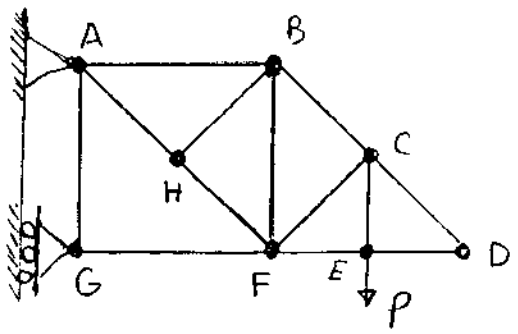
University Of Technology
Building and Construction Eng. Dept.
Final Exam 2012/2013

Subject : Structural Analysis **Class:** Third Class
Branch : Building& construction management **Time :** 3 Hours
Examiner : Dr. Zeyad M. Ali **Date :** 9 / 6 / 2013

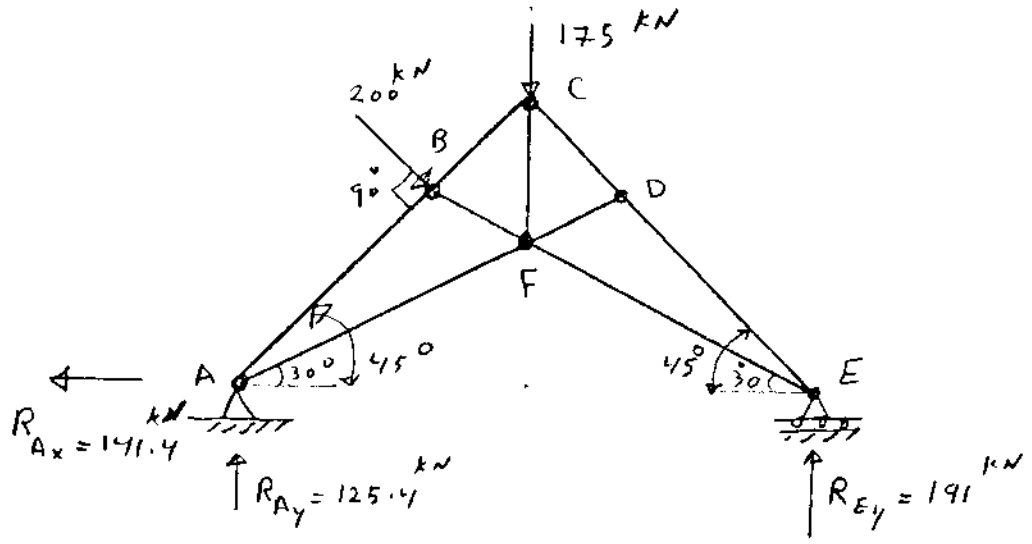
Note : **Answer Four questions only.**

Q1/

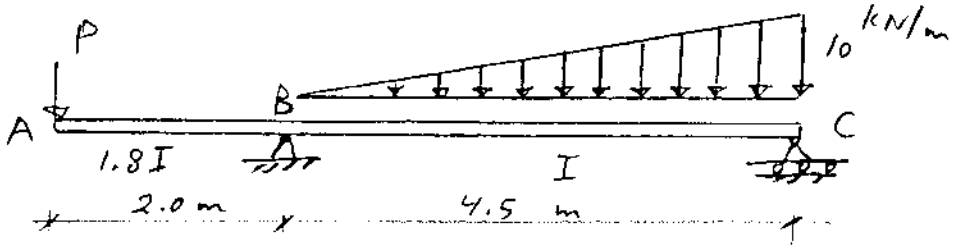
A/Indicate all the members which have zero force for the truss shown in the fig. by the joint method.



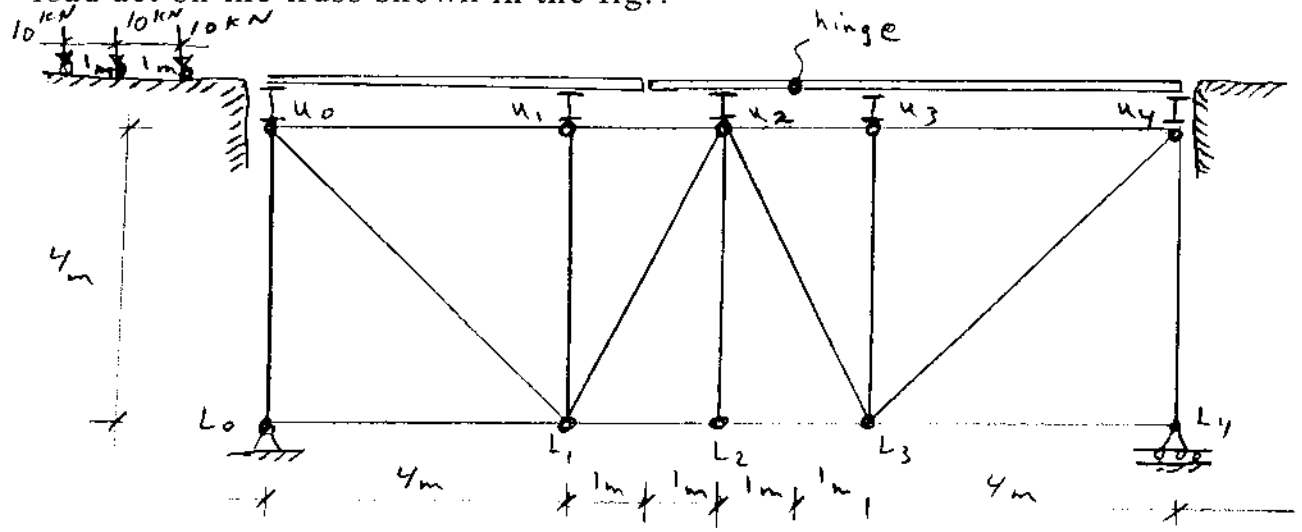
B/Determine the force in member CF of the truss shown in the fig.? The supports reaction are given.



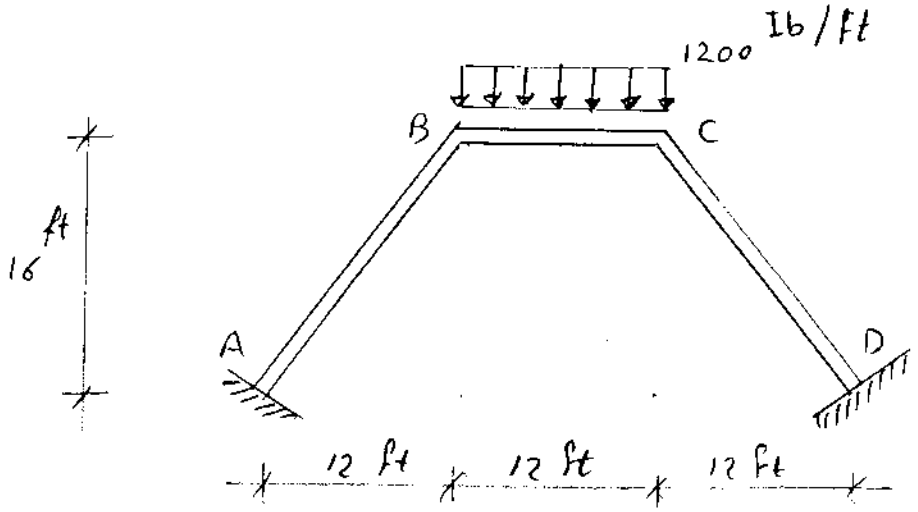
Q2/Determine the value of lood (P) which introduce a vertical deflection at A=3 cm ?
Given EI =10000 kN.m^2 .



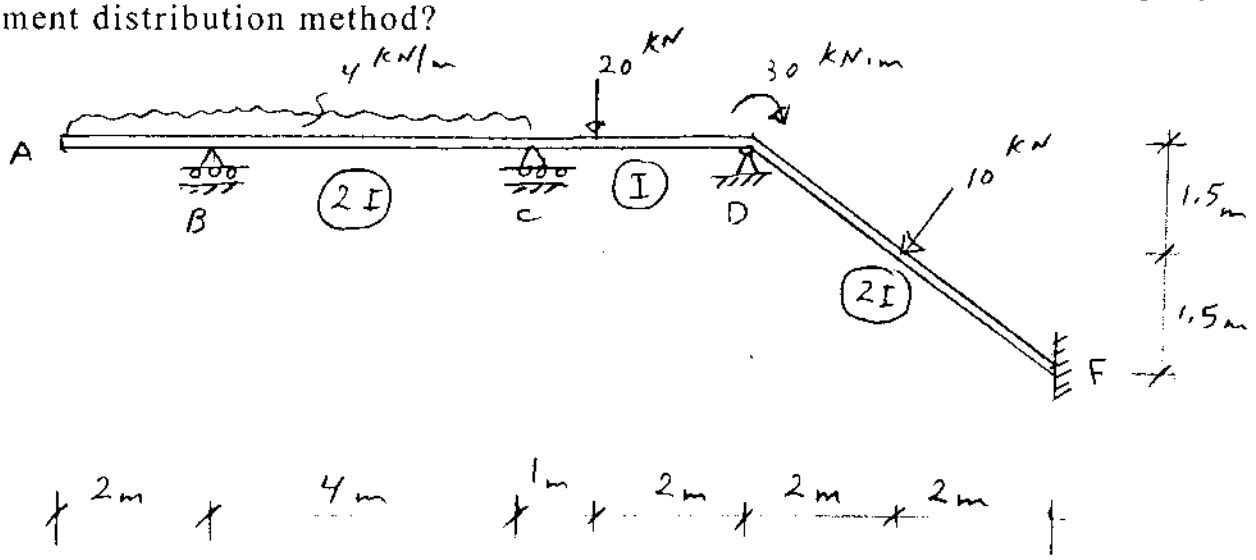
Q3/ Find the max. tension & max. compression force in member L_1U_2 due to moving load act on the truss shown in the fig.?



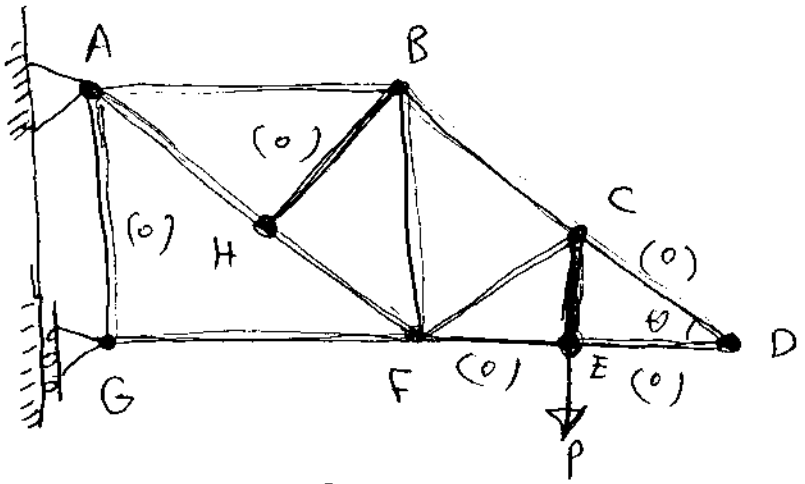
Q4/ Determine the end moments at each joint by the slope-deflection method for the plane frame shown in the fig. ? Given EI is constant .



Q5/Compute the ends moment for the joint of the plane frame shown in the fig. by the moment distribution method?



Q1/@ Indicate all the members which have zero force for the truss shown in the fig, using the method of joints.



Sol.

joint D

$+ve \uparrow \Sigma F_y = 0$ $\quad \therefore F_{DC} \sin\theta = 0 \quad \therefore F_{DC} = 0$

$+ve \rightarrow \Sigma F_x = 0$ $\quad F_{DE} + 0 = 0 \quad F_{DE} = 0$

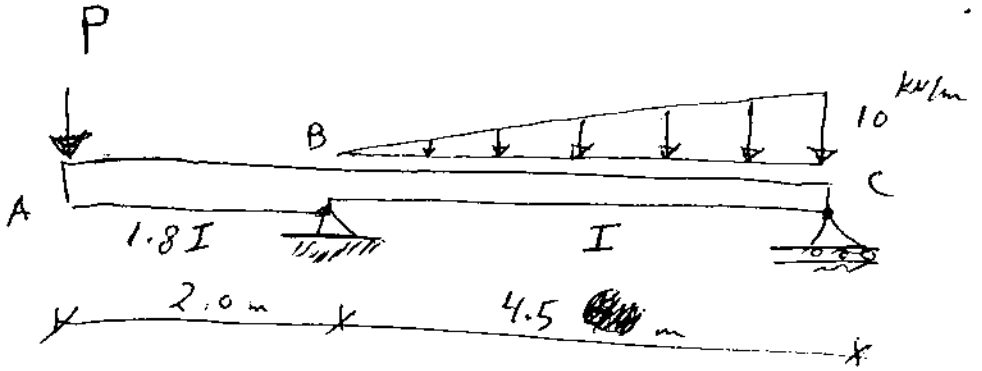
joint E

$+ve \leftarrow \Sigma F_x = 0$ $\quad F_{ED} = F_{EF} = 0$

joint H $\quad F_{HB} = 0$

joint G $\quad F_{GA} = 0$

Q2/



Determine the value of Load (P) which introduce a vertical deflection at A = 3 cm ? Given $EI = 10^4$ kN.m²

+ve

$\sum M_{at\ B} = 0$ ∴

Fig ① $R_{cy}(4.5) = \frac{10 \times 4.5}{2}$ (3)

$R_{cy} = 15$ kN

∴ $R_{By} = 7.5$ kN

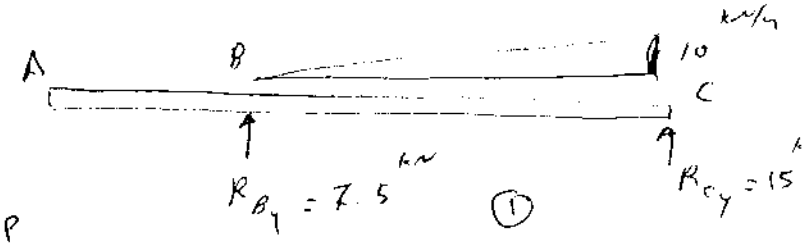
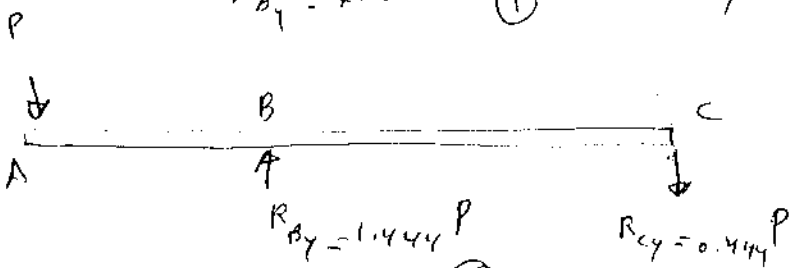


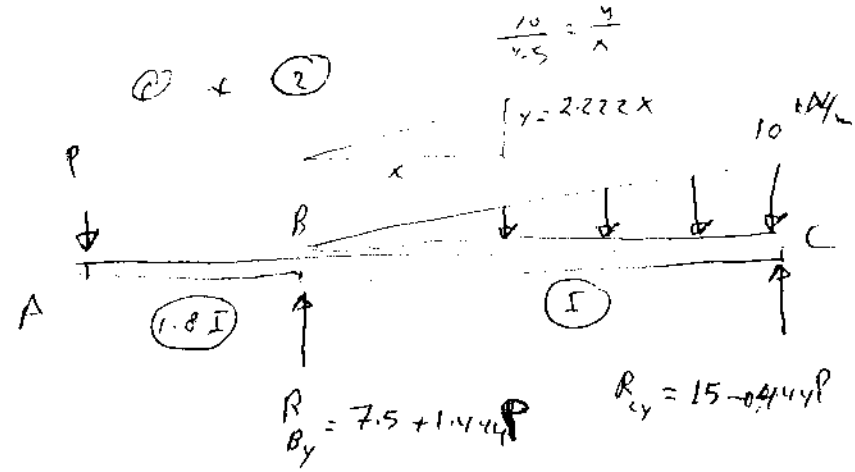
Fig ② $R_{cy}(4.5) = 2P$ kN

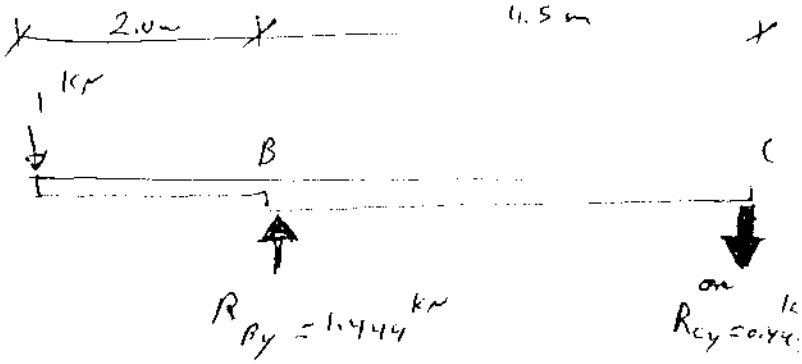
$R_{cy} = 0.444P$ ↓ kN

∴ $R_{By} = 1.444P$ ↑



Ⓜ = ① + ②





Ⓜ

Section	origin	Limit(m)	EI (kN.m²)	M	m
AB	A	0 — 2	1.8×10^4	$-Px$	$-x$
BC	B	0 — 4.5	10^4	$-P(2+x) + (7.5 + 1.444P)x - \left(\frac{1.111}{3}x^3\right)$	$1.444x - (24$

section	$\frac{M\,m}{Px^2}$
AB	
BC	$4P - 1.776xP + 0.197x^2P - 15x + 3.33x^2 + 0.74x^3 - 0.16428$

1. $\Delta_{v.at\ A} = \int_0^L \frac{M.m}{EI}\,dx$

$$1\left(\frac{3}{100}\right) = \int_0^2 \frac{Px^2}{1.8\times10^4}\,dx + \frac{1}{10^4}\left[\int_0^{4.5} 4P.dx - \int_0^{4.5} 1.776Px.dx + \int_0^{4.5} 0.197Px^2.dx - \int_0^{4.5} 15x.dx + \int_0^{4.5} 3.33x^2dx + \int_0^{4.5} 0.74x^3dx - \int_0^{4.5} 0.16428\right.$$

$$(0.03) = \frac{P}{3(1.8\times10^4)}\left(x^3\Big|_0^2\right) + \frac{1}{10^4}\left[4P\left(x\Big|_0^{4.5}\right) - \frac{1.776P}{2}\left(x^2\Big|_0^{4.5}\right) + \frac{0.197P}{3}\left(x^3\Big|_0^{4.5}\right) - 7.5\left(x^2\Big|_0^{4.5}\right) + 1.11\left(x^3\Big|_0^{4.5}\right) + \frac{0.74}{4}\left(x^4\Big|_0^{4.5}\right) - \frac{0.16428}{4}\left(x^5\Big|_0^{4.5}\right)\right]$$

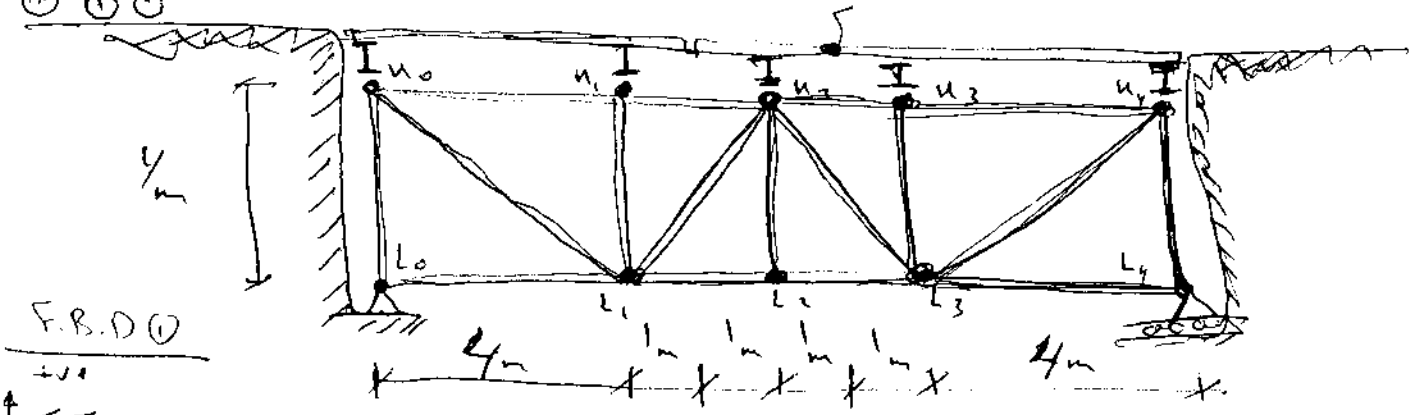
$$= 1.48148\times10^{-4}P + \frac{1}{10^4}\left[18P - 17.9820P + 5.9838P - 151.875 + 101.14875 + 75.8615 - 75.7857\right]$$

$$= 1.48148\times10^{-4}P + \frac{1}{10^4}\left[6.0018P - 50.65045\right]$$

$$0.03 = 7.48328\times10^{-4}P - 5.065\times10^{-3}$$ kN

$$\therefore P = \frac{0.024935}{7.48328\times10^{-4}} = 33.321$$

Q/3 Determine the max. Tension & Compression force in member U_2L_1 due to moving Load act on the truss shown in the fig. ?

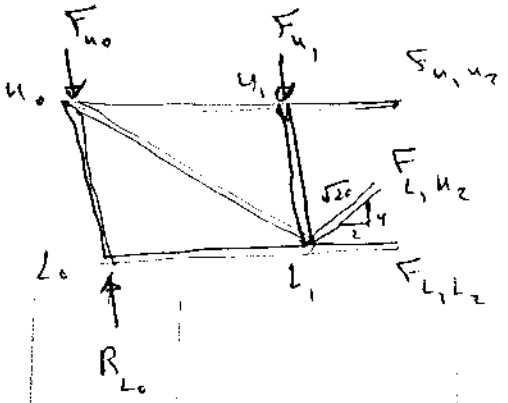


F.B.D ①

$+\circlearrowleft \sum F_{/1} = 0$

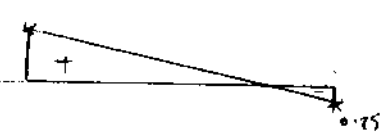
$R_{L_0} - F_{U_0} - F_{U_1} + \frac{4}{\sqrt{20}} F_{L_1U_2} = 0$

$\therefore \boxed{F_{L_1U_2} = \left(F_{U_1} + F_{U_0} - R_{L_0}\right)\frac{\sqrt{20}}{4}}$

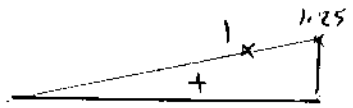


F.B.D ①

I.L for F_{U_0}

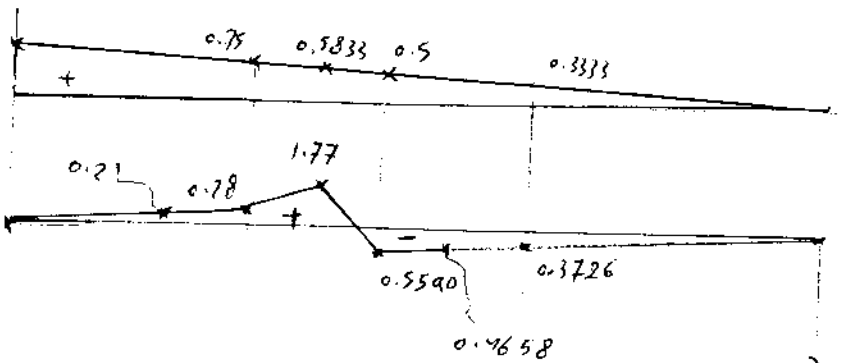


I.L for F_{U_1}



I.L for R

I.L for L_1U_2



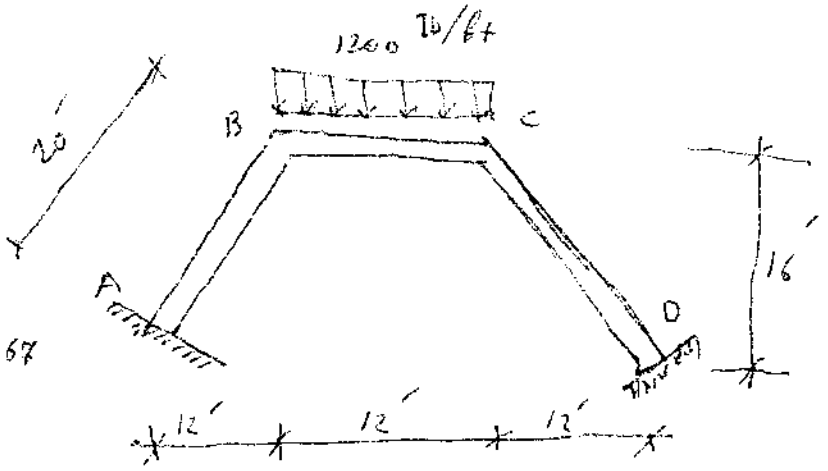
$\therefore$ max. +ve force (Tension) $= 10(0.21 + 0.28 + 1.77) = 22.6$ kN Tens.

max −ve force (Compression) $= 10(-0.559 - 0.4658 - 0.3726) = 13.974$ kN Comp.

14|

Determine the moments at each joint and support of the frame shown in the fig. by the slope-deflection method.

Given EI is Constant.



assume $EI = 1$

$\frac{2EI}{L}$ value

Span AB & Span CD $= 0.1$ (Span BC $= 0.167$

F.E.M

$M_{FAB} = M_{FBA} = M_{FCD} = M_{FDC} = 0$

$M_{FBC} = -\frac{WL^2}{12} = -\frac{14400 \text{ lb.ft}}{12} = -14.4$ k.ft

$M_{FCB} = \frac{WL^2}{12} = \frac{14400 \text{ lb.ft}}{12} = 14.4$ k.ft

slope def. eq's

$M_{AB} = 0.1(\theta_B)$

$M_{BA} = 0.2\theta_B$

$M_{BC} = -14.4 + 0.167(2\theta_B + \theta_C)$

$M_{CB} = 14.4 + 0.167(2\theta_C + \theta_B)$

$M_{CB} = 0.2\theta_C$

$M_{DC} = 0.1\theta_C$

k.ft

——— $3.922 = M_{AB}$

——— $7.844 = M_{BA}$

——— $-7.85 = M_{BC}$

——— $7.846 = M_{CB}$

——— $-7.846 = M_{CD}$

——— $-3.923 = M_{DC}$

eq.'s / Conditions

$M_{BA} + M_{BC} = 0$ — (a) $0.2\theta_B - 14.4 + 0.334\theta_B + 0.167\theta_C = 0$

$M_{CB} + M_{CD} = 0$ — (b) $14.4 + 0.534\theta_C + 0.167\theta_B = 0$

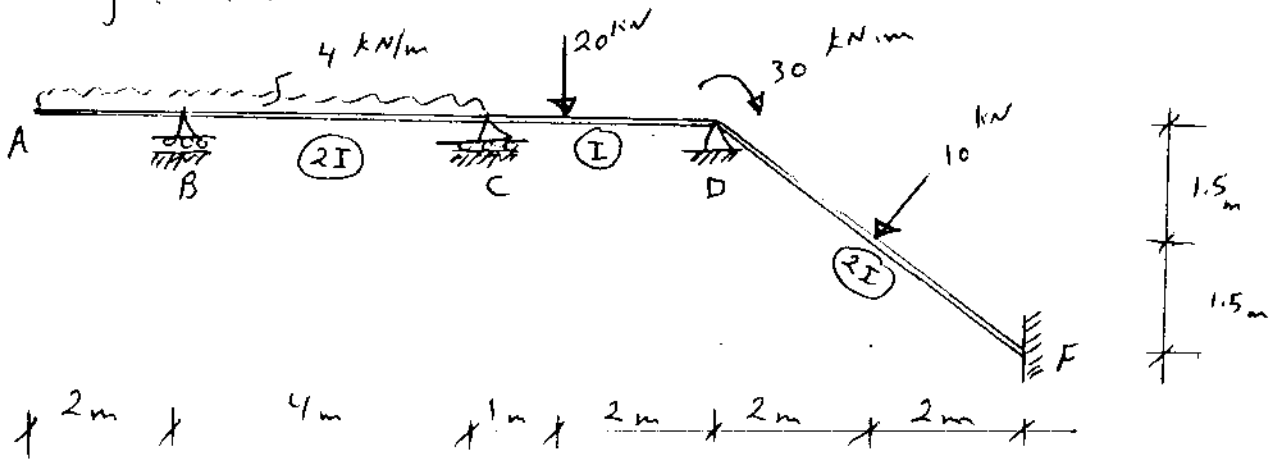
$-14.4 + 0.167\theta_C + 0.534\theta_B = 0$ — (a) * 3.2 add.

$60.48 - 1.5418\theta_B = 0$

$\therefore \theta_B = 39.2268$

$\theta_C = -39.234$

5/ Determine the internal end moments by the moment distribution method of the beam shown in the fig?



Sol.

① k value

Span BC $k = \frac{3EI}{L} = \frac{3\times 2}{4} EI = 1.5\ EI$

Span CD $k = \frac{4EI}{L} = \frac{4}{3} EI = 1.33\ EI$

Span DF $k = \frac{4EI}{L} = \frac{4\times 2}{5} EI = 1.6\ EI$

② Fixed end moment

			kN.m
Span BC	$(F.E.M)_{BC} = \frac{-wL^2}{12} = \frac{-4(4^2)}{12}$	=	-5.333
	$(F.E.M)_{CB} = \frac{wL^2}{12}$	=	5.333
Span CD	$(F.E.M)_{CD} = -\frac{20\times 1\times(2)^2}{(3)^2}$	=	-8.88
	$(F.E.M)_{DC} = \frac{20\times\frac{(3)^2}{2}\times(1)^2}{(3)^2}$	=	4.444
Span DF	$(F.E.M)_{DF} = -\frac{PL}{8} = -\frac{10(5)}{8}$	=	-6.25
	$(F.E.M)_{FD} = \frac{PL}{8}$	=	6.25

kN.m

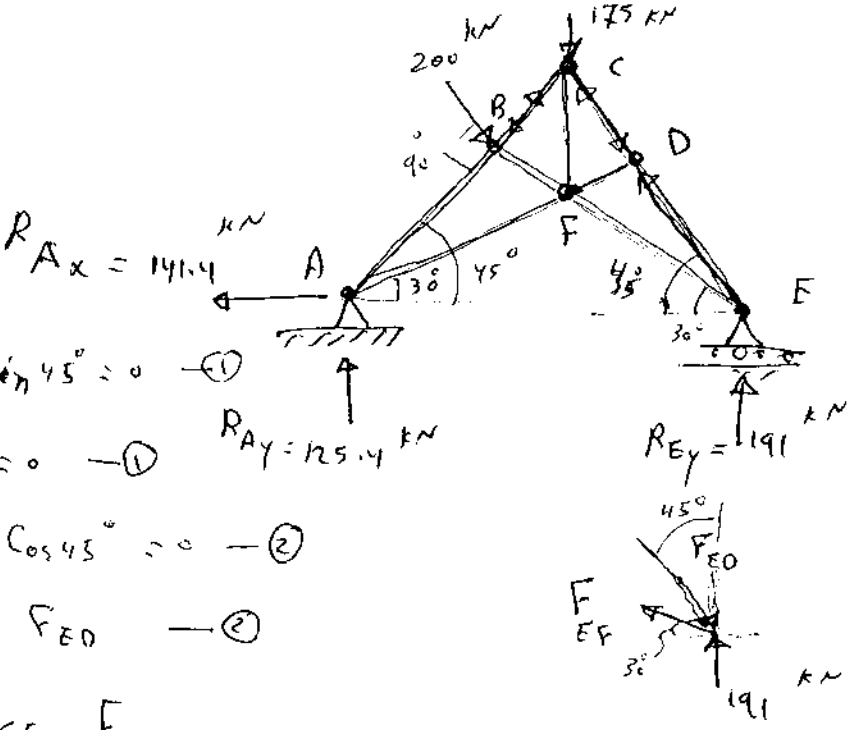
8

kN.m

30

joint	B	C		D	
member	BC	CB	CD	DC	DF
K	1.5	1.5	1.33	1.33	1.6
D.F = $K/\Sigma K$	1	0.53	0.47	0.444	0.556
① F.E.M	-5.333	5.333	-8.88	4.444	-6.25
① Bal.	-2.667	1.88	1.667	-12.52	-15.674
② F.E.M	0.94	-1.3335	-6.26	0.8335	—
② Bal.	-0.94	4.0245	3.569	-0.37	-0.4625
③ F.E.M	2.01225	-0.47	-0.185	1.7845	—
③ Bal.	-2.01225	0.34715	0.30785	-0.79	-0.9945
ΣM	-8	9.781	-9.781	-6.618	-23.382

Q/(6) Determine the force in member CF of the truss shown in the fig. The reaction at the supports are given.



Sol.

joint E

+ve
$\uparrow \Sigma F_y = 0$ $\quad 191 + F_{EF} \sin 30^\circ - F_{ED} \sin 45^\circ = 0$ —①

$\therefore 191 + \frac{1}{2} F_{EF} - \frac{1}{\sqrt{2}} F_{ED} = 0$ —①

+ve
$\rightarrow \Sigma F_x = 0$ $\quad F_{EF} \cos 30 - F_{ED} \cos 45^\circ = 0$ —②

$0.866\, F_{EF} = \frac{1}{\sqrt{2}} F_{ED}$ —②

$\therefore F_{EF} = 0.8165\, F_{ED}$

$\therefore 191 + 0.40825\, F_{ED} - 0.7071\, F_{ED} = 0$

$F_{ED} = 639.1$ kN Comp.

joint D $\quad F_{DF} = 0 \quad \therefore F_{CD} = 639.1$ kN (Comp.)

joint C

+ve
$\rightarrow \Sigma F_x = 0$ $\quad F_{CB} \cos 45^\circ = F_{CD} \cos 45^\circ$

$F_{CD} = F_{CD} = 639.1$ kN Com.

+ve
$\uparrow \Sigma F_y = 0$ $\quad -175 - F_{CF} + 2(639.1 \cos 45^\circ) = 0$

$\therefore F_{CF} = 728.82$ kN (Ten.)