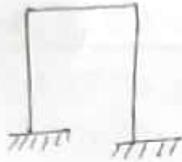


Theory of structures

(1)

Ex4m: - ESE, Nov-2022
 Course code: 201CEL301

Q.1 (a)



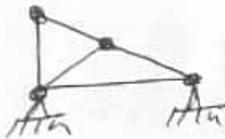
(i)

$$D_S = [r + 3m + r] - [3j + 2jP]$$

$$= [6 + 3 \times 3] - [3 \times 4]$$

$$= 15 - 12 = 3 \text{ (1)} \quad (2)$$

$$DK = 6 \text{ (1)}$$



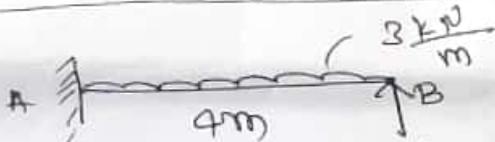
$$D_S = [2 + 1 \times 5] - [2 \times 4]$$

$$= [7] - [8] = 1$$

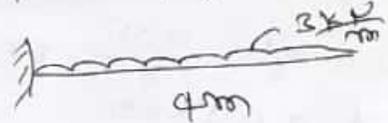
$$DK = 2j - 8$$

$$PK = 2 \times 4 - 4 = 4 \quad (2)$$

(b)



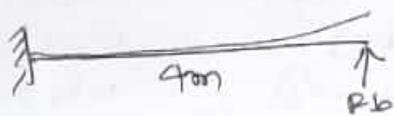
(v)



$$\delta_b = -\frac{wl^4}{8EI}$$

$$= -\frac{3 \times 4^4}{8EI} = -\frac{96}{EI}$$

(2)

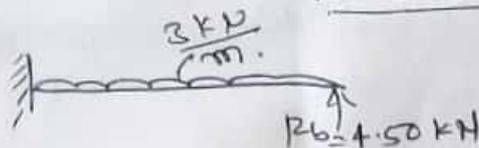


$$\delta_b = \frac{wl^3}{3EI} = \frac{P_b l^3}{3EI} = \frac{21.33 P_b}{EI}$$

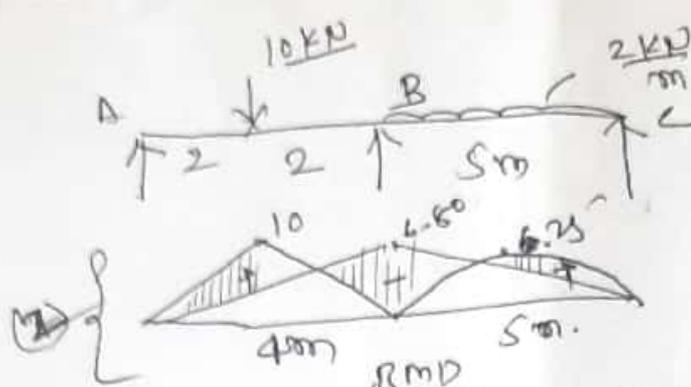
$$\therefore -\frac{96}{EI} + \frac{21.33 P_b}{EI} = 0$$

(4)

$$P_b = 4.50 \text{ KN}$$



(c)



span: mmf's
 $M_B = \frac{wl^2}{4} = 10 \text{ kNm}$

$M_C = \frac{wl^2}{8} = \frac{2 \times 5^2}{8} = 6.25 \text{ kNm}$

(12)

$\therefore m_a e_1 + 2 m_b (e_1 + e_2) + m_c e_2 = \frac{6 a_1 \bar{x}_1}{e_1} + \frac{6 a_2 \bar{x}_2}{e_2}$

$m_a = 0 \quad e_1 = 4 \text{ m} \quad a_1 \bar{x}_1 = \frac{1}{2} \times 4 \times 10 \times 2 = 40 \text{ m}^3$
 $m_b = ? \quad e_2 = 5 \text{ m} \quad a_2 \bar{x}_2 = \frac{2}{3} \times 5 \times 6.25 \times 2.5 = 52.08 \text{ m}^3$
 $m_c = 0$

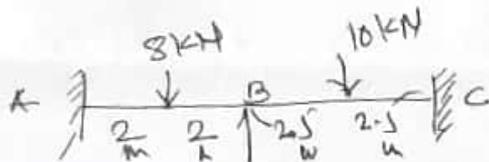
$0 + 2 m_b + 0 = \frac{6 \times 40}{4} + \frac{6 \times 52.08}{5}$

$18 m_b = 60 + 62.49$

$m_b = 6.80 \text{ kNm}$

(14)

Q.2



$M_{AB} = -\frac{wl^2}{8} = -4 \text{ kNm}$, $M_{BC} = -\frac{wl^2}{8} = -\frac{10 \times 5}{8} = -6.25 \text{ kNm}$
 $M_{BA} = +4 \text{ kNm}$, $M_{CB} = +6.25 \text{ kNm}$

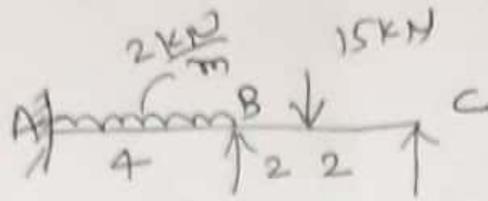
$M_{AB} = M_{AB} + \frac{2EI}{l} (2\theta_A + \theta_B - \frac{3\delta}{l})$
 $= -4 + \frac{2EI}{4} (0 + \theta_B)$
 $M_{AB} = -4 + 0.5EI\theta_B \text{ --- (i)}$
 $M_{BA} = M_{BA} + \frac{2EI}{l} (2\theta_B + \theta_A - \frac{3\delta}{l})$
 $= +4 + \frac{2EI}{4} (2\theta_B + 0 - 0)$
 $M_{BA} = 4 + EI\theta_B \text{ --- (ii)}$
 $M_{BC} = M_{BC} + \frac{2EI}{l} (2\theta_B + \theta_C)$
 $= -6.25 + \frac{2EI}{5} (2\theta_B)$
 $= -6.25 + 0.8EI\theta_B \text{ --- (iv)}$
 $M_{CB} = M_{CB} + \frac{2EI}{l} (2\theta_C + \theta_B)$
 $= 6.25 + \frac{2EI}{5} (\theta_B)$
 $= 6.25 + 0.4EI\theta_B \text{ --- (v)}$

$M_{AB} = 0$
 $M_{BA} = 5.26 \text{ kNm}$
 $M_{BC} = -5.26 \text{ kNm}$
 $M_{CB} = 0$

$M_A = 0$
 $M_C = 0$
 $\therefore 4 + EI\theta_B - 6.25 + 0.8EI\theta_B = 0$
 $EI\theta_B = 1.26$

(OR)

2



$$\begin{aligned} m_{ab} &= -\frac{wl^2}{12} = -2.66 \text{ kNm}, & m_{bc} &= -\frac{wl}{8} = -7.5 \text{ kNm} \\ m_{ba} &= +2.66 \text{ kNm}, & m_{cb} &= +7.5 \text{ kNm} \end{aligned} \quad (4)$$

$$\begin{aligned} M_{ab} &= m_{ab} + \frac{2EI}{L}(2\theta_A + \theta_B) \\ &= -2.66 + \frac{2EI}{4}(0 + \theta_B) \\ &= -2.66 + 0.5EI\theta_B \quad (i) \end{aligned}$$

$$M_{cb} = 0$$

$$M_{ab} = -0.21 \text{ kNm}$$

$$M_{ba} = 7.56 \text{ kNm}$$

$$M_{bc} = -7.56 \text{ kNm}$$

$$M_{cb} = 0$$

(2)

$$\begin{aligned} M_{bc} &= m_{bc} + \frac{2EI}{L}(2\theta_B + \theta_C) \\ &= 2.66 + \frac{2EI}{4}(2\theta_B) \\ &= 2.66 + EI\theta_B \quad (ii) \end{aligned}$$

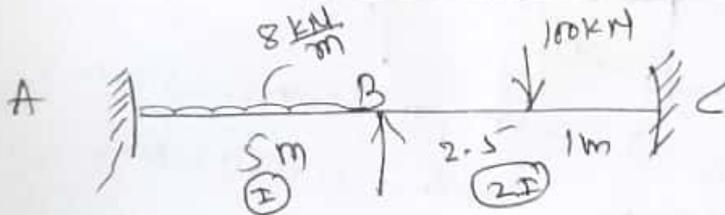
$$M_{cb} = 0$$

$$\begin{aligned} M_{bc} &= m_{bc} - \frac{1}{2}m_{cb} + \frac{3EI}{L}(2\theta_B + \theta_C) \\ &= -7.5 - \frac{1}{2}(7.5) + \frac{3EI}{4}(2\theta_B) \\ &= -11.25 + 0.75EI\theta_B \quad (iii) \end{aligned}$$

$$M_{ba} + M_{bc} = 0 \therefore 2.66 + EI\theta_B - 11.25 + 0.75EI\theta_B = 0$$

$$EI\theta_B = +4.90$$

Q.3



Joint	Members	k	Ek	DF
B	BA	0.2I	0.77I	0.23
	BC	0.57I	0.77I	0.77

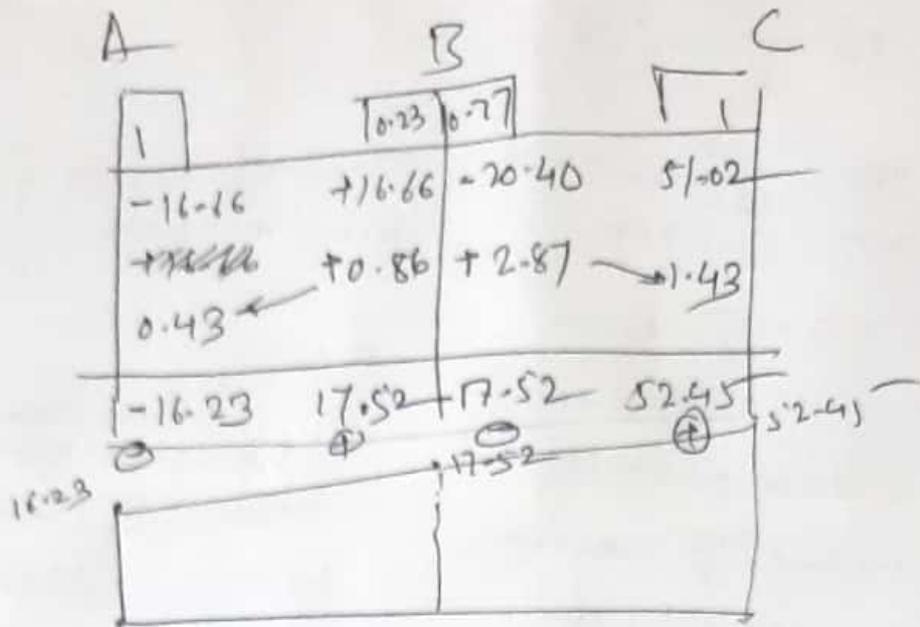
(2)

$$\begin{aligned} m_{ab} &= -\frac{wl^2}{12} = -16.66 \text{ kNm}, \\ m_{ba} &= +16.66 \text{ kNm} \end{aligned}$$

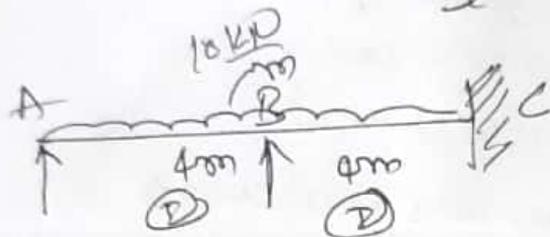
$$\begin{aligned} m_{bc} &= -\frac{wl^2}{12} \\ &= -20.40 \text{ kNm} \end{aligned}$$

$$\begin{aligned} m_{cb} &= +\frac{wl^2}{12} \\ &= +17.02 \text{ kNm} \end{aligned}$$

(4)



Span mmB $AB = \frac{wl^2}{8} = 8 \text{ kNm}$
 $BC = \frac{w \cdot ab^2}{2} = 71.42 \text{ kNm}$



J	member	k	Ek	DF
B	BA	$\frac{3}{4} I$ = 0.182	0.43 I	0.42
	BC	$\frac{1}{2} I$ = 0.21 I		0.58

} (2)

$m_{AB} = -\frac{wl^2}{12} = -13.33 \text{ kNm}$, $m_{BC} = +13.33 \text{ kNm}$
 $m_{CB} = -13.33 \text{ kNm}$, $m_{BA} = +13.33 \text{ kNm}$

} (2)

(3)

1	10.42	0.58	1
-13.33	13.38	-13.33	13.33
+13.33	→ 6.16		
0	19.99	-13.33	13.33
$\times MC$	-2.79	-3.86	→ -1.93
0	17.2	-17.2	11.4

Span
20m

