I UNIT

SIR C.R.REDDY COLLEGE OF ENGINEERING

ELURU - 534 007

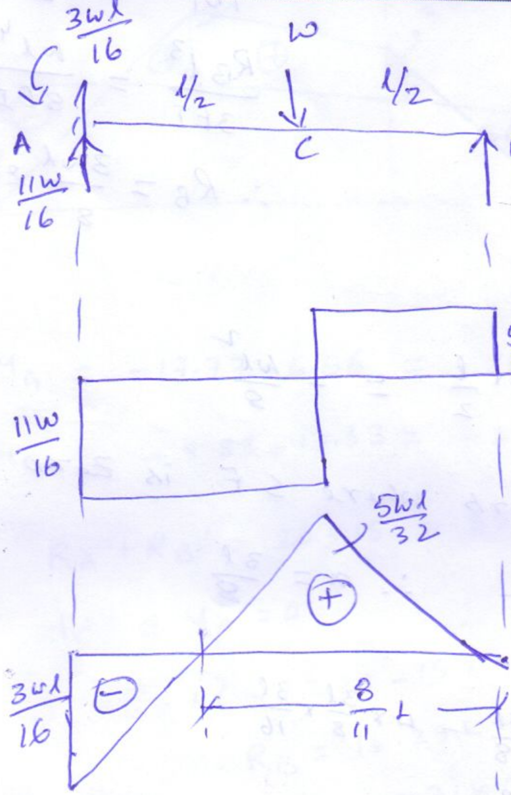
Regd. No. ANSNERS

Class : II / IV B.Tech Branch : Civil Engg. Date : 22/11/2021

Subject : Structural Analysis Signature of the Invigilator : ....

Marks Awarded : Signature of the Subject Teacher : ....

1. A.



For no deflection at 'B'

Deflection By reaction

$$Y_{B_1} = \frac{R_B l^3}{3EI}$$

Deflection by load 'w'

$$Y_{B_2} = \frac{w(\frac{l}{2})^3}{3EI} + \frac{w(\frac{l}{2})^2}{2EI} \times \frac{l}{2}$$

$$= \frac{wl^3}{24EI} + \frac{wl^3}{16EI}$$

$$Y_{B_2} = \frac{5wl^3}{48EI}$$

$$Y_{B_1} = Y_{B_2}$$

$$\therefore \frac{R_B l^3}{3EI} = \frac{5wl^3}{48EI} \quad \text{Then } R_B = \frac{5w}{16} \ \& \ R_A = \frac{11w}{16}$$

$$M_B = 0$$

$$M_C = \frac{5w}{16} \times \frac{l}{2} = \frac{5wl}{32}$$

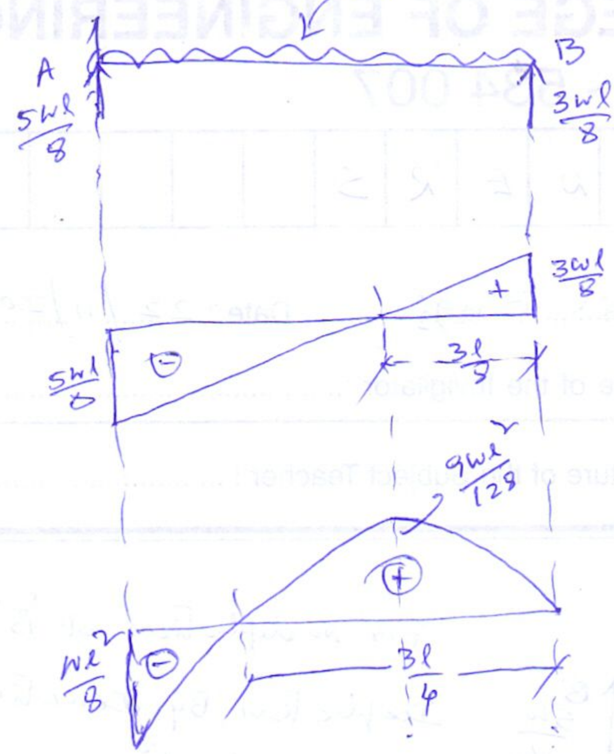
$$M_A = \frac{5w}{16} \times l - w \times \frac{l}{2} = -\frac{3wl}{16}$$

Point of contraflexure where BM changes sign or zero

$$\frac{5}{16} w \times x - w\left(x - \frac{l}{2}\right) = 0$$

$$\therefore x = \frac{8}{11} L \text{ from free end}$$

B.



For no deflection at 'B'

Deflection By Reaction 'R_B'

$$y_{B_1} = \frac{R_B l^3}{3EI}$$

Deflection because of load w kN/m

$$y_{B_2} = \frac{wl^4}{8EI}$$

$$y_{B_1} = y_{B_2}$$

$$\frac{R_B l^3}{3EI} = \frac{wl^4}{8EI}$$

$$\therefore R_B = \frac{3wl}{8} \;\&\; R_A = \frac{5wl}{8}$$

$$M_B = 0$$

$$M_A = \frac{3wl}{8} \times l - w \times l \times \frac{l}{2} = -\frac{wl^2}{8}$$

Maximum B.M. occurs where S.F. is Zero

$$\frac{x}{\frac{3wl}{8}} = \frac{l-x}{\frac{5wl}{8}} \qquad \therefore x = \frac{3l}{8}$$

$$M_{max} = \frac{3wl}{8} \times \frac{3l}{8} - w \times \frac{3l}{8} \times \frac{3l}{16}$$

$$= \frac{9wl^2}{128}$$

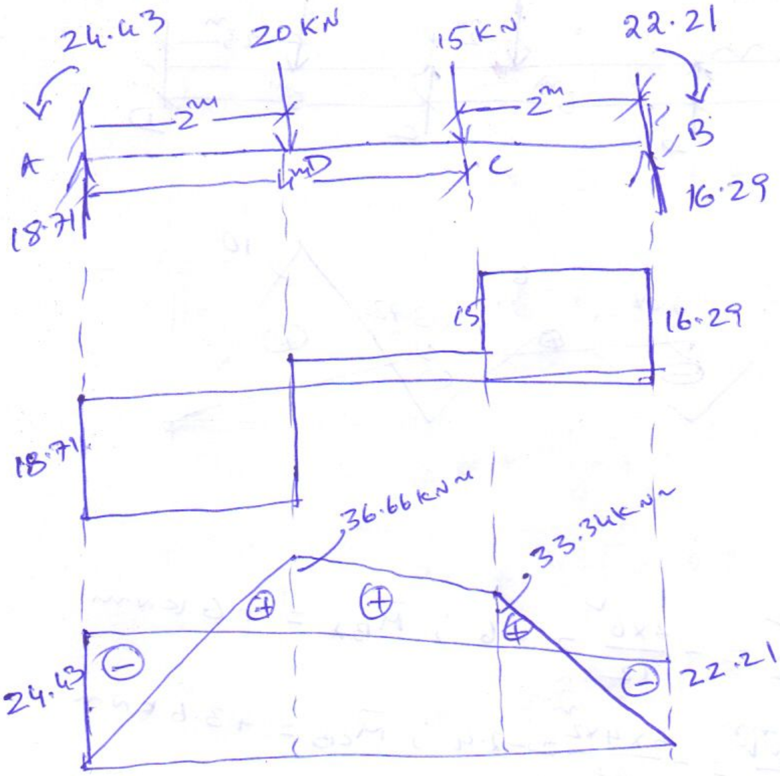
Point of contraflexure where B.M. is Zero

$$M_x = 0$$

i.e. $\frac{3wl}{8} x - w \cdot x \cdot \frac{x}{2} = 0$

$\therefore x = \frac{3l}{4}$ from free end

2.A.



Applying principle of superposition

$M_A = M_{A_1} + M_{A_2}$

$M_B = M_{B_1} + M_{B_2}$

$M_{A_1} = \frac{20 \times 2 \times 4^2}{6^2} = -17.77$

$M_{B_1} = \frac{20 \times 2^2 \times 4}{6^2} = -8.88$

$M_{A_2} = \frac{15 \times 4 \times 2^2}{6^2} = -6.66$

$M_{B_2} = \frac{15 \times 4^2 \times 2}{6^2} = 13.33$

$\therefore M_A = -17.77 - 6.66 = -24.43$ kNm

$M_B = -8.88 - 13.33 = -22.21$ kNm

$R_A + R_B = 20 + 15 = 35$ kN

$\Sigma M_A = 0$

$R_B \times 6 - 22.21 - 15 \times 4 - 20 \times 2 + 24.43 = 0$

$R_B = 16.29$ kN

$R_A = 18.71$ kN

Positive Bending Moments

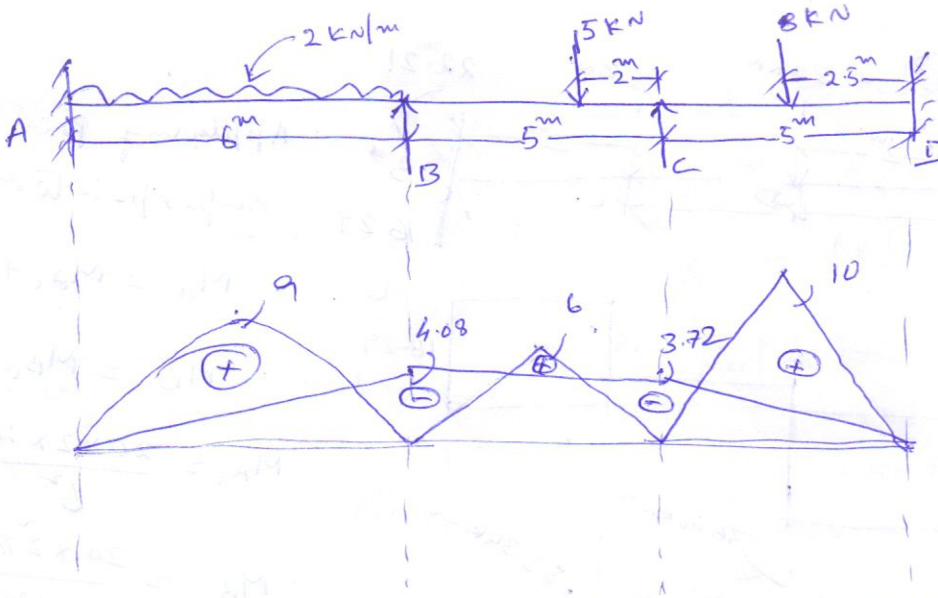
Assuming the beam as s s B

$R_A = 18.33$ kN ; $R_B = 16.67$ kN

$M_C = +16.67 \times 2 = 33.34$ kNm

$M_D = +18.33 \times 2 = 36.66$ kNm

3.



$\overline{M}_{AB} = -\frac{wl^2}{12} = -\frac{2 \times 6^2}{12} = -6$; $\overline{M}_{BA} = +6$ kNm

$\overline{M}_{BC} = -\frac{wab^2}{l^2} = -\frac{5 \times 4 \times 2^2}{5^2} = -2.4$; $\overline{M}_{CB} = +3.6$ kNm

$\overline{M}_{CD} = -\frac{wl}{8} = -\frac{8 \times 5}{8} = -5$; $\overline{M}_{DC} = +5$ kNm

Slope Deflection Equations

$M_{AB} = -6 + \frac{2EI}{6}(2\overset{0}{\cancel{\theta_A}} + \theta_B) = -6 + \frac{EI}{3}\theta_B$

$M_{BA} = +6 + \frac{2EI}{6}(\theta_A + 2\theta_B) = +6 + \frac{2EI}{3}\theta_B$

$M_{BC} = -2.4 + \frac{2EI}{5}(2\theta_B + \theta_C) = -2.4 + \frac{4EI\theta_B}{5} + \frac{2EI\theta_C}{5}$

$M_{CB} = +3.6 + \frac{2EI}{5}(\theta_B + 2\theta_C) = +3.6 + \frac{2EI\theta_B}{5} + \frac{4EI\theta_C}{5}$

$M_{CD} = -5 + \frac{2EI}{5}(2\theta_C + \cancel{\theta_D}) = -5 + \frac{4EI\theta_C}{5}$

$M_{DC} = +5 + \frac{2EI}{5}(\theta_C + 2\cancel{\theta_D}) = +5 + \frac{2EI\theta_C}{5}$

Equilibrium conditions

$M_{BA} + M_{BC} = 0$ and $M_{CB} + M_{CD} = 0$

$+6 + 0.66EI\theta_B - 2.4 + 0.8EI\theta_B + 0.4EI\theta_C = 0$

$1.46EI\theta_B + 0.4EI\theta_C = -3.6 \quad \cdots (1)$

$+3.6 + 0.4EI\theta_B + 0.8EI\theta_C - 5 + 0.8EI\theta_C = 0$

$0.4EI\theta_B + 1.6EI\theta_C = +1.4 \quad \cdots (2)$

Solving Equations (1) & (2)

We get $\theta_B = -\frac{2.89}{EI}$; $\theta_C = \frac{1.59}{EI}$

Substituting θ_B & θ_C values, in Slope Deflection Equations

$$M_{AB} = -6 + \frac{EI}{3} \times -2.89 = -6.96 \text{ KNm}$$

$$M_{BA} = +6 + \frac{2EI}{3} \times -2.89 = \underline{+4.08} \text{ KNm}$$

$$M_{BC} = -2.4 + \frac{4EI}{5} \times -2.89 + \frac{2EI}{5} \times 1.59 = \underline{-4.08} \text{ KNm}$$

$$M_{CB} = +3.6 + \frac{2EI}{5} \times -2.89 + \frac{4EI}{5} \times 1.59 = \underline{+3.72} \text{ KNm}$$

$$M_{CD} = -5 + \frac{4EI}{5} \times 1.59 = \underline{-3.72} \text{ KN-m}$$

$$M_{DC} = +5 + \frac{2EI}{5} \times 1.59 = +5.636 \text{ KN-m}$$

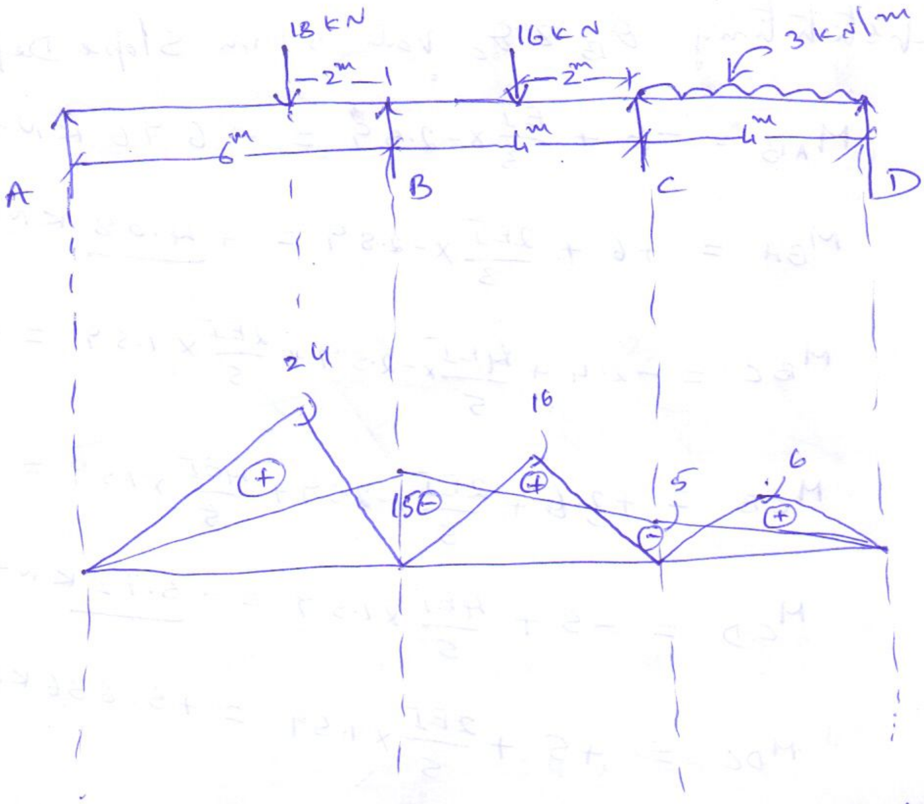
Positive Bending Moments

$$\text{for } AB = + \frac{wl^2}{8} = \frac{2 \times 6^2}{8} = +9 \text{ KNm}$$

$$\text{for } BC = + \frac{Wab}{l} = \frac{5 \times 2 \times 3}{5} = +6 \text{ KNm}$$

$$\text{for } CD = + \frac{Wl}{4} = \frac{8 \times 5}{4} = +10 \text{ KNm}$$

4.



$$DF_{BA} = \frac{3EI/6}{3EI/6 + 4EI/4} = 0.33 \; ; \quad DF_{BC} = 0.67$$

$$DF_{CB} = \frac{4EI/4}{4EI/4 + 3EI/4} = 0.57 \; ; \quad DF_{CD} = 0.43$$

FEMs

$$\overline{M}_{AB} = -\frac{18 \times 4 \times 2^2}{6^2} = -8 \text{ KNm}$$

$$\overline{M}_{BA} = +\frac{18 \times 4^2 \times 2}{6^2} = 16 \text{ KNm}$$

$$\overline{M}_{BC} = -\frac{wl}{8} = \frac{16 \times 4}{8} = -8 \text{ KNm} \; ; \quad \overline{M}_{CB} = +8 \text{ KNm}$$

$$\overline{M}_{CD} = -\frac{wl^2}{12} = -\frac{3 \times 4^2}{12} = -4 \text{ KNm} \; ; \quad \overline{M}_{DC} = +4 \text{ KNm}$$

Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF	—	0.33	0.67	0.57	0.43	—
FEM	−8	+16	−8	+8	−4	+4
ROM	+8	—	—	—	—	−4
COM	—	+4	—	—	−2	—
IM	0	+20	−8	+8	−6	0
DM	—	−3.96	−8.04	−1.14	−0.86	—
COM	—	—	−0.57	−4.02	—	—
DM	—	+0.1881	+0.3819	+2.2914	+1.7286	—
COM	—	—	+1.1457	+0.1909	—	—
DM	—	−0.3780	−0.7676	−0.1088	−0.082	—
FM	0	+15.853	−15.853	+5.2135	−5.2135	—

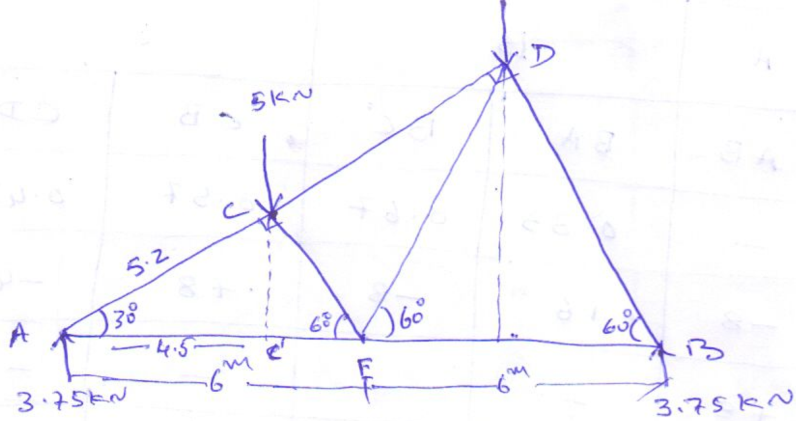
+ve B.M.

on Span AB $= \frac{wab}{l} = \frac{18 \times 2 \times 4}{6} = 24$ kNm

Span BC $= \frac{wl}{4} = \frac{16 \times 4}{4} = 16$ kNm

Span CD $= \frac{wl^2}{8} = \frac{3 \times 4^2}{8} = 6$ kNm

5.



To find out the reactions

$$AC = AE\cos 30^\circ = 6\cos 30^\circ = 5.2 \text{ mtrs}$$

$$\therefore AC' = AC\cos 30^\circ = 5.2\cos 30^\circ = 4.5 \text{ mtrs}$$

$$\Sigma M_A = 0$$

$$R_B \times 12 - 2.5 \times 9 - 5 \times 4.5 = 0$$

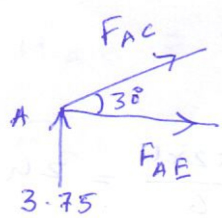
$$\therefore R_B = 3.75 \text{ kN}$$

$$R_A + R_B = 5 + 2.5 = 7.5 \text{ kN}$$

$$\therefore R_A = 3.75 \text{ kN}$$

By Method of Joints

Joint 'A'



$$\Sigma V = 0$$

$$3.75 + F_{AC}\sin 30^\circ = 0$$

$$\therefore F_{AC} = -\frac{3.75}{\sin 30^\circ} = -7.5 \ (C)$$

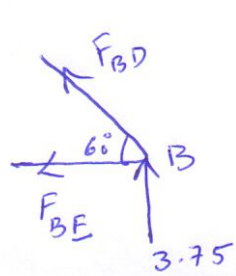
$$\Sigma H = 0$$

$$F_{AE} + F_{AC}\cos 30^\circ = 0$$

$$\therefore F_{AE} = -F_{AC}\cos 30^\circ = -(-7.5\cos 30^\circ)$$

$$F_{AE} = +6.495 \ (T)$$

Joint 'B'



$$\Sigma V = 0$$

$$3.75 + \sin 60^\circ F_{BD} = 0$$

$$\therefore F_{BD} = -\frac{3.75}{\sin 60^\circ} = -4.33 \ (C)$$

$$\Sigma H = 0$$

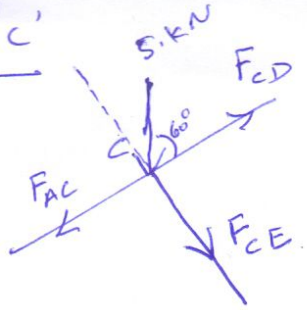
$$F_{BE} + F_{BD}\cos 60^\circ = 0$$

$$F_{BE} = -F_{BD}\cos 60^\circ$$

$$\therefore F_{BE} = -(-4.33\cos 60^\circ)$$

$$= +2.165 \ (T)$$

Joint 'C'



$\Sigma V = 0$

$F_{CE} + 5 \sin 60^\circ = 0$

$\therefore F_{CE} = -5 \sin 60^\circ = -4.33 \, (C)$

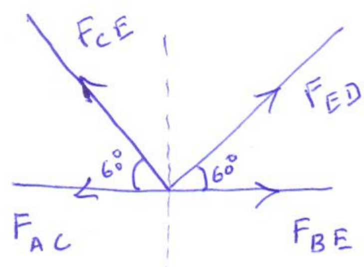
$\Sigma H = 0$

$F_{CD} - F_{AC} - 5 \cos 60^\circ = 0$

$F_{CD} = F_{AC} + 5 \cos 60^\circ = -7.5 + 2.5$

$\therefore F_{CD} = -5 \; (C)$

Joint 'E'



$\Sigma V = 0$

$F_{CE} \sin 60^\circ + F_{ED} \sin 60^\circ = 0$

$\therefore F_{ED} = -F_{CE}$

$= -(-4.33) =$

$= +4.33 \, (T)$

SN	Member	Magnitude of FORCE	Nature of FORCE
~~AE~~ 1	AE	6.495 N	T
2	AC	7.5 N	C
3	BE	2.165 N	T
4	BD	4.33 N	C
5	CE	4.33 N	C
6	CD	5.0 N	C
7	ED	4.33 N	T