- Mohanad Moayad Shannak
- 118 1401
- Final Exam (ENCE 3341).

Question 1

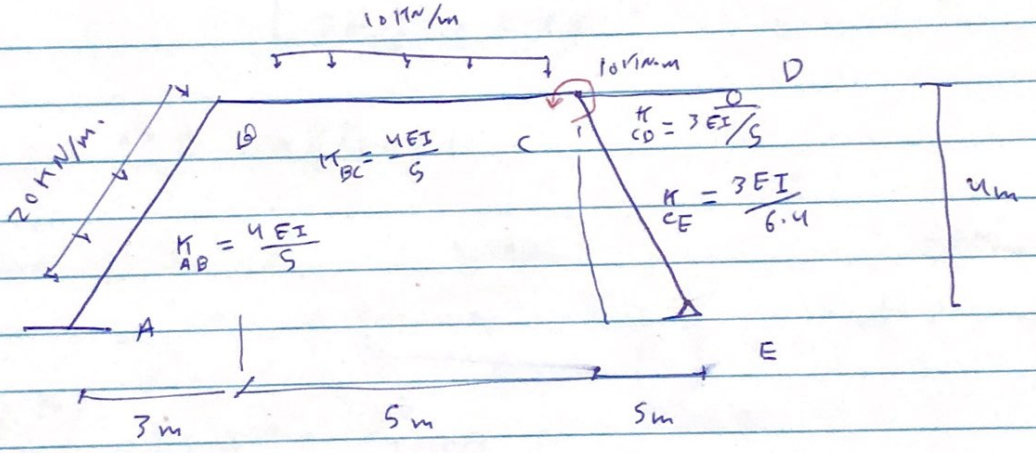
$h = 4m$, $SZ = 3m$

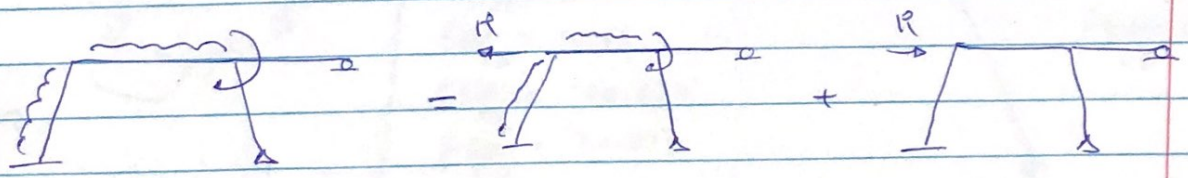
$Sz = 5m$

$m = 10\ kN.m$, $W = 10\ kN/m$, $L_{CE} = 6.4m$

$L_{AB} = 5m$

* Sway frum





Stage I Stage 2

Stage 1

DF at A → $DF_{AB} = 0$, at D → $DF_{DC} = 1$

at B → $DF_{BA} = K_{BA} / (K_{BA} + K_{BC}) = 0.5$

→ $DF_{BC} = 0.5$

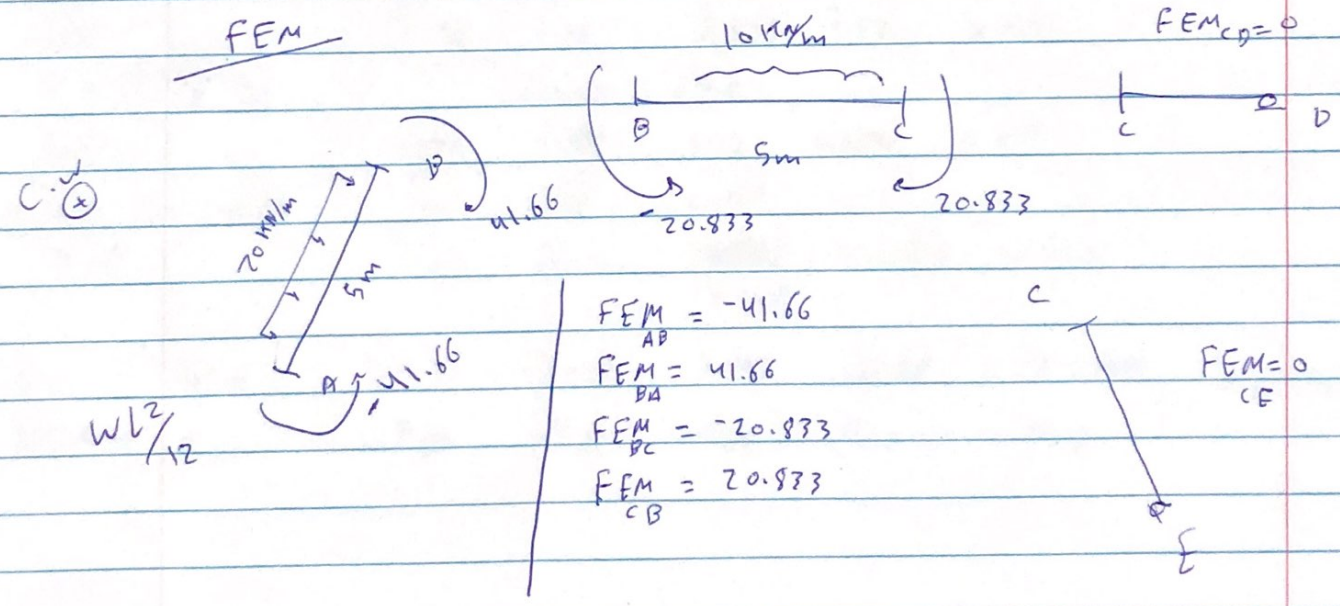
at C → $DF_{CB} = 0.43$

→ $DF_{CD} = 0.32$

→ $DF_{CE} = 0.25$

at E → $DF_{EC} = 1$

FEM

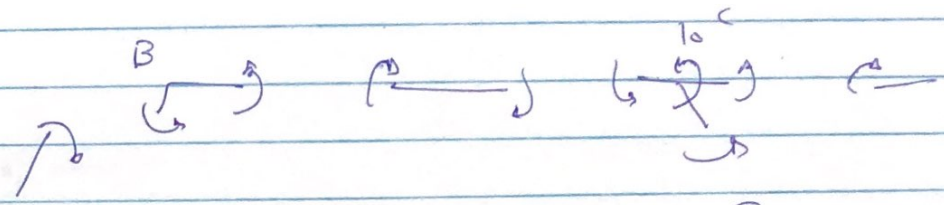


$FEM_{AB} = -41.66$

$FEM_{BA} = 41.66$

$FEM_{BC} = -20.833$

$FEM_{CB} = 20.833$



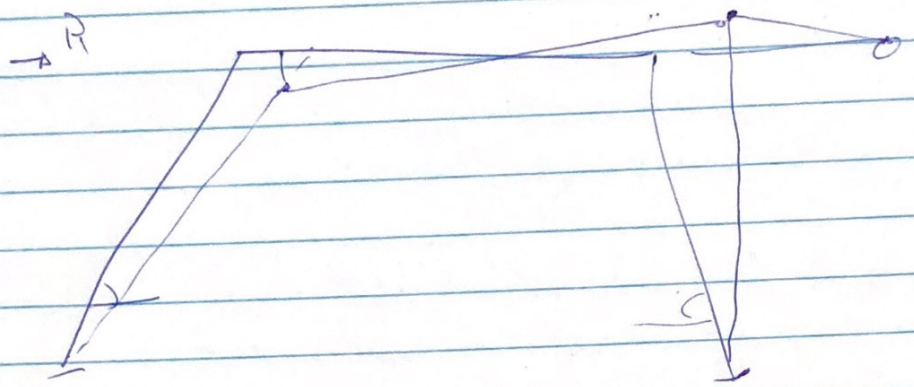
$\sum M_B = 0$

$\sum M_C = 0 \rightarrow \boxed{M_{CD} + M_{CB} + M_{CE} = -T_0}$

$M_{BA} + M_{BC} = 0$

Joint	A	B		C			D	E
Member	AB	BA	BC	CB	CD	CE	DC	EC
DF	0	0.5	0.5	0.43	0.32	0.25	1	1
FEM	-41.66	41.66	-20.833	20.833	0	0	0	0
Dist		-10.4135	-10.4135	-13.26	-9.866	-7.7		
CO	-5.2		-6.63	-5.2				
Dist		3.315	3.315	2.236	1.664	1.3		
CO	1.658		1.118	1.658				
Dist		-0.56	-0.56	-0.713	-0.53	-0.4145		
CO	-0.28		-0.3565	-0.28				
Dist		0.178	0.178	0.12	0.0896	0.07		
CO	0.089		0.06	0.089				
Dist		-0.03	-0.03	~~-0.0547~~ -0.0383	-0.02848	-0.02225		
$\sum M$	-45.4	34.15	-34.15	5.445	-8.67	-6.76675		$M_{DC} = M_{EC} = 0$
END Moment	M_{AB}	M_{BA}	M_{BC}	M_{CB}	M_{CD}	M_{CE}		

Stage II



FEM :

I Should find END moments from Stage II

and R'

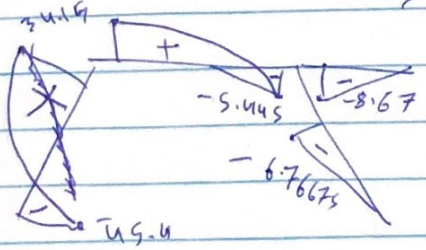
and determine END Moment for real Sway System

$$M_{ij} = M_{\text{Stage I},ij} + \left(\frac{R}{R'}\right) M_{2,ij}$$

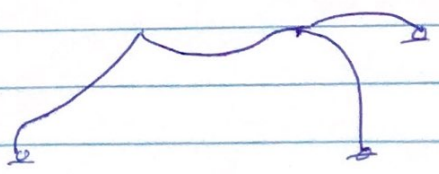
and find reactions

but no enough time

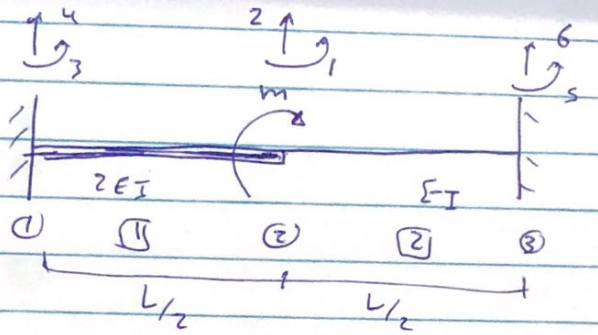
determine as Non-Sway System:



def Shape:



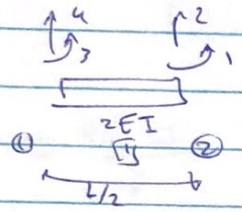
Question 2



m, L

# of DOF = 6

[1]



$$\frac{12(2EI)}{(L/2)^3} = \frac{192\,EI}{L^3}$$

$$\frac{6(2EI)}{(L/2)^2} = \frac{48}{L^2}\,EI$$

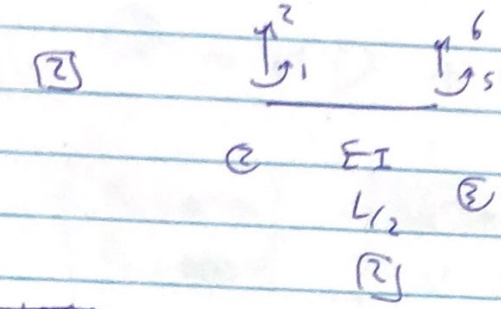
$$\frac{4(2EI)}{L/2} = \frac{16}{L}\,EI$$

$$\frac{2(2EI)}{L/2} = \frac{8}{L}\,EI$$

No FEF

$$K_{[1]} = EI$$

$$\begin{array}{c} \\ \\ \\ \\ \end{array}\begin{array}{c} 4 \\ 3 \\ 2 \\ 1 \end{array}\begin{bmatrix} 192/L^3 & 48/L^2 & -192/L^3 & 48/L^2 \\ 48/L^2 & 16/L & -48/L^2 & 8/L \\ -192/L^3 & -48/L^2 & 192/L^3 & -48/L^2 \\ 48/L^2 & 8/L & -48/L^2 & 16/L \end{bmatrix}\begin{array}{c} 4 \\ 3 \\ 2 \\ 1 \end{array}\begin{array}{l} \\ ① \\ \\ ② \end{array}$$



$$\frac{12EI}{(L/2)^3} = \frac{96EI}{L^3}$$

$$\frac{6EI}{(L/2)^2} = \frac{24EI}{L^2}$$

$$\frac{4EI}{L/2} = \frac{8EI}{L}$$

$$\frac{2EI}{L/2} = \frac{4EI}{L}$$

No FEF

$$K_{[2]} = EI \begin{array}{c|cccc} & 5 & 9 & 1 & 2 \\ \hline 2 & 27/42 & 63/96 & 27/42 & 63/96 \\ 1 & 7/4 & 27/42 & 7/8 & 27/42 \\ 9 & 27/42 & 63/96 & 27/42 & 63/96 \\ 5 & 7/8 & 27/42 & 7/4 & 27/42 \end{array}$$

$$Q = KD + Q_0$$

$$\begin{Bmatrix} Q_1 = -m \\ Q_2 = 0 \\ Q_3 \\ Q_4 \\ Q_5 \\ Q_6 \end{Bmatrix} = \begin{bmatrix} \frac{16+8}{L} & -\frac{24}{L} & -\frac{24}{L^2} \\ 24/L^2 & +288/L^3 & \\ 8/L & -48/L^2 & \\ 48/L^2 & -192/L^3 & \\ 4/L & 24/L^2 & \\ -24/L^2 & -96/L^3 & \end{bmatrix} \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{matrix} \begin{Bmatrix} D_1 \\ D_2 \\ D_3 = 0 \\ D_4 = 0 \\ D_5 = 0 \\ D_6 = 0 \end{Bmatrix} + \begin{Bmatrix} Q_{0_1} = 0 \\ Q_{0_2} = 0 \\ = 0 \\ = 0 \\ = 0 \\ = 0 \end{Bmatrix}$$

$$\Rightarrow -m = \frac{24}{L} EI\, D_1 - \frac{24}{L^2} EI\, D_2 + 0$$

$$0 = \frac{-24}{L^2} EI\, D_1 + \frac{288}{L^3} EI\, D_2 + 0$$

$$0 = -24 D_1 + \frac{288}{L} D_2 \Rightarrow \boxed{D_1 = \frac{12}{L} D_2}$$

$$-m = \frac{24}{L} EI \left(\frac{12}{L}\right) D_2 - \frac{24}{L^2} EI\, D_2$$

$$-m = \frac{24}{L^2} EI\, D_2 (12) - \frac{24}{L^2} EI\, D_2$$

$$-m = (11) \frac{24}{L^2} EI\, D_2 \Rightarrow \boxed{D_2 = \frac{-m(L^2)}{EI(264)}}$$

$$\Rightarrow \boxed{D_1 = \frac{-m(L)}{EI(22}}$$

$$Q_3 = \frac{8}{L} EI \left(\frac{-mL}{EI\,22}\right) - \frac{48}{L^2} EI \left(\frac{-mL^2}{EI\,264}\right) = -m\left(\frac{8}{22}\right) + m\left(\frac{48}{264}\right)$$

$$Q_3 = \left(-4/22\right) m$$

$$Q_4 = -\frac{48}{L^2} \frac{mL}{22} + \frac{192}{L^3} \frac{mL^2}{264} = -\frac{32}{22} m$$

$$Q_5 = \frac{-m}{22}\frac{4}{} - \frac{m(24)}{264} = \frac{-6}{22}m$$

$$Q_6 = \frac{24\ m}{L\ (22)} + \frac{96\ m}{L\ (264)} = \frac{32\ m}{L}$$

(1)
$$\begin{Bmatrix} q_{t4} \\ q_{t3} \\ q_{t2} \\ q_{t1} \end{Bmatrix} = \begin{bmatrix} & & & \\ & & & \\ & & \frac{192}{L^3} & \frac{-48}{L^2} \\ & & \frac{-48}{L^2} & \frac{96}{L} \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ d_2 \\ d_1 \end{Bmatrix}$$

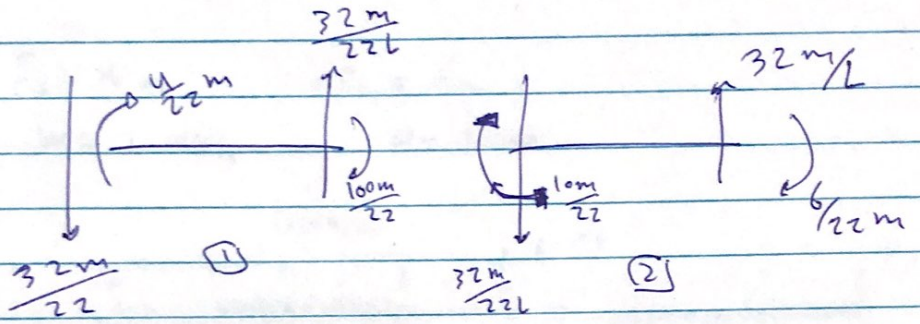
$$q_{t2} = \frac{-m\,16}{L\ (22)} + \frac{m\,48}{L\ (22)} = \frac{32\ m}{(22)L}$$

$$q_{t1} = \frac{-4m}{22} - \frac{m(96)}{22} = \frac{-100\ m}{22}$$

(2)
$$\begin{Bmatrix} q_{t2} \\ q_{t1} \\ q_{t6} \\ q_{t5} \end{Bmatrix} = \begin{bmatrix} \frac{96}{L^3} & \frac{24}{L^2} & & \\ \frac{24}{L^2} & \frac{8}{L} & & \\ & & & \\ & & & \end{bmatrix} \begin{Bmatrix} d_2 \\ d_1 \\ 0 \\ 0 \end{Bmatrix}$$

$$q_{t2} = \frac{-8\ m}{(22)L} - \frac{24m}{22L} = \frac{-32\ m}{(22)L}$$

$$q_{t1} = \frac{-2m}{22} - \frac{8\ m}{22} = \frac{-10\ m}{22}$$


32m/22
4/22m
100m/22
32m/22
1
32m/22
1om/22
32m/L
6/22m
2

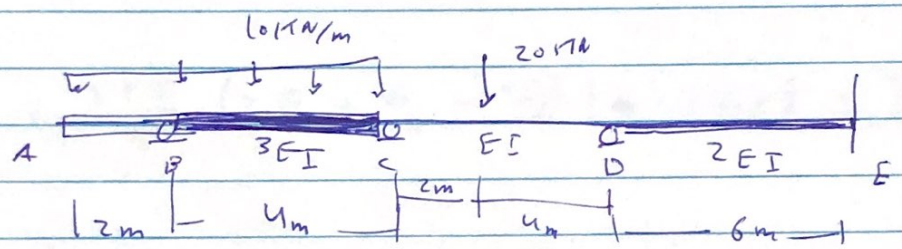
Question 3

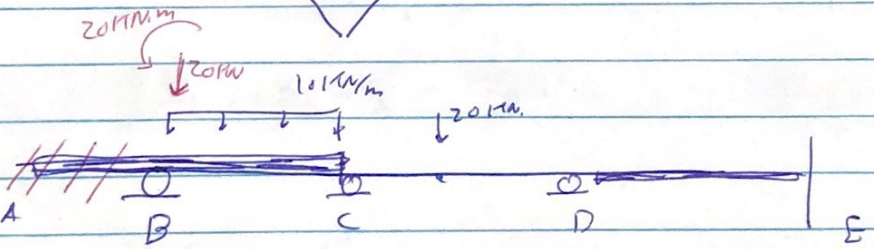
Support C ↓ 6mm $E = 30\ GPa$

" D ↓ 2mm $I = 12\ (10^8)\ mm^4$

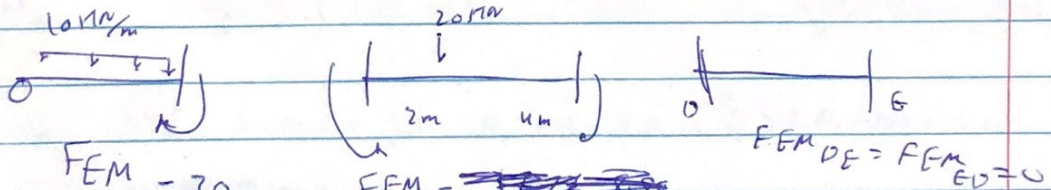
$S_1 = 4\ m$, $S_2 = 6\ m$

$W = 10\ kN/m$, $P = 20\ kN$.





FEM



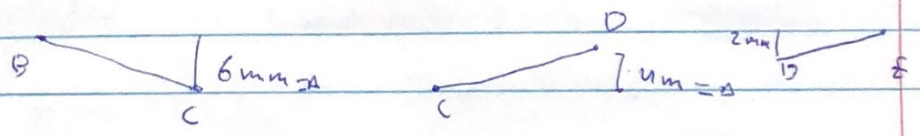
$FEM_{CB} = 20$

$FEM_{CD} = -17.77$

$FEM_{DE} = FEM_{ED} = 0$

$FEM_{DC} = 8.88$

Satellite



$E = 76000$

END Moment equations:

$$\begin{cases} M_{BC} = -20 \\ M_{CB} = \frac{3(3EI)}{4}\left(\theta_C - \frac{0.006}{4}\right) + 20 = \frac{9}{4}EI\,\theta_C - 101.5 \end{cases}$$

$$M_{CD} = \frac{2EI}{6}\left(2\theta_C + \theta_D - \frac{0.012}{6}\right) - 17.77 = \frac{2}{6}EI(2\theta_C + \theta_D) - 4$$

$$M_{DC} = \frac{2EI}{6}\left(2\theta_D + \theta_C - \frac{0.012}{6}\right) + 8.88 = \frac{2}{6}EI(2\theta_D + \theta_C) - 15.12$$

$\theta_E = 0$ $\quad M_{DE} = \frac{2(2EI)}{6}\left(2\theta_D + \theta_E^{\,0} - \frac{0.006}{6}\right) + 0 = \frac{4EI}{6}(2\theta_D) - 24$

$$M_{ED} = \frac{2(2EI)}{6}\left(2\theta_E^{\,0} + \theta_D - \frac{0.006}{6}\right) = \frac{4EI}{6}\theta_D - 24$$

$\Sigma M_C = 0 \Rightarrow \frac{2}{6}EI(2\theta_C) + \frac{2}{6}EI\,\theta_D - 4 - 17.77 + \frac{9}{4}EI\,\theta_C - 101.5 = 0$

$2.9166\,\theta_C\,EI + 0.3\bar{3}\,EI\,\theta_D = 143.3$

$\Sigma M_D = 0 \Rightarrow 39.12 = 2\,EI\,\theta_D + 0.3\bar{3}\,\theta_C\,EI$

$$\begin{Bmatrix} 143.3 \\ 39.12 \end{Bmatrix} = \begin{bmatrix} 2.9166 & 0.3\bar{3} \\ 0.3\bar{3} & 2 \end{bmatrix} \begin{Bmatrix} \theta_C \\ \theta_D \end{Bmatrix} EI$$

$\theta_D = 11.6/EI$

$\theta_C = 47.8/EI$

$M_{BC} = -20$

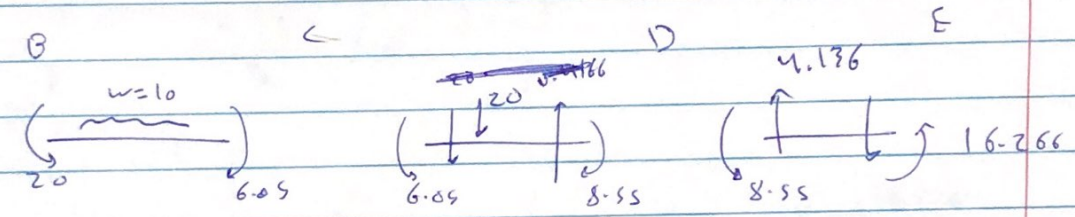
$M_{CD} = 6.05$ kN.m

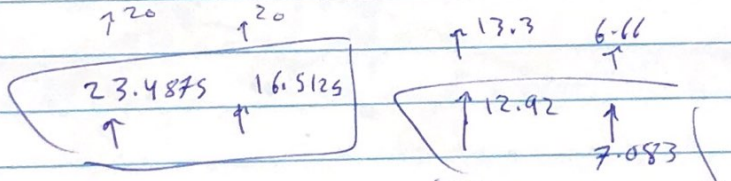
$M_{CD} = 6.05$

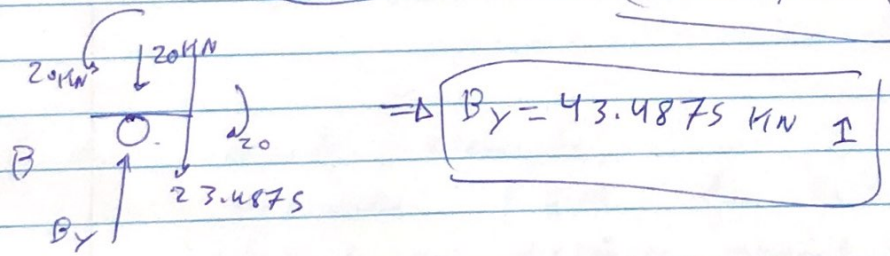
$M_{DC} = 8.55$

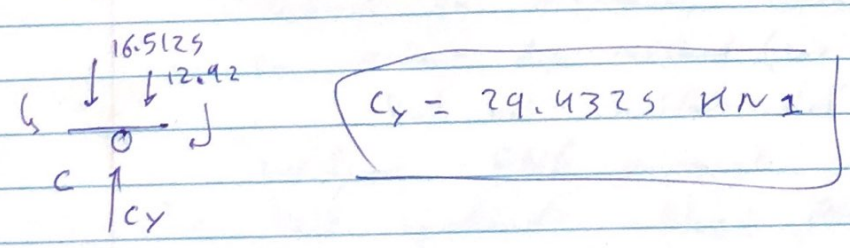
$M_{DE} = -8.55$

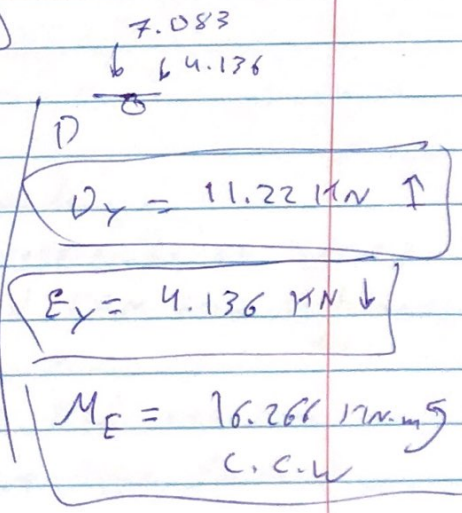
$M_{ED} = -16.266$

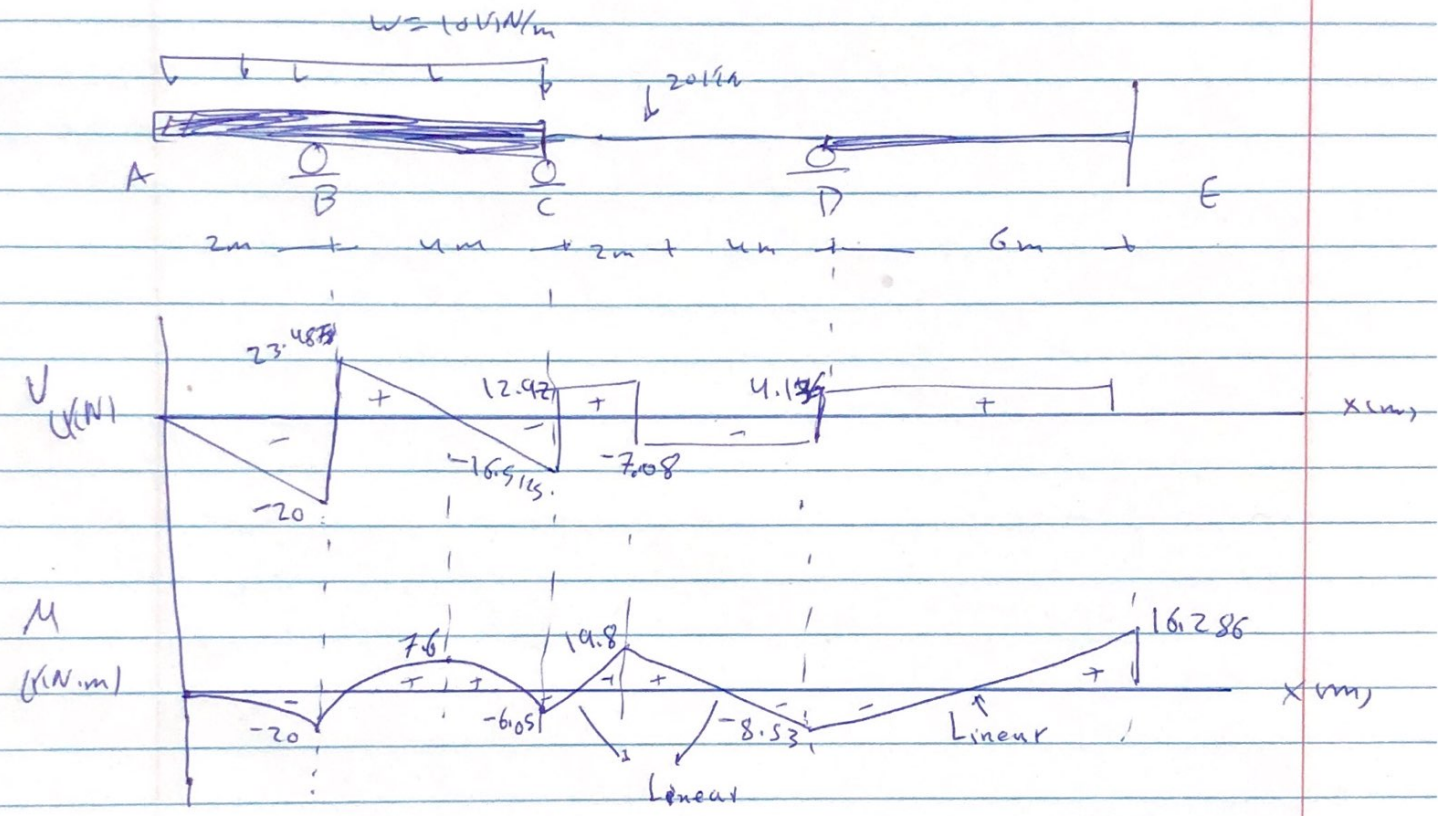












e. divide elements
determine FEM due to loading.
depend on distribute moment resistents at joints
in moment dis. method (we find FEM from settlement)
but not in slope def. equation
we find END moment and find reaction
In both methods the positive sign Convention
is ⊕ for C.w.