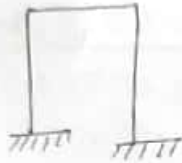


Theory of structures

①

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

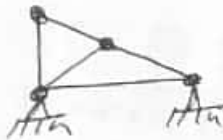
Q.1 (a)



(i)

$$\begin{aligned} D_S &= [r + 3m + r] - [3j + 2j + p] \\ &= [6 + 3 \times 3] - [3 \times 4] \\ &= 15 - 12 = 3 \text{ (1)} \end{aligned} \quad (2)$$

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

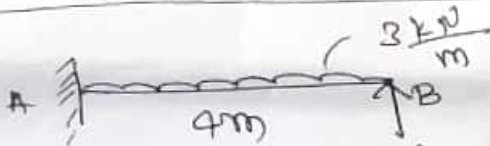


$$\begin{aligned} D_S &= [2 + 1 \times 5] - [2 \times 4] \\ &= [7] - [8] = -1 \end{aligned}$$

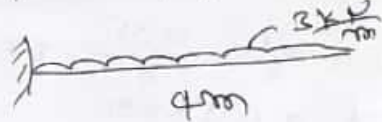
$$D_K = 2j - r$$

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

(b)



(v)



$$\begin{aligned} \delta_B &= -\frac{wl^4}{8EI} \\ &= -\frac{3 \times 4^4}{8EI} = -\frac{96}{EI} \end{aligned}$$

(2)

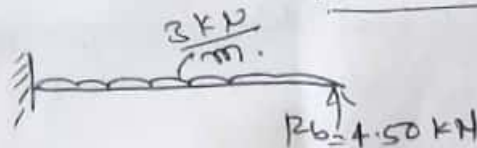


$$\delta_B = \frac{wl^3}{3EI} = \frac{P_B 4^3}{3EI} = \frac{21.33 P_B}{EI}$$

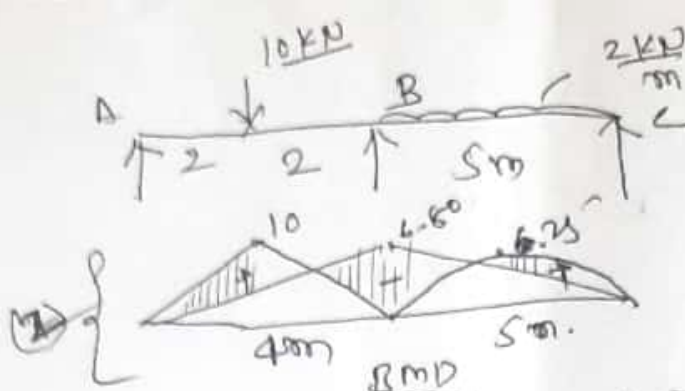
$$\therefore -\frac{96}{EI} + \frac{21.33 P_B}{EI} = 0$$

(4)

$$\boxed{P_B = 4.50 \text{ kN}}$$



(c)



Span: mmf
 $AB = \frac{wl}{4} = 10 \text{ kNm}$

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

$\therefore m_{ab} + 2m_b(l_1 + l_2) + m_{bc} = \frac{6a_1\bar{x}_1}{l_1} + \frac{6a_2\bar{x}_2}{l_2}$

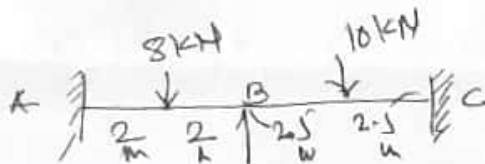
$m_a = 0 \quad l_1 = 4 \text{ m} \quad a_1\bar{x}_1 = \frac{1}{2} \times 4 \times 10 \times 2 = 40 \text{ m}^3$
 $m_b = ? \quad l_2 = 5 \text{ m} \quad a_2\bar{x}_2 = \frac{2}{3} \times 5 \times 6.25 \times 2.5 = 52.08 \text{ m}^3$
 $m_c = 0$

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

$18m_b = 60 + 62.49$

$m_b = 6.80 \text{ kNm}$

Q.2



4 $\left\{ \begin{aligned} m_{ab} &= -\frac{wl}{8} = -4 \text{ kNm} & m_{bc} &= -\frac{wl}{8} = -\frac{10 \times 5}{8} = -6.25 \text{ kNm} \\ m_{ba} &= +4 \text{ kNm} & m_{cb} &= +6.25 \text{ kNm} \end{aligned} \right.$

4 $\left\{ \begin{aligned} \therefore M_{ab} &= m_{ab} + \frac{2EI}{l} (2\theta_a + \theta_b - \frac{3\delta}{l}) \\ &= -4 + \frac{2EI}{4} (0 + \theta_b) \\ M_{ab} &= -4 + 0.5EI\theta_b \text{ --- (i)} \\ M_{ba} &= m_{ba} + \frac{2EI}{l} (2\theta_b + \theta_a - \frac{3\delta}{l}) \\ &= +4 + \frac{2EI}{4} (2\theta_b + 0 - 0) \\ M_{ba} &= 4 + EI\theta_b \text{ --- (ii)} \\ M_{bc} &= m_{bc} + \frac{2EI}{l} (2\theta_b + \theta_c) \\ &= -6.25 + \frac{2EI}{5} (2\theta_b) \\ &= -6.25 + 0.8EI\theta_b \text{ --- (iv)} \\ M_{cb} &= m_{cb} + \frac{2EI}{l} (2\theta_c + \theta_b) \\ &= 6.25 + \frac{2EI}{5} (\theta_b) \\ &= 6.25 + 0.4EI\theta_b \text{ --- (v)} \end{aligned} \right.$

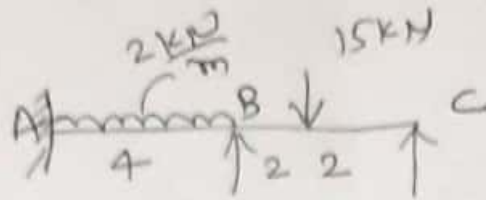
$\left. \begin{aligned} M_{ab} &= 0 \\ M_{ba} &= 5.26 \text{ kNm} \\ M_{bc} &= -5.26 \text{ kNm} \\ M_{cb} &= 0 \end{aligned} \right\} 2$

$M_a = 0$
 $M_c = 0$

$\therefore 4 + EI\theta_b = -6.25 + 0.8EI\theta_b > 0$
 $EI\theta_b = 1.26$

(OR)

②



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

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

$$m_{cb} = 0$$

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

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

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

$$m_{cb} = 0$$

(2)

$$\begin{aligned} M_{ba} &= m_{ba} + \frac{2EI}{l}(2\theta_B + \theta_A) \\ &= 2.66 + \frac{2EI}{4}(2\theta_B) \\ &= 2.66 + EI\theta_B \quad \text{--- (ii)} \end{aligned}$$

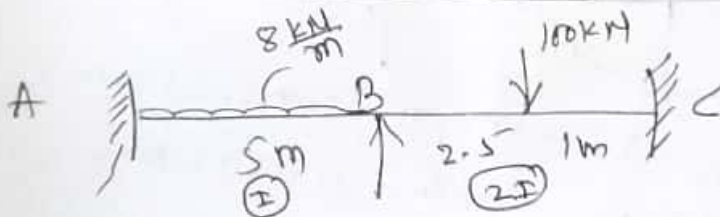
$$M_{cb} = 0$$

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

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

$$EI\theta_B = +4.90$$

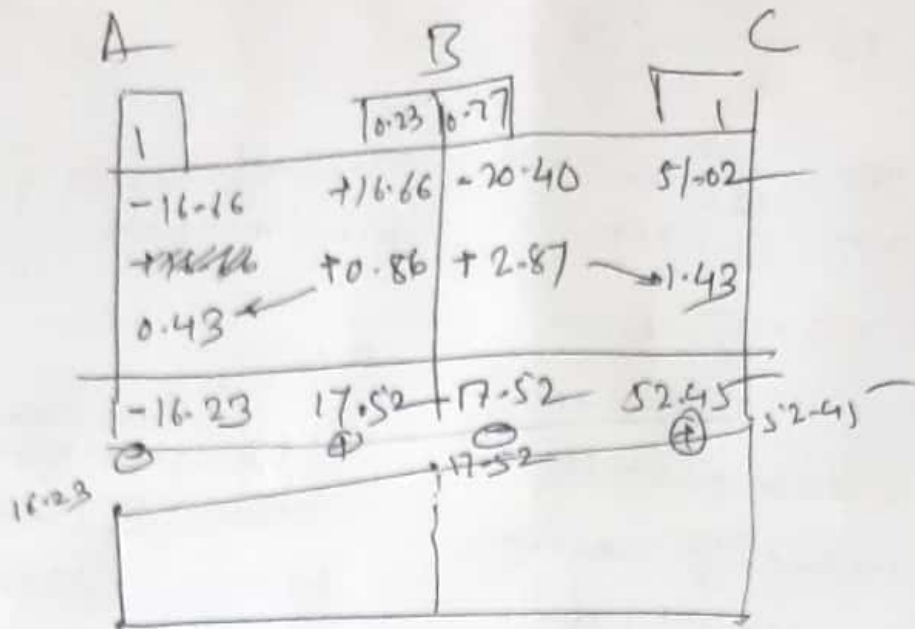
Q.3



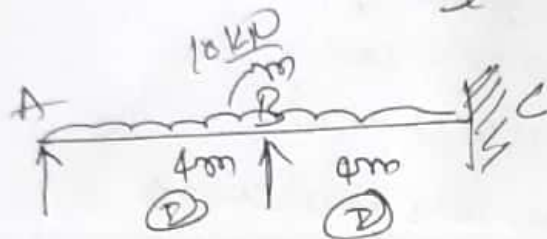
Joint	Members	k	Σk	DF
B	BA	0.2I	0.77I	0.23
	BC	0.57I		

(2)

$$\begin{aligned} m_{ab} &= -\frac{wl^2}{12} = -16.66 \text{ kNm}, & m_{bc} &= -\frac{wl^2}{12} \\ & & &= -20.40 \text{ kNm} \\ m_{ba} &= +16.66 \text{ kNm}, & m_{cb} &= +\frac{wl^2}{12} \\ & & &= +21.02 \text{ kNm} \end{aligned} \quad (4)$$



span mmf's $AB = \frac{wl^2}{8} = 8 \text{ kNm}$
 $BC = \frac{wab^2}{2} = 71.42 \text{ kNm}$



Jt	member	L	ELC	DF
B	BA	$\frac{3}{4}I$ $= 0.182$	0.432	0.42
	BC	$\frac{3}{4}I$ $= 0.182$		0.58

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

