \text{ lbs compression}$$

sign of  $Q_2$  indicates tension/compression  
 (+) (-)

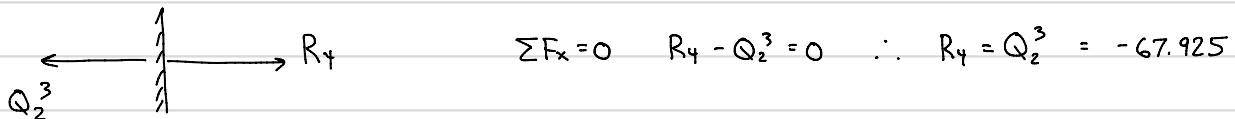
### 3. Find Reactions (joint equilibrium)



$$R_3 = 28.075 \text{ lbs } \leftarrow$$

Determining  $R_4$ :

Option 1 - joint equilibrium



$$R_4 = 67.925 \text{ lbs } \leftarrow$$

Option 2 - overall equilibrium

$$\sum F_x = 0 \quad R_3 + R_4 + P_1 + P_2 = 0$$

$$-28.075 + R_4 - 48 + 144 = 0$$

$$R_4 = -67.925$$

\* overall equilibrium good final check