DEPARTMENT OF CIVIL ENGINEERING

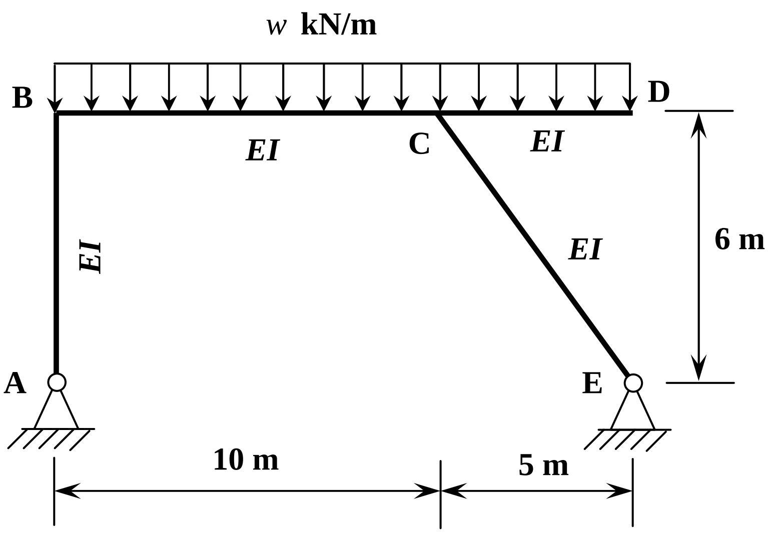
CE-317 STRUCTURAL MECHANICS II

Quiz-1 2/9/11

Problem 1

<u>Use only Slope Deflection Method</u>.
Determine the **horizontal reaction at *E*,** for the frame in **Fig. 1**.

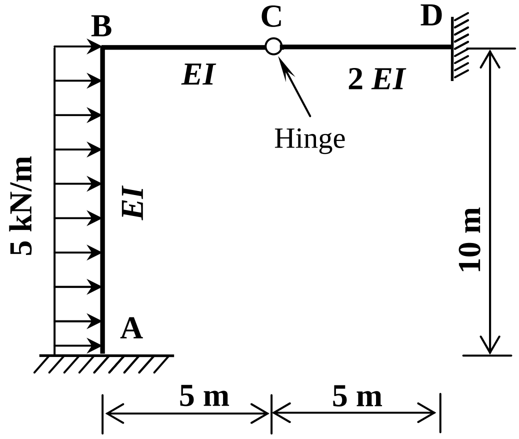
Fig. 1



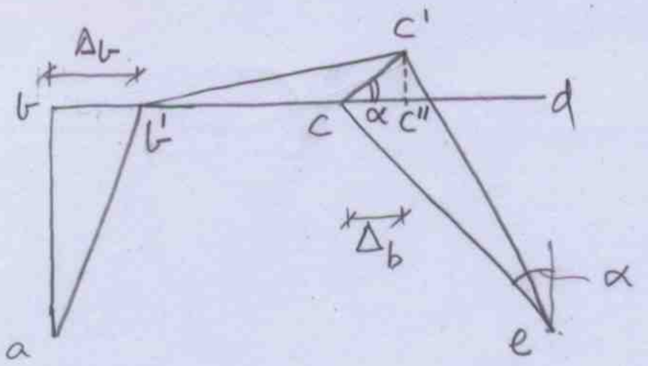
Problem 2

<u>Use only Moment Distribution Method with modified stiffnesses wherever possible</u>.
Determine the **forces in the internal hinge *C*** for the structure in **Fig. 2**.

Fig. 2



P1.



$$\cos\alpha = \frac{6}{\sqrt{61}}$$

$$\psi_{ab} = \frac{\Delta_b}{6}$$

$$\psi_{cb} = \frac{c'c''}{10} = \frac{cc''\times\tan\alpha}{10} = \frac{\Delta_b}{12}$$

$$\psi_{ce} = \frac{cc'}{\sqrt{61}} = \frac{cc''}{\cos\alpha\sqrt{61}} \doteq \frac{\Delta_b}{6}$$

$$M_{ba} = EI\left\{\frac{3}{6}\theta_b - \frac{3}{6^2}\Delta_b\right\}$$

$$M_{bc} = EI\left\{\frac{4}{10}\theta_b + \frac{2}{10}\theta_c - \frac{6}{10}\cdot\frac{\Delta_b}{12}\right\} - w\cdot\frac{10^2}{12}$$

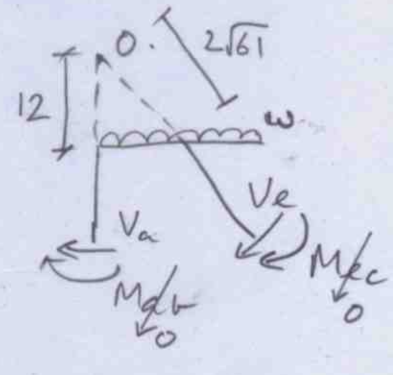
$$M_{cb} = EI\left\{\frac{2}{10}\theta_b + \frac{4}{10}\theta_c - \frac{6}{10}\cdot\frac{\Delta_b}{12}\right\} + w\cdot\frac{10^2}{12}$$

$$M_{ce} = EI\left\{\frac{3}{\sqrt{61}}\theta_c - \frac{3}{\sqrt{61}}\cdot\frac{\Delta_b}{6}\right\}$$

$$M_{cd} = -w\cdot\frac{5^2}{2}$$

Equilibrium: $M_{ba} + M_{bc} = 0 \rightarrow (i)$, $M_{cb} + M_{cd} + M_{ce} = 0 \rightarrow (ii)$

(iii) ← sway eqn. $\cancel{M_{ab}}^{0} + \cancel{M_{ec}}^{0} + V_a\cdot 18 + V_e\cdot 3\sqrt{61} + w\cdot\frac{15^2}{2} = 0$



$$V_a = -\frac{M_{ba}}{6}, \quad V_e = -\frac{M_{ce}}{\sqrt{61}}$$

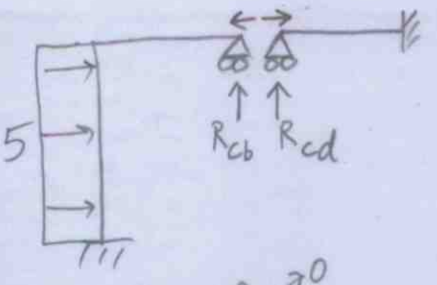
$$\Rightarrow -3M_{ba} - 3M_{ce} + w\cdot\frac{15^2}{2} = 0$$

$$EI\begin{bmatrix} \left(\frac{3}{6}+\frac{4}{10}\right) & \frac{2}{10} & \left(-\frac{3}{6^2}+\frac{6}{120}\right) \\ \frac{2}{10} & \frac{4}{10}+\frac{3}{\sqrt{61}} & \left(+\frac{6}{120}-\frac{1}{2\sqrt{61}}\right) \\ 3\left(\frac{3}{6}\right) & 3\left(\frac{3}{\sqrt{61}}\right) & \left(-3\left(\frac{3}{6^2}\right)-3\left(\frac{3}{6\sqrt{61}}\right)\right) \end{bmatrix}\begin{Bmatrix}\theta_b \\ \theta_c \\ \Delta_b\end{Bmatrix} = \begin{Bmatrix}\frac{10^2}{12} \\ -\frac{10^2}{12}+\frac{5^2}{2} \\ \frac{15^2}{2}\end{Bmatrix} * w.$$

$$\{\theta_b, \theta_c, \Delta_b\} = \{-0.3147 \quad 0.8655 \quad -253.3048\}^T \frac{w}{EI}$$

$$M_{ba} = 20.95, \quad \underset{(\leftarrow)}{V_a} = 3.4918 = \underset{(\rightarrow)}{E_x}$$

P2



$R_c = R_{cb} + \cancel{R_{cd}}^{\,0}$

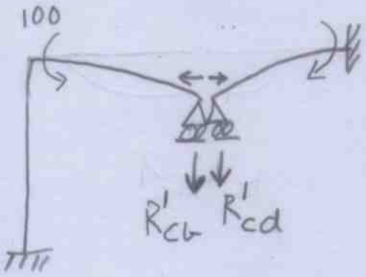
$R_c = \frac{M_{bc}}{5} = -5$

No-Sway.

jt	a	b		d
mem end	ab	ba	bc	dc
rel stiff	K	K	2K	4K
mod stiff	1	1	$\frac{3}{4}*2$	$\frac{3}{4}*4$
df	0	0.4	0.6	3
fem	-125/3	125/3	0	0
	-25/3	-50/3	-25	
BM′	-50	25	-25	0

$K = \frac{EI}{10}$

$*K$



Sway.

fem	0	0	-100	200
	20	40	60	0
BM″	20	40	-40	200
BM	-52.08	20.83	-20.83	-20.83

→ reduced fem's from RHS Table Hibbeler

$BM = BM' + BM'' * \left(\frac{R_c}{R'_c}\right)$

$= BM' + BM'' * \left(\frac{-5}{48}\right)$

$R'_c = R'_{cb} + R'_{cd}$

$= \frac{M_{bc}}{5} + \frac{M_{dc}}{5}$

$= \frac{40}{5} + \frac{200}{5}$

$= 48$

$\sum_{bc} M_b = 0: \; C_y(\downarrow) = -\frac{M_{bc}}{5} = \frac{25}{6}(\downarrow)$

$\sum_{dc} M_d = 0: \; C_y(\uparrow) = -\frac{M_{dc}}{5} = \frac{25}{6}(\uparrow)$ → this is just a check.

$\sum_{abc} M_a = 0: \; C_x(\longleftarrow) = \left[5 * \frac{10^2}{2} + (-52.08) + \frac{25}{6} * 5\right] \cdot \frac{1}{10} = 21.875$