

### Answer of Mid-Term Exam

Total Marks: 15

No. of Questions:1

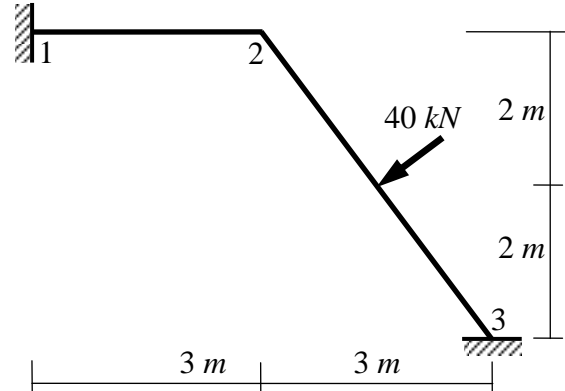
#### Question (1): (15 Marks)

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

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

$$6EI/L^2 = 2EI/3 \quad ; \quad 4EI/L = 4EI/3 \quad ; \quad 2EI/L = 2EI/3$$

$$\begin{Bmatrix} F_{x1} \\ F_{y1} \\ M_1 \\ F_{x2} \\ F_{y2} \\ M_2 \end{Bmatrix} = \begin{bmatrix} - & - & - & - & - & 0 \\ - & - & - & - & - & 2EI/3 \\ - & - & - & - & - & 2EI/3 \\ - & - & - & - & - & 0 \\ - & - & - & - & - & -2EI/3 \\ - & - & - & - & - & 4EI/3 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$



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

$$\alpha = -53.13 \quad \lambda = \cos \alpha = 0.6 \quad \text{and} \quad \mu = \sin \alpha = -0.8$$

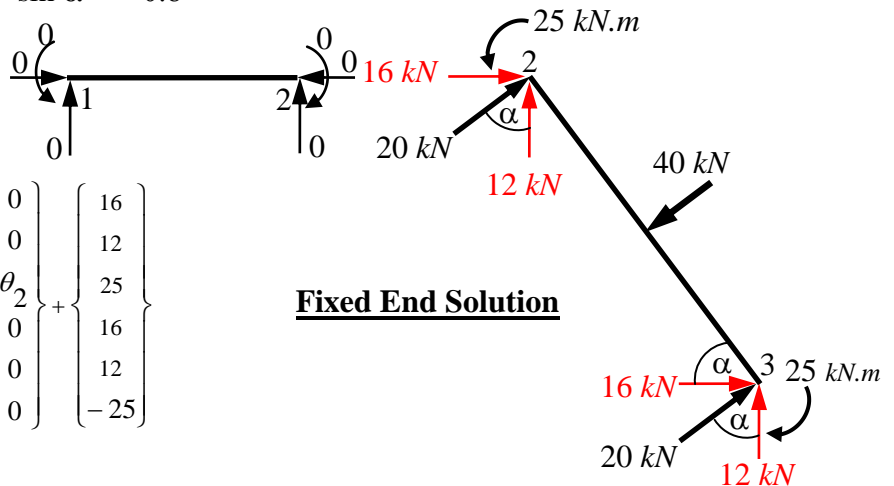
$$6\mu EI/L^2 = 6(-0.8)EI/25 = -0.192EI$$

$$6\lambda EI/L^2 = 6(0.6)EI/25 = 0.144EI$$

$$4EI/L = 0.8EI$$

$$2EI/L = 0.4EI$$

$$\begin{Bmatrix} F_{x2} \\ F_{y2} \\ M_2 \\ F_{x3} \\ F_{y3} \\ M_3 \end{Bmatrix} = \begin{bmatrix} - & - & 0.192EI & - & - & - \\ - & - & 0.144EI & - & - & - \\ - & - & 0.8EI & - & - & - \\ - & - & -0.192EI & - & - & - \\ - & - & -0.144EI & - & - & - \\ - & - & 0.4EI & - & - & - \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 16 \\ 12 \\ 25 \\ 16 \\ 12 \\ -25 \end{Bmatrix}$$



#### Fixed End Solution

#### Frame equation

$$\begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ 0 \\ 0 \\ 0 \\ X_3 \\ Y_3 \\ M_3 \end{Bmatrix} = \begin{bmatrix} - & - & - & - & - & 0 \\ - & - & - & - & - & 2EI/3 \\ - & - & - & - & - & 2EI/3 \\ - & - & - & - & - & (0+0.192EI) \\ - & - & - & - & - & (-2EI/3+0.144EI) \\ - & - & - & - & - & (4EI/3+0.8EI) \\ - & - & - & - & - & -0.192EI \\ - & - & - & - & - & -0.144EI \\ - & - & - & - & - & 0.4EI \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 16 \\ 12 \\ 25 \\ 16 \\ 12 \\ -25 \end{Bmatrix}$$

From Row No. 6  $\rightarrow 0 = (4EI/3+0.8EI)(\theta_2) + 25$

$\rightarrow \theta_2 = -11.71875/EI$

#### From Element 1

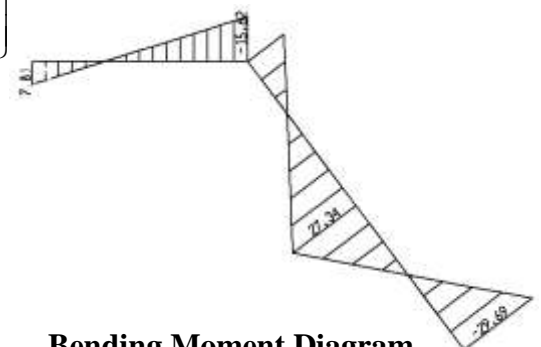
$$M_1 = 2EI/3 (-11.71875/EI) + 0 = -7.8125 \text{ kN.m}$$

$$M_2 = 4EI/3 (-11.71875/EI) + 0 = -15.625 \text{ kN.m}$$

#### From Element 2

$$M_2 = 0.8EI (-11.71875/EI) + 25 = +15.625 \text{ kN.m}$$

$$M_3 = 0.4EI (-11.71875/EI) - 25 = -29.6875 \text{ kN.m}$$



#### Bending Moment Diagram

With my best wishes

Dr. M. Abdel-Kader