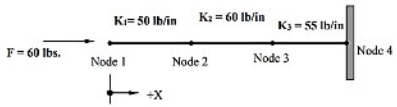
HW01

Sunday, September 10, 2023 3:04 PM

1)



Element 1:

$F_1 = X_1K_1 - X_2K_1$

$F_{2_1} = -X_1K_1 + X_2K_1$

Element 2:

$F_{2_2} = X_2K_2 - X_3K_2$

$F_{3_2} = -X_2K_2 + X_3K_2$

Element 3:

$F_{3_3} = X_3K_3 - X_4K_3$

$F_{4_3} = -X_3K_3 + X_4K_3$

MATRICES →

$$\begin{bmatrix} F_1 \\ F_{2_1} \\ F_{2_2} \\ F_{3_2} \\ F_{3_3} \\ F_{4_3} \end{bmatrix} = \begin{bmatrix} K_1 & -K_1 & 0 & 0 \\ -K_1 & K_1 & 0 & 0 \\ 0 & K_2 & -K_2 & 0 \\ 0 & -K_2 & K_2 & 0 \\ 0 & 0 & K_3 & -K_3 \\ 0 & 0 & -K_3 & K_3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix}$$

$$\begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ F_4 \end{bmatrix} = \begin{bmatrix} K_1 & -K_1 & 0 & 0 \\ -K_1 & K_1+K_2 & -K_2 & 0 \\ 0 & -K_2 & K_2+K_3 & -K_3 \\ 0 & 0 & -K_3 & K_3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix}$$

$\sum F_x = 0 = F_1 + F_4$

$F_1 = 60$

$\rightarrow -60 = F_4$

$$\begin{bmatrix} 60 \\ 0 \\ 0 \\ -60 \end{bmatrix} = \begin{bmatrix} 50 & -50 & 0 & 0 \\ -50 & 110 & -60 & 0 \\ 0 & -60 & 115 & -55 \\ 0 & 0 & -55 & 55 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ 0 \end{bmatrix}$$

$60 = 50X_1 - 50X_2$

$0 = -50X_1 + 110X_2 - 60X_3$

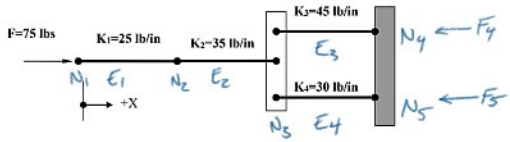
$0 = -60X_2 + 105X_3$

$-60 = -55X_3 \rightarrow X_3 = 1.09$ in

$\frac{115(1.09)}{60} = X_2 = 2.11$ in

$X_1 = \frac{60 + 50(1.91)}{50} = 3.31$ in $= X_1$

2)



$\sum F_x = 0 = F_1 + F_4 + F_5$

$F_1 = 75$ lbs

$F_4 = -F_1 - F_5$

$F_4 = -F_5 - 75$

Element 1:

$F_1 = X_1K_1 - X_2K_1$

$F_{2_1} = X_2K_1 - X_1K_1$

Element 2:

$F_{2_2} = X_2K_2 - X_3K_2$

$F_{3_2} = X_3K_2 - X_2K_2$

Element 3:

$F_{3_3} = X_3K_3 - X_4K_3$

$F_4 = X_4K_3 - X_3K_3$

Element 4:

$F_{3_4} = X_3K_4 - X_5K_4$

$F_5 = X_5K_4 - X_3K_4$

$$\begin{bmatrix} F_1 \\ F_{2_1} \\ 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} K_1 & -K_1 & 0 & 0 & 0 \\ -K_1 & K_1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ F_{2_2} \\ F_{3_2} \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & K_2 & -K_2 & 0 & 0 \\ 0 & -K_2 & K_2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ X_2 \\ X_3 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \\ F_{3_3} \\ F_4 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & K_3 & -K_3 & 0 \\ 0 & 0 & -K_3 & K_3 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ X_3 \\ X_4 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \\ F_{3_4} \\ 0 \\ F_5 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & K_4 & 0 & -K_4 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -K_4 & 0 & K_4 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ X_3 \\ 0 \\ X_5 \end{bmatrix}$$

$$\begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ F_4 \\ F_5 \end{bmatrix} = \begin{bmatrix} K_1 & -K_1 & 0 & 0 & 0 \\ -K_1 & K_1+K_2 & -K_2 & 0 & 0 \\ 0 & -K_2 & K_2+K_3 & -K_3 & 0 \\ 0 & 0 & -K_3 & K_3 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{bmatrix}$$

$$\begin{bmatrix} 75 \\ F_2 \\ F_3 \\ F_4 \\ F_5 \end{bmatrix} = \begin{bmatrix} 25 & -25 & 0 & 0 & 0 \\ -25 & 60 & -35 & 0 & 0 \\ 0 & -35 & 110 & -45 & -30 \\ 0 & 0 & -45 & 45 & 0 \\ 0 & 0 & -30 & 0 & 30 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ 0 \\ 0 \end{bmatrix}$$

$75 = 25X_1 - 25X_2$

$0 = -25X_1 + 60X_2 - 35X_3 \rightarrow X_1 = \frac{60(3.14) - 35(1)}{25} = 6.19$ in $= X_1$

$0 = -35X_2 + 110X_3 \rightarrow X_2 = 110(\frac{1}{35}) = 3.14 = X_2$

$F_4 = -45X_3 \rightarrow -F_5 - 75 = -45X_3$

$F_5 = -30X_3$

$45X_3 - 75 = -30X_3$

$75X_3 = 75$

$X_3 = 1$ in

$F_4 = -45(1) = -45$ lbs

$F_5 = -30(1) = -30$ lbs