



Answer of Second Semester Final Exam

Question (1): (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.	✓

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

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

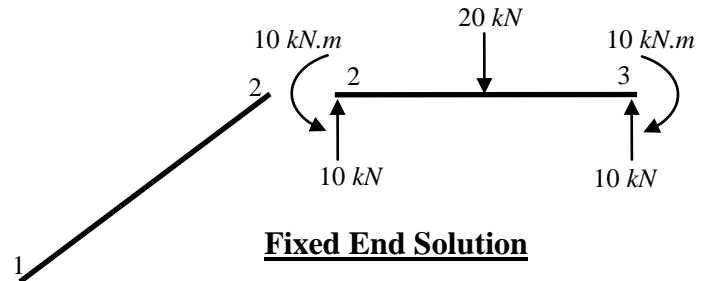
With my best wishes
Dr. M. Abdel-Kader

Question (2): (20 Marks)

Element (1): (nodes 1 & 2)

$\lambda = \cos \alpha = 0.8$ and $\mu = \sin \alpha = 0.6$
 $6EI/L^2 = 6 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 5^2 = 15750$
 $4EI/L = 4 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 5 = 52500$
 $2EI/L = 26250$

$$\begin{Bmatrix} X_1 \\ Y_1 \\ M_1 \\ F_{x2} \\ F_{y2} \\ M_2 \end{Bmatrix} = \begin{bmatrix} - & - & - & - & - & -9450 \\ - & - & - & - & - & 12600 \\ - & - & - & - & - & 26250 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ - & - & - & - & - & 9450 \\ - & - & - & - & - & -12600 \\ - & - & - & - & - & 52500 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_2 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$



Element (2): (nodes 2 & 3)

$\lambda = \cos \alpha = 1$ and $\mu = \sin \alpha = 0$
 $6EI/L^2 = 6 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 4^2 = 24609$
 $4EI/L = 4 \times 2.1 \times 10^7 \times 3.125 \times 10^{-3} / 4 = 65625$
 $2EI/L = 32813$

$$\begin{Bmatrix} F_{x2} \\ F_{y2} \\ M_2 \\ F_{x3} \\ F_{y3} \\ M_3 \end{Bmatrix} = \begin{bmatrix} - & - & 0 & - & - & - \\ - & - & 24609 & - & - & - \\ - & - & 65625 & - & - & - \\ \dots & \dots & \dots & \dots & \dots & \dots \\ - & - & 0 & - & - & - \\ - & - & -24609 & - & - & - \\ - & - & 32813 & - & - & - \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ \theta_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 10 \\ 10 \\ 0 \\ 10 \\ -10 \end{Bmatrix}$$

Frame equation

	1	2	3		
X_1	-	-	-	-9450	0 0 0
Y_1	-	-	-	12600	0 0 0
M_1	-	-	-	26250	0 0 0
0	-	-	-	(9450+0)	- - -
0	-	-	-	(-12600+24609)	0 - -
0	-	-	-	(52500+65625)	θ_2 - -
F_{x3}	0 0 0	- - -	- - -	0	0 0
F_{y3}	0 0 0	- - -	- - -	-24609	0 10
M_3	0 0 0	- - -	- - -	32813	0 -10

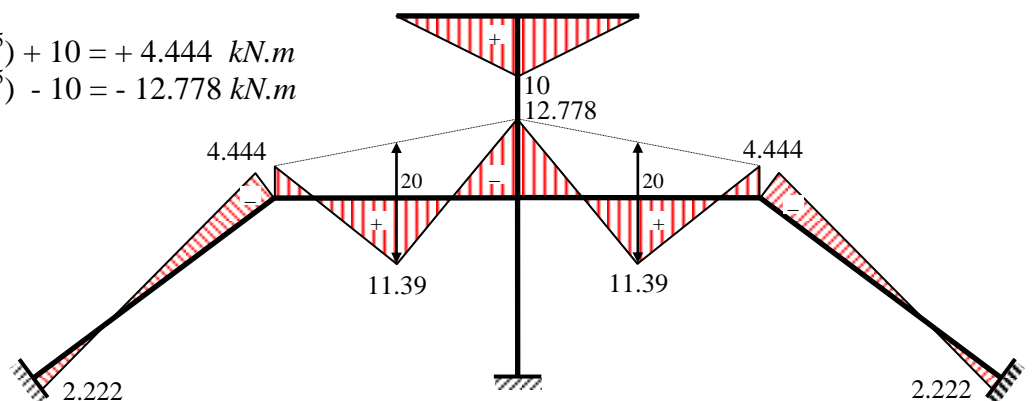
From Row No. 6 $\rightarrow 0 = (52500+65625) (\theta_2) + 10 \rightarrow \theta_2 = -8.4656 \times 10^{-5} \text{ rad}$

From Element 1

$M_1 = 26250 (-8.4656 \times 10^{-5}) + 0 = -2.222 \text{ kN.m}$
 $M_2 = 52500 (-8.4656 \times 10^{-5}) + 0 = -4.444 \text{ kN.m}$

From Element 2

$M_2 = 65625 (-8.4656 \times 10^{-5}) + 10 = +4.444 \text{ kN.m}$
 $M_3 = 32813 (-8.4656 \times 10^{-5}) - 10 = -12.778 \text{ kN.m}$



Bending Moment Diagram (kN.m)

Question (3): (20 Marks)

(a)

Element (1): (nodes 1 & 2)

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

$$EA/L = 2.0 \times 10^7 \times 2.0 \times 10^{-4} / 5 = 800$$

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

Element (2): (nodes 2 & 3)

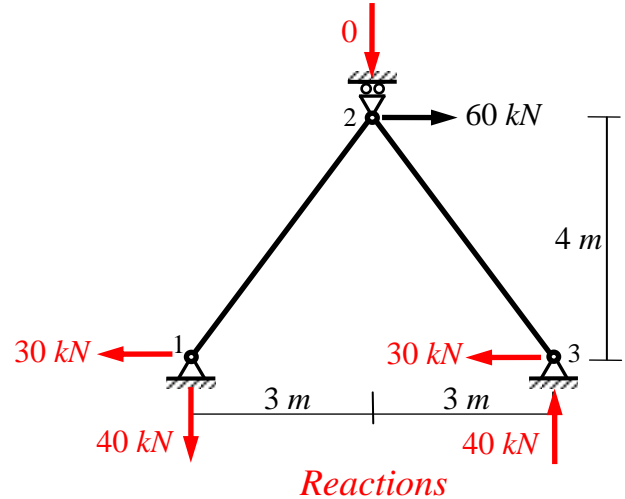
$$\lambda = \cos \alpha = 0.6 \quad \text{and} \quad \mu = \sin \alpha = -0.8$$

$$EA/L = 2.0 \times 10^7 \times 2.0 \times 10^{-4} / 5 = 800$$

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

Truss equation

$$\begin{Bmatrix} X_1 \\ Y_1 \\ 60 \\ Y_2 \\ X_3 \\ Y_3 \end{Bmatrix} = \begin{bmatrix} - & - & -288 & - & 0 & 0 \\ - & - & -384 & - & 0 & 0 \\ - & - & (288+288) & - & - & - \\ - & - & (384-384) & - & - & - \\ 0 & 0 & -288 & - & - & - \\ 0 & 0 & 384 & - & - & - \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ u_2 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$



From Row No. 3 $\rightarrow 60 = (288+288) (u_2) \rightarrow$

$u_2 = 0.1042 \text{ m} = 10.42 \text{ cm} \rightarrow$

(b)

From Row No. 1 $\rightarrow X_1 = -288 (0.1042) = -30 \text{ kN}$

From Row No. 2 $\rightarrow Y_1 = -384 (0.1042) = -40 \text{ kN}$

From Row No. 4 $\rightarrow Y_2 = (384-384) (0.1042) = 0$

From Row No. 5 $\rightarrow X_3 = -288 (0.1042) = -30 \text{ kN}$

From Row No. 6 $\rightarrow Y_3 = 384 (0.1042) = 40 \text{ kN}$

$X_1 = 30 \text{ kN} \leftarrow$

$Y_1 = 40 \text{ kN} \downarrow$

$Y_2 = 0$

$X_3 = 30 \text{ kN} \leftarrow$

$Y_3 = 40 \text{ kN} \uparrow$

(c)

At Joint 1

$$F_{1-2} = +30 \cos \alpha + 40 \sin \alpha$$

$$= +30 \times 0.6 + 40 \times 0.8$$

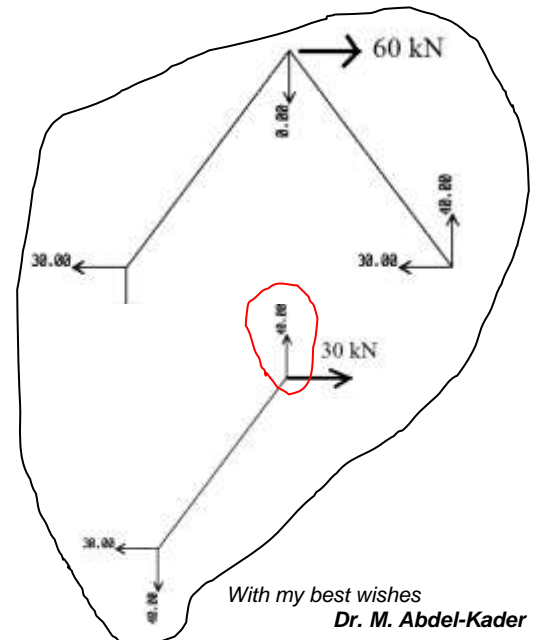
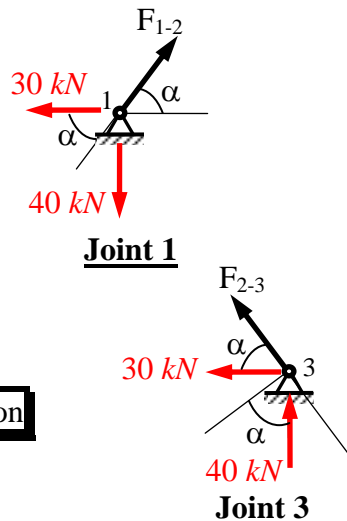
$$= +50 \text{ kN} = \boxed{50 \text{ kN Tension}}$$

At Joint 3

$$F_{2-3} = -30 \cos \alpha - 40 \sin \alpha$$

$$= -30 \times 0.6 - 40 \times 0.8$$

$$= -50 \text{ kN} = \boxed{50 \text{ kN Compression}}$$



With my best wishes
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