Problems carry equal weightage

Problem 1   **YOU MUST USE ONLY SLOPE DEFLECTION METHOD**

Refer Fig. 1. For the frame having an internal hinge at *C*, and loaded as shown, **determine the rotation at *B* (i.e., θ_B) and reactions (i.e., forces and moment) at support *D*.** Use $EI = 4 \times 10^{13} \, \text{N.mm}^2$, $P = 50 \, \text{kN}$, $L = 10 \, \text{m}$
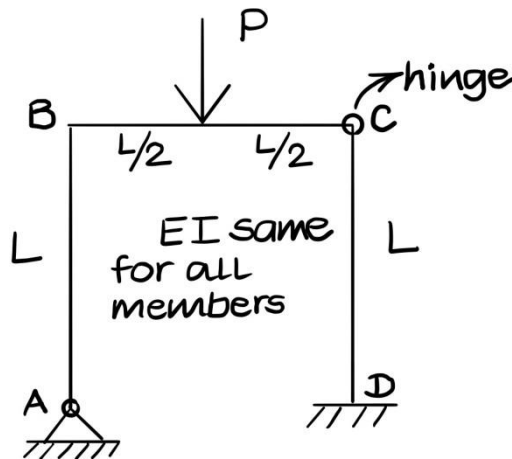

Figure 1

Problem 2   **YOU MUST USE ONLY MOMENT DISTRIBUTION METHOD**

Refer Fig. 2. Members ***BC*** and ***CD*** are hinge connected to each other, and the hinge is supported by a roller at *C* as shown. For the loading shown, **determine all support reactions (i.e., forces and moments).** Use $P = 50 \, \text{kN}$, $L = 10 \, \text{m}$
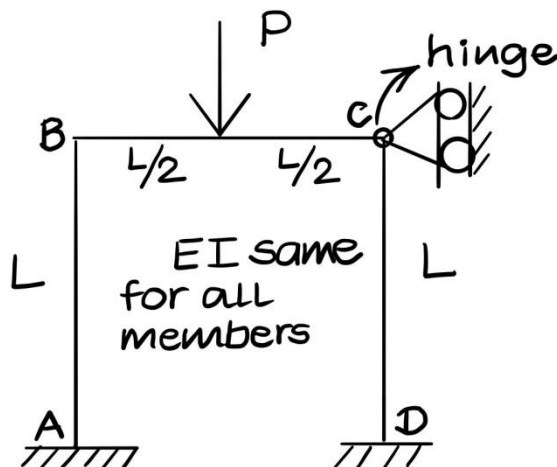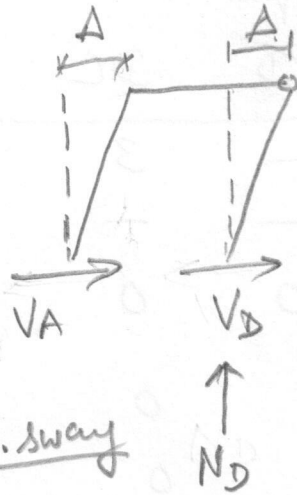

Figure 2

P1

θ_B, Δ d.o.f's considered

$$M_{BA} = 3\frac{EI}{L}\left(\theta_B - \frac{\Delta}{L}\right)$$

$$M_{BC} = 3\frac{EI}{L}\theta_B - \frac{3PL}{16}$$

1 d.o. sway N_D

$$M_{DC} = -\frac{3EI}{L}\frac{\Delta}{L}$$

$$V_A = \frac{M_{AB} + M_{BA}}{L} = \frac{3EI}{L^2}\left(\theta_B - \frac{\Delta}{L}\right)$$

$$V_D = \frac{M_{DC} + M_{CD}}{L} = -\frac{3EI}{L^3}\Delta$$

Equil: $M_{BA} + M_{BC} = 0 \Rightarrow \frac{6EI}{L}\theta_B - \frac{3EI}{L}\frac{\Delta}{L} = \frac{3PL}{16}$ ①

$V_A + V_D = 0 \Rightarrow \theta_B = 2\frac{\Delta}{L}$ → ②

①, ②, → $\Delta = \frac{1}{48}\frac{PL^3}{EI}$, $\theta_B = \frac{1}{24}\frac{PL^2}{EI}$

$= 5.208 \times 10^{-3}$ rad

$= 0.2984$ deg.

$$M_{DC} = -\frac{3EI}{L}\frac{\Delta}{L} = -\frac{3}{48}PL = 31.25 \text{ kN·m} \circlearrowright$$

$$V_D = -\frac{3}{48}P = 3.125 \text{ kN} \leftarrow$$

$$N_D = \frac{M_{DC} + PL/2}{L} = \left(-\frac{3}{48} + \frac{1}{2}\right)P = \frac{7}{16}P = 21.875 \text{ kN} \uparrow$$

P2

No sway problem

these two columns are not required.

	AB	BA	BC	CB	CD	DC
R	4	4	3	—	—	3
df	—	4/7	3/7	—	—	—
Fem	0	0	$-\frac{3PL}{16} = -93.75$	0	0	0
dist, CO	+26.79	+53.57	+40.18	0	0	0
Convg BM	26.79	53.57	−53.57	0	0	0

non-iterative

$$M_A = 26.79 \text{ kN.m} \circlearrowleft$$

$$V_A = \frac{M_{AB} + M_{BA}}{L} = 8.036 \text{ kN} \rightarrow$$

$\Sigma M_C = 0$: $N_A = \frac{1}{L}\left(-M_{AB} + P\frac{L}{2} + V_A L\right) = 30.357 \uparrow$
for ABC

$$N_D = P - N_A = 19.643 \text{ kN} \uparrow$$

$$M_D = 0, \quad V_D = 0, \quad$$

$$C_X = V_A = 8.036 \text{ kN} \leftarrow$$