Ministry of Higher Education
Giza Higher Institute for Eng. & Tech.
Civil Engineering Department
Course Name: Computer Applications in Civil Eng.
Course Code : **CIV 410**

Academic Year : **2014–2015**
Semester : **Second**
Level : **4th**
Time : **3 Hours**
Date : **31 / 5 / 2015**
Examiner: ***Dr. M. Abdel-Kader***

Answer of Second Semester Final Examination

Question (1): (10 Marks)

(a) Choose the correct answer (**Put a, b, c or d in front of the statement number in your answer sheet**).

1.	a
2.	d
3.	c
4.	b
5.	a
6.	d

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

1.	✗	6.	✓	11.	✓
2.	✓	7.	✓	12.	✓
3.	✓	8.	✓	13.	✓
4.	✓	9.	✓	14.	✗
5.	✗	10.	✗		

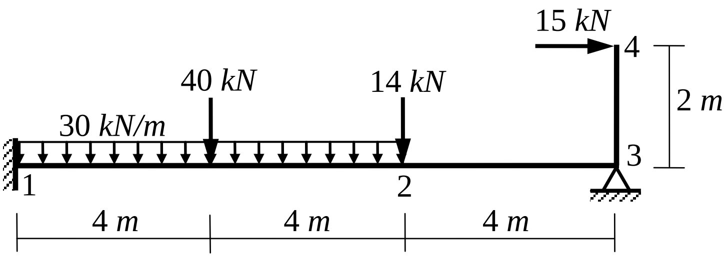
Question (2): (10 Marks)

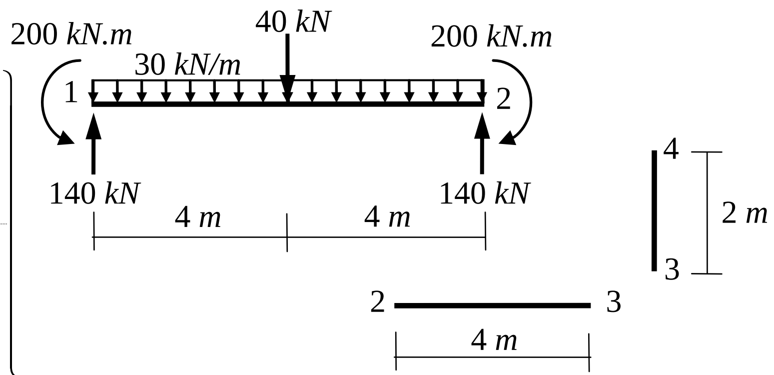
The matrix equilibrium equation of the shown structure is:

$$\{F\} = [K]\{\Delta\} + \{F^f\}$$

Write

- The nodal forces vector $\{F\}$
- The nodal displacements vector $\{\Delta\}$
- The fixed end solution $\{F^f\}$





$$\begin{array}{c} \\ 1 \\ \\ \\ 2 \\ \\ \\ 3 \\ \\ \\ 4 \\ \\ \end{array} \{F\} = \left\{\begin{array}{c} X_1 \\ Y_1 \\ M_1 \\ \hline 0 \\ -14 \\ 0 \\ \hline X_3 \\ Y_3 \\ 0 \\ \hline 15 \\ 0 \\ 0 \end{array}\right\} \quad \{\Delta\} = \left\{\begin{array}{c} 0 \\ 0 \\ 0 \\ \hline u_2 \\ v_2 \\ \theta_2 \\ \hline 0 \\ 0 \\ \theta_3 \\ \hline u_4 \\ v_4 \\ \theta_4 \end{array}\right\} \quad \{F^f\} = \left\{\begin{array}{c} 0 \\ 140 \\ 200 \\ \hline 0 \\ 140 \\ -200 \\ \hline 0 \\ 0 \\ 0 \\ \hline 0 \\ 0 \\ 0 \end{array}\right\}$$

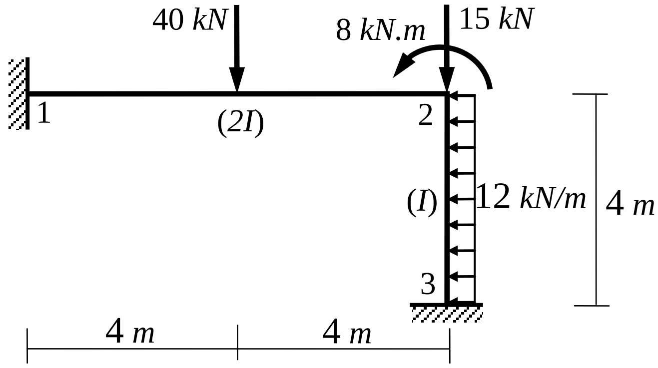
With my best wishes
Dr. M. Abdel-Kader

Question (3): (20 Marks)

For the shown loaded frame with variable moment of inertia, using the stiffness method and **neglecting axial deformation,**

(a) determine the displacements at the nodes due to the given load.

(b) draw the bending moment diagram.



Given Data:

$E = 2.1\times10^{7}\ kN/m^2$ $\quad I = 0.8\times10^{-3}\ m^4$ $\quad A = 0.02\ m^2$

Element (1): (nodes 1 & 2)

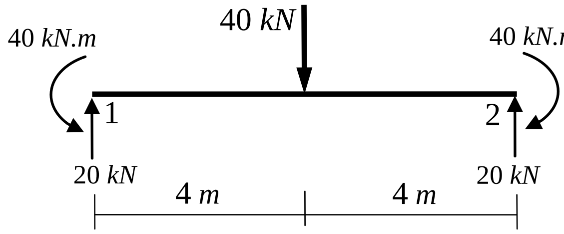
$\alpha = 0 \quad \lambda = \cos\alpha = 1 \quad \text{and} \quad \mu = \sin\alpha = 0$

$6EI/L^2 = 6\,(2.1\times10^7)\,(2\times0.8\times10^{-3})/8^2 = 3150$

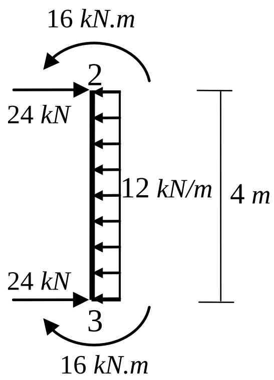
$4EI/L = 4\,(2.1\times10^7)\,(2\times0.8\times10^{-3})/8 = 16800$

$2EI/L = 8400$

$$\begin{Bmatrix} F_{x1} \\ F_{y1} \\ M_1 \\ F_{x2} \\ F_{y2} \\ M_2 \end{Bmatrix} = \begin{bmatrix} - & - & - & - & - & 0 \\ - & - & - & - & - & 3150 \\ - & - & - & - & - & 8400 \\ - & - & - & - & - & 0 \\ - & - & - & - & - & -3150 \\ - & - & - & - & - & 16800 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 20 \\ 40 \\ 0 \\ 20 \\ -40 \end{Bmatrix}$$



Fixed End Solution



Element (2): (nodes 2 & 3)

$\alpha = 270 = -90 \quad \lambda = \cos\alpha = 0 \quad \text{and} \quad \mu = \sin\alpha = -1$

$6EI/L^2 = 6\,(2.1\times10^7)\,(0.8\times10^{-3})/4^2 = 6300$

$4EI/L = 4\,(2.1\times10^7)\,(0.8\times10^{-3})/4 = 16800$

$2EI/L = 8400$

$$\begin{Bmatrix} F_{x2} \\ F_{y2} \\ M_2 \\ F_{x3} \\ F_{y3} \\ M_3 \end{Bmatrix} = \begin{bmatrix} - & - & 6300 & - & - & - \\ - & - & 0 & - & - & - \\ - & - & 16800 & - & - & - \\ - & - & -6300 & - & - & - \\ - & - & 0 & - & - & - \\ - & - & 8400 & - & - & - \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 24 \\ 0 \\ 16 \\ 24 \\ 0 \\ -16 \end{Bmatrix}$$

Frame equation

$$\begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ 0 \\ -15 \\ 8 \\ X_3 \\ Y_3 \\ M_3 \end{Bmatrix} = \begin{array}{c} \begin{array}{ccc} 1 \qquad\qquad & 2 & \qquad\qquad 3 \end{array} \\ \begin{bmatrix} - & - & - & - & - & 0 & - & - & - \\ - & - & - & - & - & 3150 & - & - & - \\ - & - & - & - & - & 8400 & - & - & - \\ - & - & - & - & - & (0+6300) & - & - & - \\ - & - & - & - & - & (-3150+0) & - & - & - \\ - & - & - & - & - & (16800+16800) & - & - & - \\ - & - & - & - & - & -6300 & - & - & - \\ - & - & - & - & - & 0 & - & - & - \\ - & - & - & - & - & 8400 & - & - & - \end{bmatrix} \end{array} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 20 \\ 40 \\ 24 \\ 20 \\ -24 \\ 24 \\ 0 \\ -16 \end{Bmatrix}$$

From Row No. 6 $\rightarrow$ $8 = (16800+16800)\,(\theta_2) + (-24)$

$\rightarrow$ $\boxed{\theta_2 = +9.5238\times10^{-4}\ \text{rad}}$

From Element 1

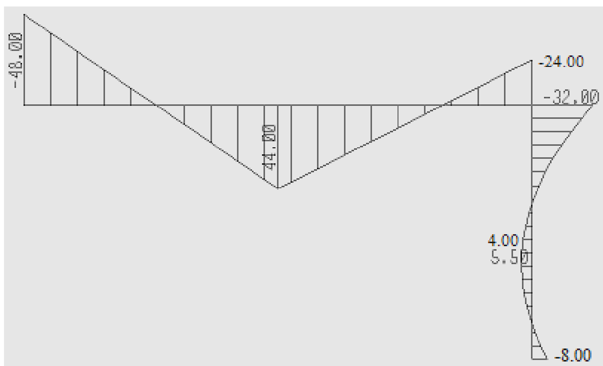
$M_1 = 8400\,(9.5238\times10^{-4}) + 40 \quad = +48\ kN.m$

$M_2 = 16800\,(9.5238\times10^{-4}) - 40 \quad = -24\ kN.m$

From Element 2

$M_2 = 16800\,(9.5238\times10^{-4}) + 16 \quad = +32\ kN.m$

$M_3 = 8400\,(9.5238\times10^{-4}) - 16 \quad = -8\ kN.m$



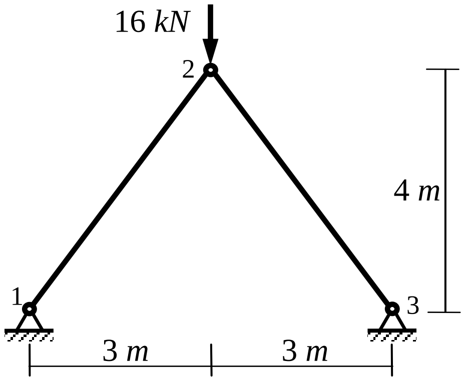
Question (4): (20 Marks)

For the shown truss, using the stiffness method:

(a) Determine the displacements at the nodes due to the given load.

(b) Determine the reactions at the supports.

Given Data: $E = 2.0\times10^{7}\ kN/m^2 \qquad A = 2.0\times10^{-4}\ m^2$



Element (1): (nodes 1 & 2)

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

$EA/L = 2.0\times10^{7} \times 2.0\times10^{-4}/5 = 800$

$$\begin{Bmatrix} F_{x1} \\ F_{y1} \\ F_{x2} \\ F_{y2} \end{Bmatrix} = \begin{bmatrix} - & - & -288 & -384 \\ - & - & -384 & -512 \\ - & - & 288 & 384 \\ - & - & 384 & 512 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ u_2 \\ v_2 \end{Bmatrix}$$

Element (2): (nodes 2 & 3)

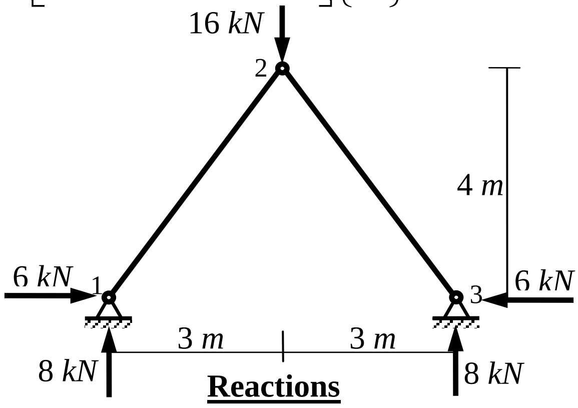
$\lambda = \cos\alpha = 0.6$ and $\mu = \sin\alpha = -0.8$

$EA/L = 2.0\times10^{7} \times 2.0\times10^{-4}/5 = 800$

$$\begin{Bmatrix} F_{x2} \\ F_{y2} \\ F_{x3} \\ F_{y3} \end{Bmatrix} = \begin{bmatrix} 288 & -384 & - & - \\ -384 & 512 & - & - \\ -288 & 384 & - & - \\ 384 & -512 & - & - \end{bmatrix} \begin{Bmatrix} u_2 \\ v_2 \\ 0 \\ 0 \end{Bmatrix}$$

Truss equation

$$\begin{Bmatrix} X_1 \\ Y_1 \\ 0 \\ -16 \\ X_3 \\ Y_3 \end{Bmatrix} = \begin{array}{c} \begin{array}{ccc} \quad 1 \quad & \quad\quad 2 \quad\quad & \quad 3 \quad \end{array} \\ \begin{bmatrix} - & - & -288 & -384 & 0 & 0 \\ - & - & -384 & -512 & 0 & 0 \\ - & - & (288+288) & (384-384) & - & - \\ - & - & (384-384) & (512+512) & - & - \\ 0 & 0 & -288 & 384 & - & - \\ 0 & 0 & 384 & -512 & - & - \end{bmatrix} \end{array} \begin{Bmatrix} 0 \\ 0 \\ u_2 \\ v_2 \\ 0 \\ 0 \end{Bmatrix}$$



Reactions

From Row No. 3 → $0 = (288+288)(u_2) + (384-384)(v_2)$ → $\boxed{u_2 = 0}$

From Row No. 4 → $-16 = (384-384)(u_2) + (512+512)(v_2)$ → $\boxed{v_2 = -0.015625\ m}$

From Row No. 1 → $X_1 = -288\,(0) - 384\,(-0.015625) = 6\ kN$ $\boxed{X_1 = 6\ kN \rightarrow}$

From Row No. 2 → $Y_1 = -384\,(0) - 512\,(-0.015625) = 8\ kN$ $\boxed{Y_1 = 8\ kN \uparrow}$

From Row No. 5 → $X_3 = -288\,(0) + 384\,(-0.015625) = -6\ kN$ $\boxed{X_3 = 6\ kN \leftarrow}$

From Row No. 6 → $Y_3 = 384\,(0) - 512\,(-0.015625) = 8\ kN$ $\boxed{Y_3 = 8\ kN \uparrow}$

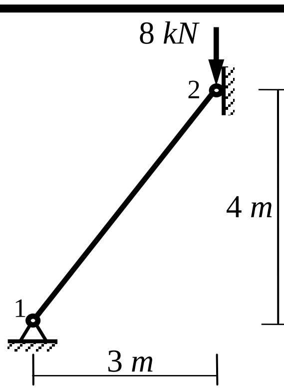
Another Solution using symmetry

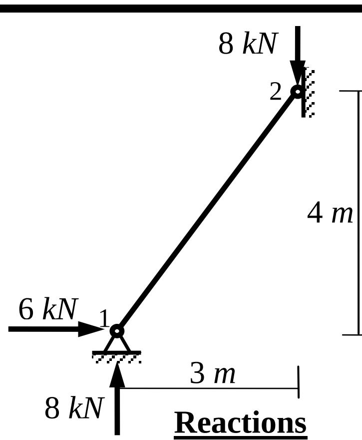
Truss equation = Element (1): (nodes 1 & 2)

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

$EA/L = 2.0\times10^{7} \times 2.0\times10^{-4}/5 = 800$

$$\begin{Bmatrix} X_1 \\ Y_1 \\ X_2 \\ -8 \end{Bmatrix} = \begin{bmatrix} - & - & -288 & -384 \\ - & - & -384 & -512 \\ - & - & 288 & 384 \\ - & - & 384 & 512 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ v_2 \end{Bmatrix}$$





Reactions

From Row No. 4 → $-8 = (512)(v_2)$ → $\boxed{v_2 = -0.015625\ m}$

From Row No. 1 → $X_1 = -384\,(-0.015625) = 6\ kN$ $\boxed{X_1 = 6\ kN \rightarrow}$

From Row No. 2 → $Y_1 = -512\,(-0.015625) = 8\ kN$ $\boxed{Y_1 = 8\ kN \uparrow}$

With my best wishes

Dr. M. Abdel-Kader