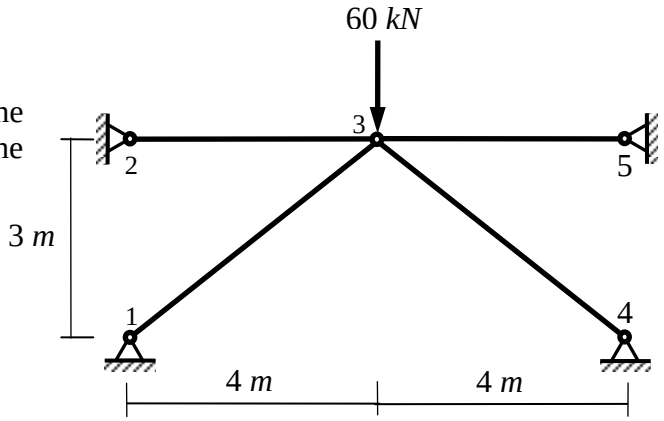
Ministry of Higher Education **Giza Higher Institute for Eng. & Tech.** **Civil Engineering Department**		Academic Year : **2016/2017** Semester : **Second** Level : **4th**
Course Name: **Computer Applications in Civil Eng.**		Time : **3 Hours**
Course Code : **CIV 410**	Date : **24 / 5 / 2017**	Examiner: ***Dr. M. Abdel-Kader***
Answer of Final Term Exam		
Total Marks: **60**		No. of Questions: **3**

Question (1): (20 Marks)

For the shown truss, **using the stiffness method**, determine the vertical displacement at node 3 and the reactions at the supports due to the given load.



Given Data:

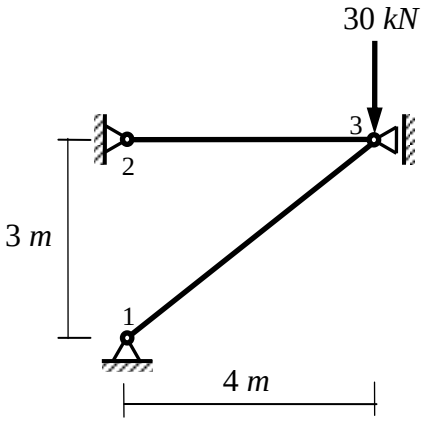
$E = 2.0\times10^{7}\ kN/m^2$ and $A = 5.0\times10^{-4}\ m^2$

Element (1): (nodes 1 & 3)

$\lambda = \cos\alpha = 0.8$ and $\mu = \sin\alpha = 0.6$

$EA/L = 2.0\times10^{7} \times 5.0\times10^{-4} /5 = 2000$

$$\begin{Bmatrix} X_1 \\ Y_1 \\ F_{x3} \\ F_{y3} \end{Bmatrix} = \begin{bmatrix} \cdots & \cdots & \cdots & -960 \\ \cdots & \cdots & \cdots & -720 \\ \cdots & \cdots & \cdots & 960 \\ \cdots & \cdots & \cdots & 720 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ v_3 \end{Bmatrix}$$



Element (2): (nodes 2 & 3)

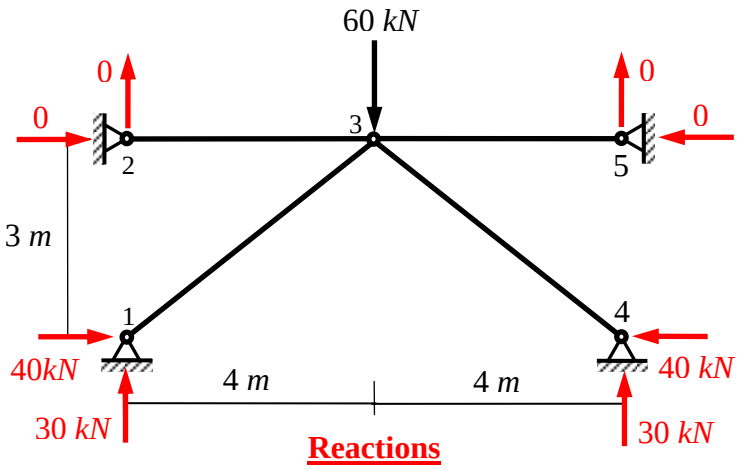
$\lambda = \cos\alpha = 1$ and $\mu = \sin\alpha = 0$

$EA/L = 2.0\times10^{7} \times 5.0\times10^{-4} /4 = 2500$

$$\begin{Bmatrix} F_{x2} \\ F_{y2} \\ X_3 \\ Y_3 \end{Bmatrix} = \begin{bmatrix} \cdots & \cdots & \cdots & 0 \\ \cdots & \cdots & \cdots & 0 \\ \cdots & \cdots & \cdots & 0 \\ \cdots & \cdots & \cdots & 0 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ v_3 \end{Bmatrix}$$

Truss equation

$$\begin{Bmatrix} X_1 \\ Y_1 \\ X_2 \\ Y_2 \\ X_3 \\ -30 \end{Bmatrix} = \begin{bmatrix} \cdots & \cdots & 0 & 0 & \cdots & -960 \\ \cdots & \cdots & 0 & 0 & \cdots & -720 \\ 0 & 0 & \cdots & \cdots & \cdots & 0 \\ 0 & 0 & \cdots & \cdots & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & (960+0) \\ \cdots & \cdots & \cdots & \cdots & \cdots & (720+0) \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ v_3 \end{Bmatrix}$$



Reactions

From Row No. 6 → $-30 = (720+0)\ v_3$ → $v_3 = -1/24 = -0.0416667\ m = 41.7\ mm\downarrow$

From Row No. 1 → $X_1 = -960\ (-1/24) = 40\ kN$ → $X_1 = 40\ kN \rightarrow$

From Row No. 2 → $Y_1 = -720\ (-1/24) = 30\ kN$ → $Y_1 = 30\ kN \uparrow$

From Row No. 3 → $X_2 = 0\ (-1/24) = 0\ kN$ → $X_2 = 0$

From Row No. 4 → $Y_2 = 0\ (-1/24) = 0\ kN$ → $Y_2 = 0$

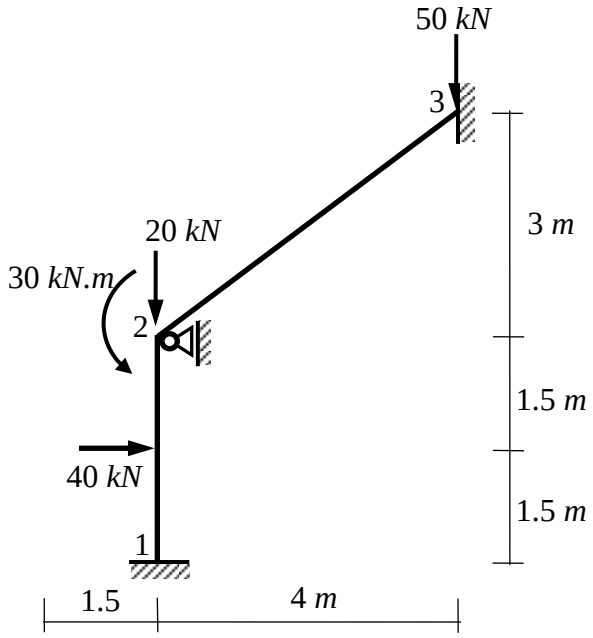
From Row No. 5 → $X_3 = 960\ (-1/24) = -40\ kN$ → $X_3 = 40\ kN \leftarrow$

With my best wishes

Dr. M. Abdel-Kader

Question (2): (20 Marks)

For the shown frame, **using the stiffness method**, draw the bending moment diagram.
Neglect axial deformation. **Given Data:** *E*, *I* and *A* are constants



Element (1): (nodes 1 & 2)

$\lambda = \cos 90^o = 0$ and $\mu = \sin 90^o = 1$

$6EI/L^2 = 2EI/3$

$4EI/L = 4EI/3$

$2EI/L = 2EI/3$

$$\begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ F_{x2} \\ F_{y2} \\ M_2 \end{Bmatrix} = \begin{bmatrix} \dots & \dots & \dots & \dots & \dots & -2EI/3 \\ \dots & \dots & \dots & \dots & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots & 2EI/3 \\ \dots & \dots & \dots & \dots & \dots & 2EI/3 \\ \dots & \dots & \dots & \dots & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots & 4EI/3 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \end{Bmatrix} + \begin{Bmatrix} -20 \\ 0 \\ 15 \\ -20 \\ 0 \\ -15 \end{Bmatrix}$$

Element (2): (nodes 2 & 3)

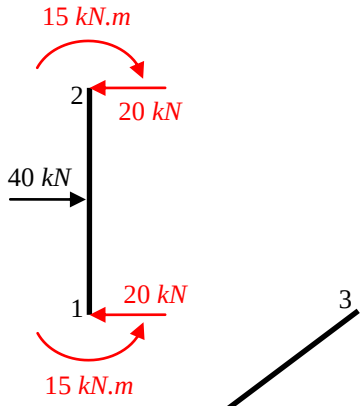
$\lambda = \cos \alpha = 4/5 = 0.8$ and $\mu = \sin \alpha = 3/5 = 0.6$

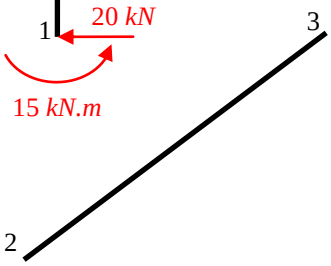
$6EI/L^2 = 0.24EI$

$4EI/L = 0.8EI$

$2EI/L = 0.4EI$

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





Fixed End Solution

Frame equation

$$\begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ 0 \\ -20 \\ 30 \\ F_{x3} \\ F_{y3} \\ M_3 \end{Bmatrix} = \begin{bmatrix} \dots & \dots & \dots & \dots & \dots & -2EI/3 & 0 & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & 0 & 0 & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & 2EI/3 & 0 & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & (2EI/3 - 0.144EI) & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & (0 + 0.192EI) & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & (4EI/3 + 0.8EI) & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & \dots & 0.144EI & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & \dots & -0.192EI & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & \dots & 0.4EI & \dots & \dots & \dots \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} -20 \\ 0 \\ 15 \\ -20 \\ 0 \\ -15 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$

(1) (2) (3)

From Row No. 6 → $30 = (32EI/15)(\theta_2) - 15$ → $\theta_2 = 21.09375/EI \ \ rad$

From Element 1

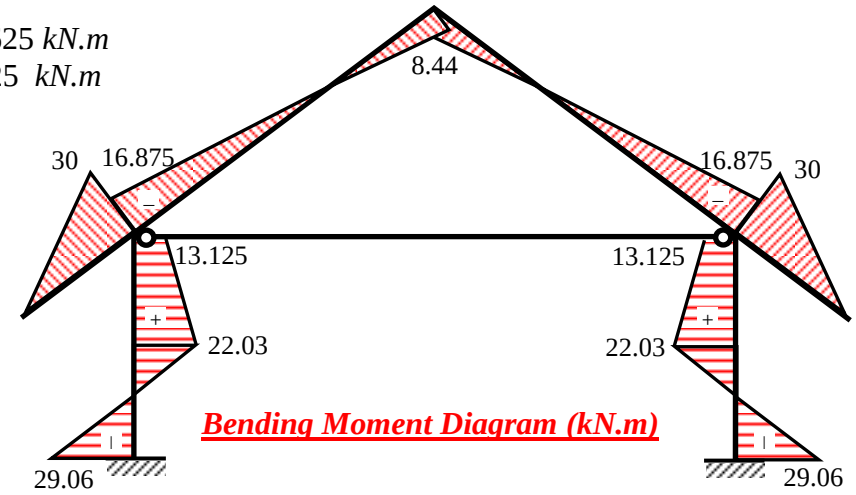
$M_1 = 2EI/3\ (21.09375/EI) + 15 = 29.0625\ kN.m$

$M_2 = 4EI/3\ (21.09375/EI) - 15 = 13.125\ kN.m$

From Element 2

$M_2 = 0.8EI\ (21.09375/EI) + 0$
$= 16.875\ kN.m$

$M_3 = 0.4EI\ (21.09375/EI) + 0$
$= 8.4375\ kN.m$



Bending Moment Diagram (kN.m)

Question (3): (20 Marks)

(a) TRUE or FALSE (Put ✓ or ✗ in front of the statement number in your answer sheet)

1.	✓
2.	✓
3.	✓
4.	✓
5.	✓
6.	✓
7.	✓
8.	✓
9.	✗
10.	✗
11.	✗
12.	✓
13.	✗
14.	✗
15.	✗
16.	✗
17.	✓
18.	✗
19.	✗
20.	✗

With my best wishes
Dr. M. Abdel-Kader