

-----1

-1

$$\text{solve}\left(\left\{\begin{array}{l} v_l + v_r = 60 \\ 60 \cdot 6 - 18 \cdot v_r = 0 \end{array}\right\}, \{v_l, v_r\}\right)$$

 $v_l = 40$  and  $v_r = 20$ 

-----2

2

$$\text{solve} \left\{ \begin{array}{l} \frac{f1}{\sqrt{2}} + f2 = 0 \\ 40 + \frac{f1}{\sqrt{2}} = 0 \\ \frac{-f5}{\sqrt{2}} + \frac{f4}{\sqrt{2}} = 0 \\ \frac{-f5}{\sqrt{2}} - \frac{f4}{\sqrt{2}} - f6 = 0, \{f1, f2, f3, f4, f5, f6, f7\} \\ -f2 + f3 - \frac{f7}{\sqrt{5}} = 0 \\ f6 + \frac{2 \cdot f7}{\sqrt{5}} = 0 \\ -f3 - \frac{f4}{\sqrt{2}} = 0 \end{array} \right.$$

$$f1 = -40 \cdot \sqrt{2} \text{ and } f2 = 40 \text{ and } f3 = 20 \text{ and } f4 = -20 \cdot \sqrt{2} \text{ and } f5 = -20 \cdot \sqrt{2} \text{ and } f6 = 40 \text{ and } f7 = -20 \cdot \sqrt{5}$$

-----3

-3

$$60 \cdot 3 \cdot b - 2 \cdot 20 \cdot b \rightarrow a$$

$$140 \cdot b$$

$$\text{solve}\left(\frac{f5 \cdot 1000}{a} = 20, b\right) | f5 = -20 \cdot \sqrt{2}$$

$$b = -10.1015$$

$$\text{solve}\left(\frac{f6 \cdot 1000}{a} = 10, b\right) | f6 = 40$$

$$b = 28.5714$$

[]

-----1

1

$$\text{solve} \left( \begin{cases} ha+he=0 \\ va+ve=100 \\ 6 \cdot va - 3 \cdot ha - 20 \cdot 3 = 0 \\ -6 \cdot ve - 4 \cdot he + 40 \cdot (3+6) = 0 \end{cases}, \{va, ha, ve\} \right)$$

$$ha = \frac{180}{7} \text{ and } he = \frac{-180}{7} \text{ and } va = \frac{160}{7} \text{ and } ve = \frac{540}{7}$$

-----2

-2

$$\text{solve} \left( \frac{160}{7} \cdot 3 - \frac{180}{7} \cdot 1.5 + \frac{3 \cdot fg \cdot 0.5}{\sqrt{3^2 + (0.5)^2}} + \frac{0.5 \cdot fg \cdot 3}{\sqrt{3^2 + (0.5)^2}} = 0, fg \right) \quad fg = -30.4138$$

-----3

3

$$\text{solve} \left( 40 \cdot 3 - \frac{540}{7} \cdot 3 + \frac{180}{7} \cdot 3 + \frac{3 \cdot cd \cdot 1}{\sqrt{3^2 + 2^2}} = 0, cd \right) \quad cd = 41.2063$$

-----4

-4

$$\text{solve} \left( 40 \cdot 3 - \frac{540}{7} \cdot 3 + \frac{180}{7} \cdot 2 - \frac{1 \cdot ij \cdot 3}{\sqrt{3^2 + 1^2}} = 0, ij \right) \quad ij = -63.2456$$

[]

-----1

-1

$$\text{solve} \left( \begin{cases} \frac{2 \cdot f1}{\sqrt{13}} - f2 = 0 \\ \frac{p \cdot 2}{3} + \frac{3 \cdot f1}{\sqrt{13}} = 0 \\ \frac{-4}{5} \cdot f3 - f4 = 0 \\ \frac{3 \cdot f3}{5} + \frac{p}{3} = 0 \end{cases}, \{f1, f2, f3, f4\} \right)$$

$$f1 = \frac{-2 \cdot p \cdot \sqrt{13}}{9} \text{ and } f2 = \frac{-4 \cdot p}{9} \text{ and } f3 = \frac{-5 \cdot p}{9} \text{ and } f4 = \frac{4 \cdot p}{9}$$

-----2

-2

$$\{f1, f2, f3, f3, f4, f4, p\} | f1 = \frac{-2 \cdot p \cdot \sqrt{13}}{9} \text{ and } f2 = \frac{-4 \cdot p}{9} \text{ and } f3 = \frac{-5 \cdot p}{9} \text{ and } f4 = \frac{4 \cdot p}{9} \rightarrow f$$

$$\left\{ \frac{-2 \cdot p \cdot \sqrt{13}}{9}, \frac{-4 \cdot p}{9}, \frac{-5 \cdot p}{9}, \frac{-5 \cdot p}{9}, \frac{4 \cdot p}{9}, \frac{4 \cdot p}{9}, p \right\}$$

$$\{2 \cdot a0, a0, a0, a0, a0, a0, 2 \cdot a0\} \rightarrow a \qquad \{2 \cdot a0, a0, a0, a0, a0, a0, 2 \cdot a0\}$$

$$1000 \cdot \{\sqrt{13}, 2, 2.5, 2.5, 2, 2, 3\} \rightarrow l \qquad \{1000 \cdot \sqrt{13}, 2000, 2500., 2500., 2000, 2000, 3000\}$$

$$\sum \left( \frac{f^2 \cdot l}{2 \cdot e \cdot a} \right) |_{e=205000 \rightarrow u}$$

$$\frac{0.013136 \cdot p^2}{a0}$$

-----3

-3

$$\frac{d}{dp}(u) |_{p=60000 \text{ and } a0=400}$$

$$3.94078$$

[]

PE.A-91-4-1(SM)

$$\begin{bmatrix} 0 & -1 & 0 & 0 & 0 & \frac{-1}{\sqrt{2}} \\ 1 & 0 & 0 & 0 & 0 & \frac{1}{\sqrt{2}} \\ 0 & 0 & 1 & 0 & \frac{1}{\sqrt{2}} & 0 \\ 0 & 1 & 0 & 0 & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 0 & 1 & 0 & \frac{1}{\sqrt{2}} \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} 0 & -1 & 0 & 0 & 0 & \frac{-\sqrt{2}}{2} \\ 1 & 0 & 0 & 0 & 0 & \frac{\sqrt{2}}{2} \\ 0 & 0 & 1 & 0 & \frac{\sqrt{2}}{2} & 0 \\ 0 & 1 & 0 & 0 & \frac{\sqrt{2}}{2} & 0 \\ 0 & 0 & 0 & 1 & 0 & \frac{\sqrt{2}}{2} \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{\sqrt{2}} \end{bmatrix} \cdot 210 \cdot 753 \rightarrow s$$

$$\begin{bmatrix} 158130 & 0 & 0 & 0 & 0 & 0 \\ 0 & 158130 & 0 & 0 & 0 & 0 \\ 0 & 0 & 158130 & 0 & 0 & 0 \\ 0 & 0 & 0 & 158130 & 0 & 0 \\ 0 & 0 & 0 & 0 & 79065 \cdot \sqrt{2} & 0 \\ 0 & 0 & 0 & 0 & 0 & 79065 \cdot \sqrt{2} \end{bmatrix}$$

$$(a \cdot s \cdot a^T)^{-1} \cdot \begin{bmatrix} 5 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \qquad \begin{bmatrix} 0.000076 \\ 0.000016 \\ -0.000016 \\ 0.000061 \\ 0.000016 \end{bmatrix}$$

$$s \cdot a^T \cdot (a \cdot s \cdot a^T)^{-1} \cdot \begin{bmatrix} 5 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \qquad \begin{bmatrix} 2.5 \\ -2.5 \\ -2.5 \\ 2.5 \\ 3.53553 \\ -3.53553 \end{bmatrix}$$

[]



PE.A-91-4-1(EM)

$$\left\{0,-5,-5,0,5\cdot\sqrt{2},0\right\}\rightarrow f1\qquad\qquad\qquad\left\{0,-5,-5,0,5\cdot\sqrt{2},0\right\}$$

$$\left\{\frac{-1}{\sqrt{2}},\frac{-1}{\sqrt{2}},\frac{-1}{\sqrt{2}},\frac{-1}{\sqrt{2}},1,1\right\}\rightarrow f2\qquad\qquad\qquad\left\{\frac{-\sqrt{2}}{2},\frac{-\sqrt{2}}{2},\frac{-\sqrt{2}}{2},\frac{-\sqrt{2}}{2},1,1\right\}$$

$$5000\cdot\left\{1,1,1,1,\sqrt{2},\sqrt{2}\right\}\rightarrow l\qquad\qquad\qquad\left\{5000,5000,5000,5000,5000\cdot\sqrt{2},5000\cdot\sqrt{2}\right\}$$

$$210\cdot 753\rightarrow ea\qquad\qquad\qquad 158130$$

$$\text{solve}\left(0=\text{sum}\left(\frac{f1\cdot f2\cdot l}{ea}\right)+x\cdot\text{sum}\left(\frac{f2^2\cdot l}{ea}\right),x\right)\qquad\qquad\qquad x=-3.53553$$

$$f1+x\cdot f2|x=\frac{-5\cdot\sqrt{2}}{2}\qquad\qquad\qquad\left\{2.5,-2.5,-2.5,2.5,3.53553,-3.53553\right\}$$

$$\square$$

PE.A-116-4-6

-----1

1

21.1  $\rightarrow a1$

21.1

10.55  $\rightarrow a2$

10.55

2.1  $\cdot 10^5 \rightarrow e$

210000.

-----2

2

$$\text{solve} \left\{ \begin{array}{l} f_2 + \frac{3}{\sqrt{10}} \cdot f_3 = 0 \\ \frac{-p}{2} + 2 \cdot p + \frac{q}{2} - \frac{1}{\sqrt{10}} \cdot f_3 = 0 \\ -f_2 + f_6 + \frac{3}{\sqrt{10}} \cdot f_7 = 0 \\ -p - f_5 - \frac{1}{\sqrt{10}} \cdot f_7 = 0 \\ \frac{-3}{\sqrt{10}} \cdot f_3 + f_4 = 0 \\ \frac{1}{\sqrt{10}} \cdot f_3 + f_5 = 0 \end{array} \right. , \{f_2, f_3, f_4, f_5, f_6, f_7\}$$

$$f_2 = \frac{-3 \cdot (3 \cdot p + q)}{2} \text{ and } f_3 = \frac{(3 \cdot p + q) \cdot \sqrt{10}}{2} \text{ and } f_4 = \frac{3 \cdot (3 \cdot p + q)}{2} \text{ and } f_5 = \frac{-(3 \cdot p + q)}{2} \text{ and } f_6 = -3 \cdot (2 \cdot p + q) \text{ and } f_7 = \frac{(p + q) \cdot \sqrt{10}}{2}$$

$$\left\{-\left(2\cdot p+\frac{q}{2}\right),-\left(2\cdot p+\frac{q}{2}\right),f2,f2,f3,f3,f4,f4,f5,f5,f6,f6,f7,f7,-p\right\}|f2=\frac{-3\cdot \left(3\cdot p+q\right)}{2}\text{ and }f3=\frac{\left(3\cdot p+q\right)\cdot \sqrt{10}}{2}\text{ and }f4=\frac{3\cdot \left(3\cdot p+q\right)}{2}\text{ a}$$

$$\left\{-2\cdot p-\frac{q}{2},-2\cdot p-\frac{q}{2},\frac{-3\cdot \left(3\cdot p+q\right)}{2},\frac{-3\cdot \left(3\cdot p+q\right)}{2},\frac{\left(3\cdot p+q\right)\cdot \sqrt{10}}{2},\frac{\left(3\cdot p+q\right)\cdot \sqrt{10}}{2},\frac{3\cdot \left(3\cdot p+q\right)}{2},\frac{3\cdot \left(3\cdot p+q\right)}{2},\frac{-\left(3\cdot p+q\right)}{2},\frac{-\left(3\cdot p+q\right)}{2}\right\}$$

$$\left\{1,1,3,3,\sqrt{10},\sqrt{10},3,3,1,1,3,3,\sqrt{10},\sqrt{10},1\right\}\rightarrow l\qquad\qquad\qquad\left\{1,1,3,3,\sqrt{10},\sqrt{10},3,3,1,1,3,3,\sqrt{10},\sqrt{10},1\right\}$$

$$\left\{a2,a2,a1,a1,a2,a2,a1,a1,a2,a2,a1,a1,a2,a2,a2\right\}\rightarrow a$$

$$\left\{10.55,10.55,21.1,21.1,10.55,10.55,21.1,21.1,10.55,10.55,21.1,21.1,10.55,10.55,10.55\right\}$$

$$\text{sum}\left(\frac{f^2\cdot l}{2\cdot e\cdot a}\right)\rightarrow u\qquad\qquad\qquad 0.000091\cdot p^2+0.000073\cdot p\cdot q+0.000017\cdot q^2$$

$$\frac{d}{dq}(u)|_{q=0}\qquad\qquad\qquad 0.000073\cdot p$$

$$\square$$

-----1

-1

$$\frac{ea}{l0} \cdot \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} | ea=200000 \cdot 6000 \rightarrow kij$$



$$\begin{bmatrix} \frac{1200000000}{l0} & 0 & \frac{-1200000000}{l0} & 0 \\ 0 & 0 & 0 & 0 \\ \frac{-1200000000}{l0} & 0 & \frac{1200000000}{l0} & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 & 0 \\ -\sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & \cos(\theta) & \sin(\theta) \\ 0 & 0 & -\sin(\theta) & \cos(\theta) \end{bmatrix} \rightarrow tk$$

$$\begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 & 0 \\ -\sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & \cos(\theta) & \sin(\theta) \\ 0 & 0 & -\sin(\theta) & \cos(\theta) \end{bmatrix}$$

-----2. k12

-2. k12

$$tk^T \cdot kij \cdot tk|l0 = \frac{12000}{\sqrt{3}} \text{ and } \theta = -150^\circ$$

$$\begin{bmatrix} 75000 \cdot \sqrt{3} & 75000 & -75000 \cdot \sqrt{3} & -75000 \\ 75000 & 25000 \cdot \sqrt{3} & -75000 & -25000 \cdot \sqrt{3} \\ -75000 \cdot \sqrt{3} & -75000 & 75000 \cdot \sqrt{3} & 75000 \\ -75000 & -25000 \cdot \sqrt{3} & 75000 & 25000 \cdot \sqrt{3} \end{bmatrix}$$

$$\begin{bmatrix} 75000 \cdot \sqrt{3} & 75000 & -75000 \cdot \sqrt{3} & -75000 & 0 & 0 \\ 75000 & 25000 \cdot \sqrt{3} & -75000 & -25000 \cdot \sqrt{3} & 0 & 0 \\ -75000 \cdot \sqrt{3} & -75000 & 75000 \cdot \sqrt{3} & 75000 & 0 & 0 \\ -75000 & -25000 \cdot \sqrt{3} & 75000 & 25000 \cdot \sqrt{3} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \rightarrow k_{12}$$

$$\begin{bmatrix} 75000 \cdot \sqrt{3} & 75000 & -75000 \cdot \sqrt{3} & -75000 & 0 & 0 \\ 75000 & 25000 \cdot \sqrt{3} & -75000 & -25000 \cdot \sqrt{3} & 0 & 0 \\ -75000 \cdot \sqrt{3} & -75000 & 75000 \cdot \sqrt{3} & 75000 & 0 & 0 \\ -75000 & -25000 \cdot \sqrt{3} & 75000 & 25000 \cdot \sqrt{3} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

-----2.  $k_{13}$

-2.  $k_{13}$

$$tk^T \cdot k_{ij} \cdot tk|l0 = \frac{6000}{\sqrt{3}} \text{ and } \theta = -90^\circ$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 200000 \cdot \sqrt{3} & 0 & -200000 \cdot \sqrt{3} \\ 0 & 0 & 0 & 0 \\ 0 & -200000 \cdot \sqrt{3} & 0 & 200000 \cdot \sqrt{3} \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 200000 \cdot \sqrt{3} & 0 & 0 & 0 & -200000 \cdot \sqrt{3} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -200000 \cdot \sqrt{3} & 0 & 0 & 0 & 200000 \cdot \sqrt{3} \end{bmatrix} \rightarrow k_{13}$$

----- $-2 \cdot k_{23\_}$

$tk^T \cdot kij \cdot tk|l=6000$  and  $\theta=0^\circ$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 200000 & 0 & -200000 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -200000 & 0 & 200000 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \rightarrow k_{23}$$

----- $-2 \cdot k_t\_$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 200000 \cdot \sqrt{3} & 0 & 0 & 0 & -200000 \cdot \sqrt{3} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -200000 \cdot \sqrt{3} & 0 & 0 & 0 & 200000 \cdot \sqrt{3} \end{bmatrix}$$

----- $-2 \cdot k_{23\_}$

$$\begin{bmatrix} 200000 & 0 & -200000 & 0 \\ 0 & 0 & 0 & 0 \\ -200000 & 0 & 200000 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 200000 & 0 & -200000 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -200000 & 0 & 200000 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

----- $-2 \cdot k_t\_$

$$k12+k13+k23 \rightarrow kt \quad \begin{bmatrix} 75000 \cdot \sqrt{3} & 75000 & -75000 \cdot \sqrt{3} & -75000 & 0 & 0 \\ 75000 & 225000 \cdot \sqrt{3} & -75000 & -25000 \cdot \sqrt{3} & 0 & -200000 \cdot \sqrt{3} \\ -75000 \cdot \sqrt{3} & -75000 & 75000 \cdot \sqrt{3} + 200000 & 75000 & -200000 & 0 \\ -75000 & -25000 \cdot \sqrt{3} & 75000 & 25000 \cdot \sqrt{3} & 0 & 0 \\ 0 & 0 & -200000 & 0 & 200000 & 0 \\ 0 & -200000 \cdot \sqrt{3} & 0 & 0 & 0 & 200000 \cdot \sqrt{3} \end{bmatrix}$$

$$\text{-----} -3 \cdot xt \quad \text{-----} -3 \cdot xt$$

$$6000 \cdot 200000 \cdot -20 \cdot 1.2 \cdot 10^{-5} \cdot \begin{bmatrix} \cos(-150^\circ) + \cos(-90^\circ) \\ \sin(-150^\circ) + \sin(-90^\circ) \\ -\cos(-150^\circ) + \cos(0^\circ) \\ -\sin(-150^\circ) + \sin(0^\circ) \\ -\cos(-90^\circ) - \cos(0^\circ) \\ -\sin(-90^\circ) - \sin(0^\circ) \end{bmatrix} \quad \begin{bmatrix} 249415. \\ 432000. \\ -537415. \\ -144000. \\ 288000. \\ -288000. \end{bmatrix}$$

$$\text{-----} -4 \quad \text{-----} -4$$

$$25000 \cdot \begin{bmatrix} 9 \cdot \sqrt{3} & -8 \cdot \sqrt{3} \\ -8 \cdot \sqrt{3} & 8 \cdot \sqrt{3} \end{bmatrix} \rightarrow kaa \quad \begin{bmatrix} 225000 \cdot \sqrt{3} & -200000 \cdot \sqrt{3} \\ -200000 \cdot \sqrt{3} & 200000 \cdot \sqrt{3} \end{bmatrix}$$

$$\begin{bmatrix} 432000 \\ -288000 \end{bmatrix} \rightarrow xta \quad \begin{bmatrix} 432000 \\ -288000 \end{bmatrix}$$



$$\begin{bmatrix} -250000 \\ 0 \end{bmatrix} \rightarrow xa$$

$$\begin{bmatrix} -250000 \\ 0 \end{bmatrix}$$

$$kaa^{-1} \cdot (xa - xta) \rightarrow ua$$

$$\begin{bmatrix} -9.09904 \\ -8.26766 \end{bmatrix}$$

-----5

-5

$$25000 \cdot \begin{bmatrix} 3 & 0 \\ -3 & 0 \\ -\sqrt{3} & 0 \\ 0 & 0 \end{bmatrix} \rightarrow kba$$

$$\begin{bmatrix} 75000. & 0. \\ -75000. & 0. \\ -43301.3 & 0. \\ 0. & 0. \end{bmatrix}$$

$$\begin{bmatrix} 249415.31628992 \\ -537415.31628994 \\ -144000. \\ 288000. \end{bmatrix} \rightarrow xtb$$

$$\begin{bmatrix} 249415. \\ -537415. \\ -144000. \\ 288000. \end{bmatrix}$$

$$kba \cdot ua + xtb \rightarrow xb$$

$$\begin{bmatrix} -433013. \\ 145013. \\ 250000. \\ 288000. \end{bmatrix}$$

-----6

-6

$$\frac{6000 \cdot 200000}{\frac{12000}{\sqrt{3}}} \cdot [\cos(-150^\circ) \quad \sin(-150^\circ)] \cdot \begin{bmatrix} 0-0 \\ 0-ua[1,1] \end{bmatrix} - 6000 \cdot 200000 \cdot -20 \cdot 1.2 \cdot 10^{-5} \quad [-500000.]$$

$$\frac{6000 \cdot 200000}{\frac{6000}{\sqrt{3}}} \cdot [\cos(-90^\circ) \quad \sin(-90^\circ)] \cdot \begin{bmatrix} 0-0 \\ ua[2,1]-ua[1,1] \end{bmatrix} - 6000 \cdot 200000 \cdot -20 \cdot 1.2 \cdot 10^{-5} \quad [2.E-8]$$

$$\frac{6000 \cdot 200000}{6000} \cdot [\cos(0^\circ) \quad \sin(0^\circ)] \cdot \begin{bmatrix} 0-0 \\ ua[2,1]-0 \end{bmatrix} - 6000 \cdot 200000 \cdot -20 \cdot 1.2 \cdot 10^{-5} \quad [288000.]$$

[]

-----1

1

$$\begin{bmatrix} \frac{1}{2} & \frac{1}{2} & 1 & 0 & 0 \\ \frac{\sqrt{3}}{2} & \frac{-\sqrt{3}}{2} & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} \frac{1}{2} & \frac{1}{2} & 1 & 0 & 0 \\ \frac{\sqrt{3}}{2} & \frac{-\sqrt{3}}{2} & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 \end{bmatrix}$$

-----2

2

$$\frac{ea}{6000} \cdot \begin{bmatrix} \frac{\sqrt{3}}{2} & 0 & 0 & 0 & 0 \\ 0 & \frac{\sqrt{3}}{2} & 0 & 0 & 0 \\ 0 & 0 & \sqrt{3} & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} | ea=6000 \cdot 200000 \rightarrow s$$

$$\begin{bmatrix} 100000 \cdot \sqrt{3} & 0 & 0 & 0 & 0 \\ 0 & 100000 \cdot \sqrt{3} & 0 & 0 & 0 \\ 0 & 0 & 200000 \cdot \sqrt{3} & 0 & 0 \\ 0 & 0 & 0 & 200000 & 0 \\ 0 & 0 & 0 & 0 & 200000 \end{bmatrix}$$

-----3

3

$$\begin{bmatrix} -500000 & 0 & 0 & 0 \end{bmatrix}^{\mathsf{T}} \rightarrow p$$

$$\begin{bmatrix} -500000 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$1.2 \cdot 10^{-5} \cdot -20 \cdot 1000 \cdot \begin{bmatrix} \frac{12}{\sqrt{3}} & \frac{12}{\sqrt{3}} & \frac{6}{\sqrt{3}} & 6 & 6 \end{bmatrix}^{\mathsf{T}} \rightarrow e0$$

$$\begin{bmatrix} -1.66277 \\ -1.66277 \\ -0.831384 \\ -1.44 \\ -1.44 \end{bmatrix}$$

$$(a \cdot s \cdot a^{\mathsf{T}})^{-1} \cdot (p + a \cdot s \cdot e0) \rightarrow d$$

$$\begin{bmatrix} -9.09904 \\ 0. \\ -8.26766 \\ 0. \end{bmatrix}$$

$$s \cdot a^{\mathsf{T}} \cdot (a \cdot s \cdot a^{\mathsf{T}})^{-1} \cdot (p + a \cdot s \cdot e0) - s \cdot e0 \rightarrow q$$

$$\begin{bmatrix} -500000. \\ -500000. \\ 3.E-8 \\ 288000. \\ 288000. \end{bmatrix}$$

$$\begin{bmatrix} \end{bmatrix}$$

$$\begin{bmatrix} \frac{1}{2} & 1 & 0 \\ 0 & -1 & 0 \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} \frac{1}{2} & 1 & 0 \\ 0 & -1 & 0 \end{bmatrix}$$

$$\frac{ea}{6000} \cdot \begin{bmatrix} \frac{\sqrt{3}}{2} & 0 & 0 \\ 0 & \sqrt{3} & 0 \\ 0 & 0 & 1 \end{bmatrix} | ea=6000 \cdot 200000 \rightarrow s$$

$$\begin{bmatrix} 100000 \cdot \sqrt{3} & 0 & 0 \\ 0 & 200000 \cdot \sqrt{3} & 0 \\ 0 & 0 & 200000 \end{bmatrix}$$

$$[-250000 \ 0] \tau \rightarrow p$$

$$\begin{bmatrix} -250000 \\ 0 \end{bmatrix}$$

$$1.2 \cdot 10^{-5} \cdot -20 \cdot 1000 \cdot \begin{bmatrix} \frac{12}{\sqrt{3}} & \frac{6}{\sqrt{3}} & 6 \end{bmatrix} \tau \rightarrow e0$$

$$\begin{bmatrix} -1.66277 \\ -0.831384 \\ -1.44 \end{bmatrix}$$

$$(a \cdot s \cdot a^T)^{-1} \cdot (p + a \cdot s \cdot e0) \rightarrow d$$


$$\begin{bmatrix} -9.09904 \\ -8.26766 \end{bmatrix}$$

$$s \cdot a^T \cdot (a \cdot s \cdot a^T)^{-1} \cdot (p + a \cdot s \cdot e0) - s \cdot e0 \rightarrow q$$

$$\begin{bmatrix} -500000. \\ 0. \\ 288000. \end{bmatrix}$$

-----1

1



$$\frac{ea}{li} \cdot \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \rightarrow kij$$

$$\begin{bmatrix} \frac{ea}{li} & 0 & \frac{-ea}{li} & 0 \\ 0 & 0 & 0 & 0 \\ \frac{-ea}{li} & 0 & \frac{ea}{li} & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 & 0 \\ -\sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & \cos(\theta) & \sin(\theta) \\ 0 & 0 & -\sin(\theta) & \cos(\theta) \end{bmatrix} \rightarrow tk$$

$$\begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 & 0 \\ -\sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & \cos(\theta) & \sin(\theta) \\ 0 & 0 & -\sin(\theta) & \cos(\theta) \end{bmatrix}$$

-----2. \_k12

2. \_k12

 $tk^T \cdot kij \cdot tk | li=l \text{ and } \theta=0^\circ$ 


$$\begin{bmatrix} \frac{ea}{l} & 0 & \frac{-ea}{l} & 0 \\ 0 & 0 & 0 & 0 \\ \frac{-ea}{l} & 0 & \frac{ea}{l} & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} \frac{ea}{l} & 0 & \frac{-ea}{l} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{-ea}{l} & 0 & \frac{ea}{l} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \rightarrow k_{12}$$

$$\begin{bmatrix} \frac{ea}{l} & 0 & \frac{-ea}{l} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{-ea}{l} & 0 & \frac{ea}{l} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

-----2.  $_k23$

-2.  $_k23$

$$tk^i \cdot kij \cdot tk^l i = \sqrt{2} \cdot l \text{ and } \theta = 135^\circ$$



$$\begin{bmatrix} \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \\ \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \\ \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & 0 & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & 0 & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & 0 & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \end{bmatrix} \rightarrow k_{23}$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & 0 & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & 0 & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & 0 & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \end{bmatrix}$$

-----2.  $k_{13}$

2.  $k_{13}$

$tk^i \cdot kij \cdot tk^j li = l$  and  $\theta = 90^\circ$



$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{ea}{l} & 0 & \frac{-ea}{l} \\ 0 & 0 & 0 & 0 \\ 0 & \frac{-ea}{l} & 0 & \frac{ea}{l} \end{bmatrix}$$



$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{ea}{l} & 0 & 0 & 0 & \frac{-ea}{l} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{-ea}{l} & 0 & 0 & 0 & \frac{ea}{l} \end{bmatrix} \rightarrow k_{13}$$

----- $-3 \cdot \_kt$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{ea}{l} & 0 & 0 & 0 & \frac{-ea}{l} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{-ea}{l} & 0 & 0 & 0 & \frac{ea}{l} \end{bmatrix}$$

$-3 \cdot \_kt$

$$k_{12}+k_{23}+k_{13} \rightarrow k t$$

$$\begin{bmatrix} \frac{ea}{l} & 0 & \frac{-ea}{l} & 0 & 0 & 0 \\ 0 & \frac{ea}{l} & 0 & 0 & 0 & \frac{-ea}{l} \\ \frac{-ea}{l} & 0 & \frac{ea \cdot \left( \frac{\sqrt{2}}{4} + 1 \right)}{l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & 0 & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & 0 & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ 0 & \frac{-ea}{l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \left( \frac{\sqrt{2}}{4} + 1 \right)}{l} \end{bmatrix}$$

$$-----4 \cdot _d$$

$$4 \cdot _d$$

$$\begin{bmatrix} \frac{ea \cdot \left(\frac{\sqrt{2}}{4} + 1\right)}{l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \end{bmatrix} \rightarrow k_{aa}$$

$$k_{aa}^{-1} \cdot \begin{bmatrix} r_3 \\ r_4 \end{bmatrix} \rightarrow d$$



$$\begin{bmatrix} \frac{ea \cdot \left(\frac{\sqrt{2}}{4} + 1\right)}{l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \end{bmatrix}$$

$$\begin{bmatrix} \frac{l \cdot (r_3 + r_4)}{ea} \\ \frac{l \cdot (r_3 + r_4 \cdot (2 \cdot \sqrt{2} + 1))}{ea} \end{bmatrix}$$

-----5.  $r$

-----5.  $r$

$$\begin{bmatrix} \frac{-ea}{l} & 0 \\ 0 & 0 \\ \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \\ \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \end{bmatrix} \rightarrow k_{ba}$$

$$\begin{bmatrix} \frac{-ea}{l} & 0 \\ 0 & 0 \\ \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \\ \frac{ea \cdot \sqrt{2}}{4 \cdot l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \end{bmatrix}$$

$$\triangle kba \cdot kaa^{-1} \cdot \begin{bmatrix} r3 \\ r4 \end{bmatrix} \rightarrow r \quad \begin{bmatrix} -r3-r4 \\ 0 \\ r4 \\ -r4 \end{bmatrix}$$

$$-----6 \cdot q \quad -6 \cdot q$$

$$\triangle \frac{ea}{l} \cdot [\cos(\theta) \quad \sin(\theta)] \cdot \begin{bmatrix} d[1,1] \\ d[2,1] \end{bmatrix} \Big|_{\theta=0^\circ} \quad [r3+r4]$$


$$\triangle \frac{ea}{\sqrt{2} \cdot l} \cdot [\cos(\theta) \quad \sin(\theta)] \cdot \begin{bmatrix} -d[1,1] \\ -d[2,1] \end{bmatrix} \Big|_{\theta=135^\circ} \quad [-r4 \cdot \sqrt{2}]$$

$$\triangle \frac{ea}{l} \cdot [\cos(\theta) \quad \sin(\theta)] \cdot \begin{bmatrix} 0 \\ 0 \end{bmatrix} \Big|_{\theta=90^\circ} \quad [0]$$

□

$$\begin{bmatrix} 1 & \frac{1}{\sqrt{2}} & 0 \\ 0 & \frac{-1}{\sqrt{2}} & 0 \end{bmatrix} \rightarrow a$$

$$\begin{bmatrix} 1 & \frac{\sqrt{2}}{2} & 0 \\ 0 & \frac{-\sqrt{2}}{2} & 0 \end{bmatrix}$$



$$\frac{ea}{l} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{bmatrix} \rightarrow s$$

$$\begin{bmatrix} \frac{ea}{l} & 0 & 0 \\ 0 & \frac{ea \cdot \sqrt{2}}{2 \cdot l} & 0 \\ 0 & 0 & \frac{ea}{l} \end{bmatrix}$$

$$a \cdot s \cdot a^T \rightarrow k$$



$$\begin{bmatrix} \frac{ea \cdot \left( \frac{\sqrt{2}}{4} + 1 \right)}{l} & \frac{-ea \cdot \sqrt{2}}{4 \cdot l} \\ \frac{-ea \cdot \sqrt{2}}{4 \cdot l} & \frac{ea \cdot \sqrt{2}}{4 \cdot l} \end{bmatrix}$$

$$(a \cdot s \cdot a^{\intercal})^{-1} \cdot [r_3 \ r_4]^{\intercal} \rightarrow d$$



$$\begin{bmatrix} \frac{l \cdot (r_3 + r_4)}{ea} \\ \frac{l \cdot (r_3 + r_4 \cdot (2 \cdot \sqrt{2} + 1))}{ea} \end{bmatrix}$$

$$s \cdot a^{\intercal} \cdot (a \cdot s \cdot a^{\intercal})^{-1} \cdot [r_3 \ r_4]^{\intercal} \rightarrow q$$



$$\begin{bmatrix} r_3 + r_4 \\ -r_4 \cdot \sqrt{2} \\ 0 \end{bmatrix}$$

[]

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-----1

1

$8+4-2 \cdot 6$

0

-----2.1

2.1

$\text{solve}\left(\begin{cases} vb+ve+vf=0 \\ 4 \cdot p-12 \cdot ve-6 \cdot vf+4 \cdot p=0 \end{cases}, \{ve, vf\}\right)$

$ve = \frac{4 \cdot p + 3 \cdot vb}{3}$  and  $vf = \frac{-2 \cdot (2 \cdot p + 3 \cdot vb)}{3}$

-----2.2

2.2

$$\begin{array}{l}
 \text{solve} \left\{ \begin{array}{l}
 f5 + \frac{3}{\sqrt{13}} \cdot f1 = 0 \\
 vb + \frac{2}{\sqrt{13}} \cdot f1 = 0 \\
 \frac{-3}{5} \cdot f7 + \frac{3}{5} \cdot f8 - p = 0 \\
 \frac{4}{5} \cdot f7 + \frac{4}{5} \cdot f8 + vf = 0 \\
 p - \frac{3}{\sqrt{13}} \cdot f1 - \frac{3}{5} \cdot f2 + \frac{3}{5} \cdot f3 + \frac{3}{\sqrt{13}} \cdot f4 = 0 \\
 \frac{-2}{\sqrt{13}} \cdot f1 - \frac{4}{5} \cdot f2 - \frac{4}{5} \cdot f3 - \frac{2}{\sqrt{13}} \cdot f4 = 0 \\
 \frac{-3}{\sqrt{13}} \cdot f4 + f6 = 0 \\
 \frac{2}{\sqrt{13}} \cdot f4 + ve = 0
 \end{array} \right. \{f1, f2, f3, f4, f5, f6, f7, f8\} \left| \begin{array}{l}
 ve = \frac{4 \cdot p + 3 \cdot vb}{3} \text{ and } vf = \frac{-2 \cdot (2 \cdot p + 3 \cdot vb)}{3}
 \end{array} \right.
 \end{array}$$

$$f1 = \frac{-vb \cdot \sqrt{13}}{2} \text{ and } f2 = \frac{5 \cdot vb}{4} \text{ and } f3 = \frac{5 \cdot (4 \cdot p + 3 \cdot vb)}{12} \text{ and } f4 = \frac{-(4 \cdot p + 3 \cdot vb) \cdot \sqrt{13}}{6} \text{ and } f5 = \frac{3 \cdot vb}{2} \text{ and } f6 = \frac{-(4 \cdot p + 3 \cdot vb)}{2} \text{ and }$$



