

امتحان منتصف الترم

**Element (1): (nodes 1 & 2)**

$$\lambda = \cos \alpha = 0.8 \quad \text{and} \quad \mu = \sin \alpha = 0.6$$

$$EA/L = 2.1 \times 10^7 \times 0.15 / 5 = 630000$$

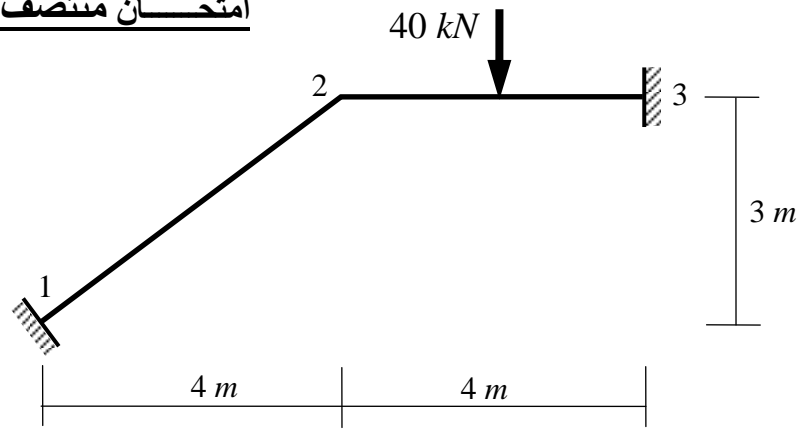
$$12EI/L^3 = 12 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 5^3 = 6300$$

$$6EI/L^2 = 6 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 5^2 = 15750$$

$$4EI/L = 4 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 5 = 52500$$

$$2EI/L = 26250$$

$$\begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ F_{x2} \\ F_{y2} \\ M_2 \end{Bmatrix} = \begin{bmatrix} - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$



**Element (2): (nodes 2 & 3)**

$$\lambda = \cos \alpha = 1 \quad \text{and} \quad \mu = \sin \alpha = 0$$

$$EA/L = 2.1 \times 10^7 \times 0.15 / 4 = 787500$$

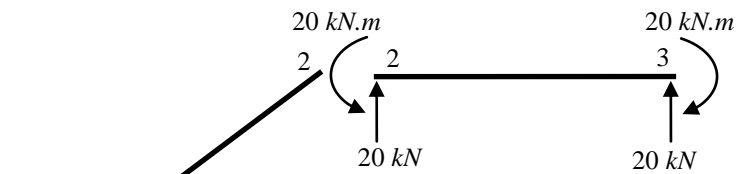
$$12EI/L^3 = 12 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 4^3 = 12305$$

$$6EI/L^2 = 6 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 4^2 = 24609$$

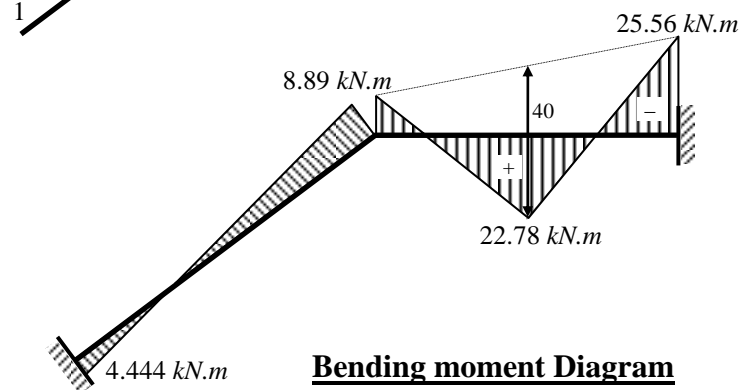
$$4EI/L = 4 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 4 = 65625$$

$$2EI/L = 32813$$

$$\begin{Bmatrix} F_{x2} \\ F_{y2} \\ M_2 \\ X_3 \\ Y_3 \\ M_3 \end{Bmatrix} = \begin{bmatrix} - & - & 0 & - & - & - \\ - & - & 24609 & - & - & - \\ - & - & 65625 & - & - & - \\ - & - & 0 & - & - & - \\ - & - & -24609 & - & - & - \\ - & - & 32813 & - & - & - \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 20 \\ 20 \\ 0 \\ 20 \\ -20 \end{Bmatrix}$$



**Fixed End Solution**



**Frame equation**

$$\begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ 0 \\ 0 \\ 0 \\ X_3 \\ Y_3 \\ M_3 \end{Bmatrix} = \begin{bmatrix} - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 20 \\ 20 \\ 0 \\ 20 \\ -20 \end{Bmatrix}$$

**Bending moment Diagram**

From Row No. 6  $\rightarrow 0 = (52500+65625) (\theta_2) + 20 \rightarrow$

$\theta_2 = -1.69312 \times 10^{-4} \text{ rad}$

**From Element 1**

$$M_1 = 26250 (-1.69312 \times 10^{-4}) + 0 = -4.444 \text{ kN.m}$$

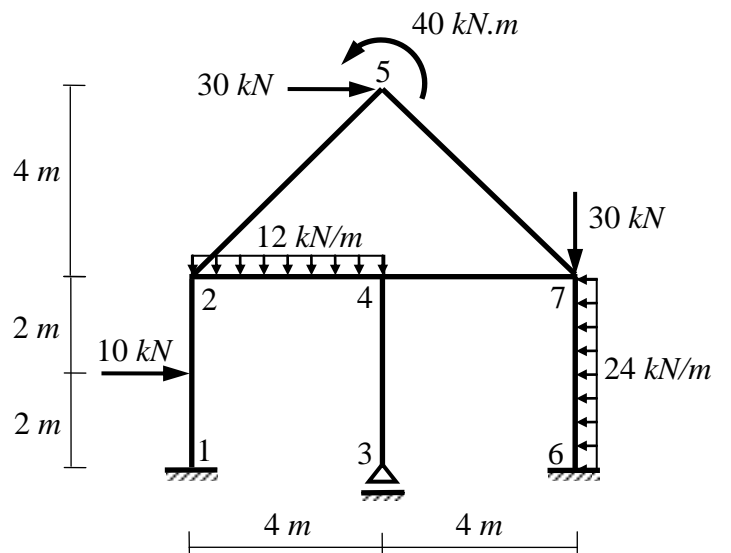
$$M_2 = 52500 (-1.69312 \times 10^{-4}) + 0 = -8.89 \text{ kN.m}$$

**From Element 2**

$$M_2 = 65625 (-1.69312 \times 10^{-4}) + 20 = +8.89 \text{ kN.m}$$

$$M_3 = 32813 (-1.69312 \times 10^{-4}) - 20 = -25.56 \text{ kN.m}$$

**Question (2): (6 Marks)**



$$\{F\} = \begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 30 \\ 0 \\ 40 \\ X_6 \\ Y_6 \\ M_6 \\ 0 \\ -30 \\ 0 \end{Bmatrix} \quad \{\Delta\} = \begin{Bmatrix} 0 \\ 0 \\ 0 \\ u_2 \\ v_2 \\ \theta_2 \\ u_3 \\ 0 \\ \theta_3 \\ u_4 \\ v_4 \\ \theta_4 \\ u_5 \\ v_5 \\ \theta_5 \\ 0 \\ 0 \\ 0 \\ u_7 \\ v_7 \\ \theta_7 \end{Bmatrix} \quad \{F^f\} = \begin{Bmatrix} -5 \\ 0 \\ 5 \\ -5 \\ 0+24=24 \\ -5+16=11 \\ 0 \\ 0 \\ 0 \\ 0 \\ 24 \\ -16 \\ 0 \\ 0 \\ 0 \\ 48 \\ 0 \\ -32 \\ 48 \\ 0 \\ 32 \end{Bmatrix}$$