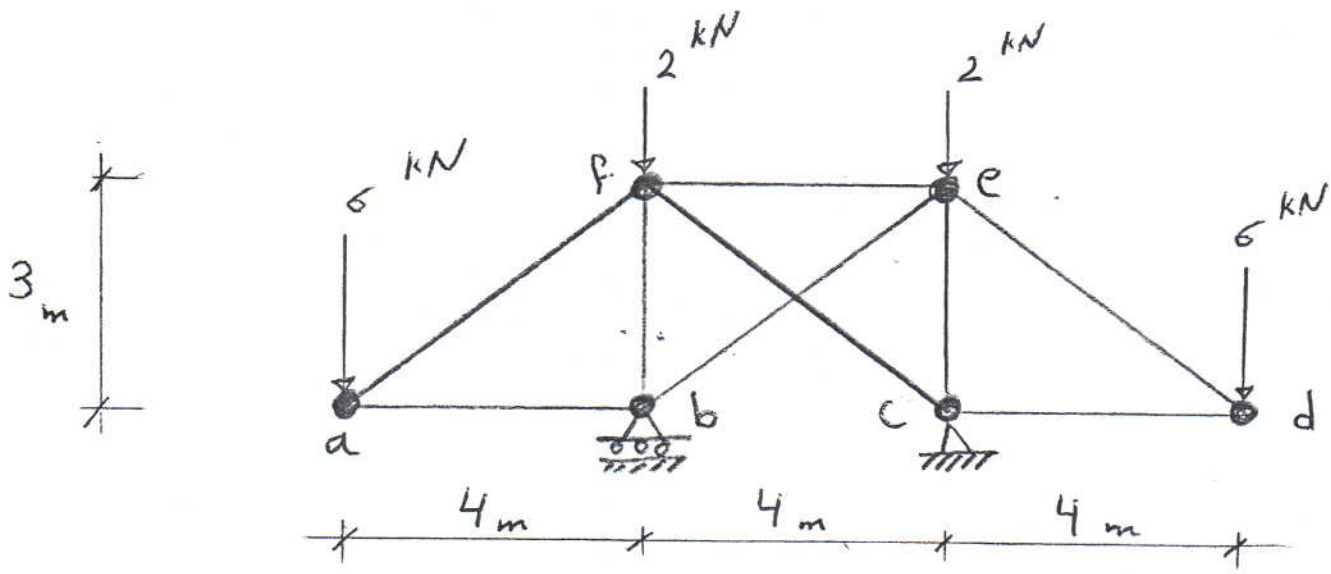
University Of Technology
Building and Construction Eng. Dept.
Final Exam 2014-2015

Subject : Structural Analysis **Class:** Third Class
Branch : Building& construction management **Time :** 3 Hours
Examiner : Dr. Zeyad M. Ali **Date :** 13 / 6 / 2015

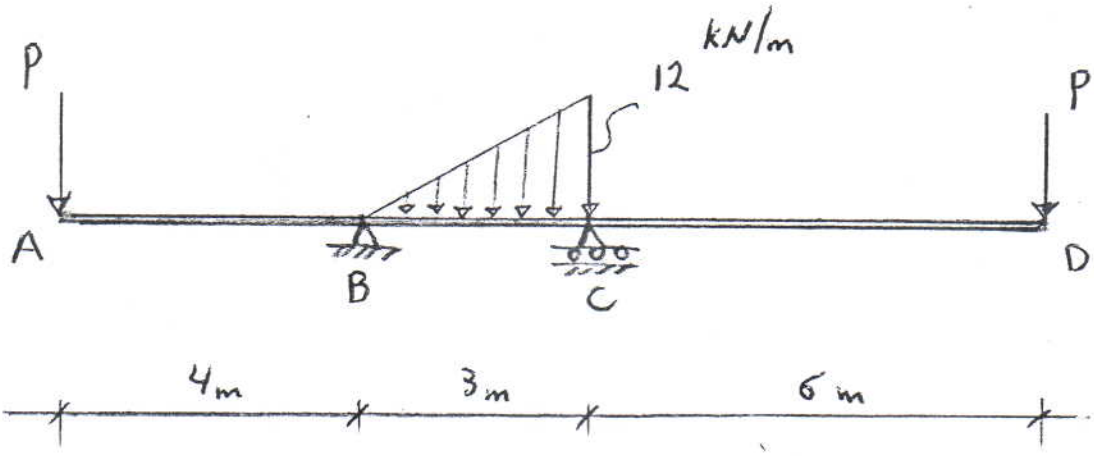
Note : **Answer Four questions only.**

Q1/For the plan loaded truss shown in the fig. , Determine the rotation of member (af) by the virtual work method ? Assume EA = 1000 kN where :-

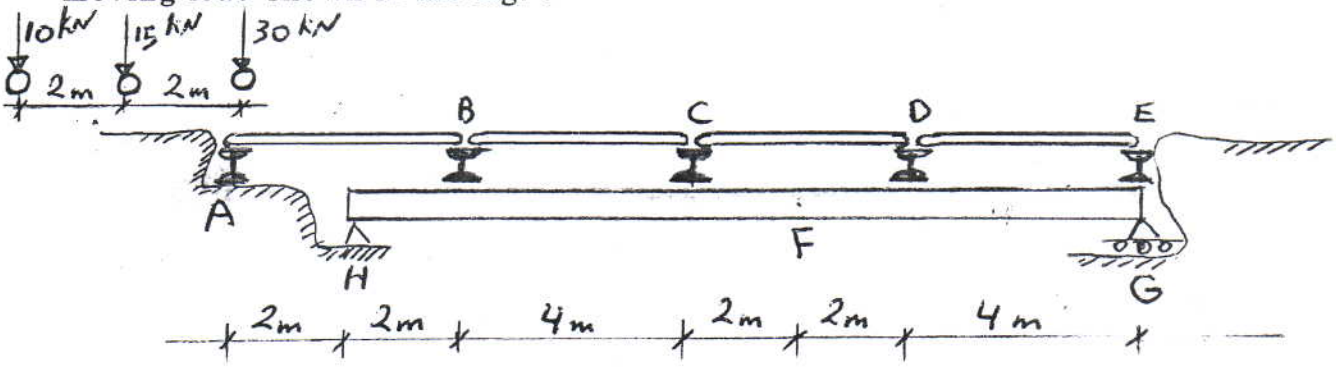
A = the gross section area of member (m^2) (constant)
E = modulus of elasticity of member (kN/m^2) (constant)



Q2/ Determine the value of load (P) which introduce a vertical deflection at (A & D) equal to (2.25 mm)? Given EI =1000 $kN.m^2$ (constant) .

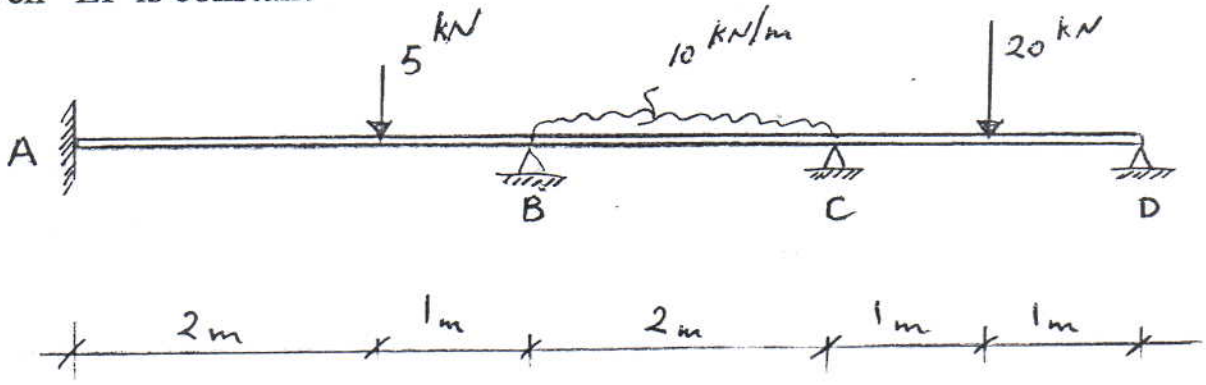


Q3/Determine the max.-moment at section (F) for the plan beam girder due the **moving load** shown in the fig. ?

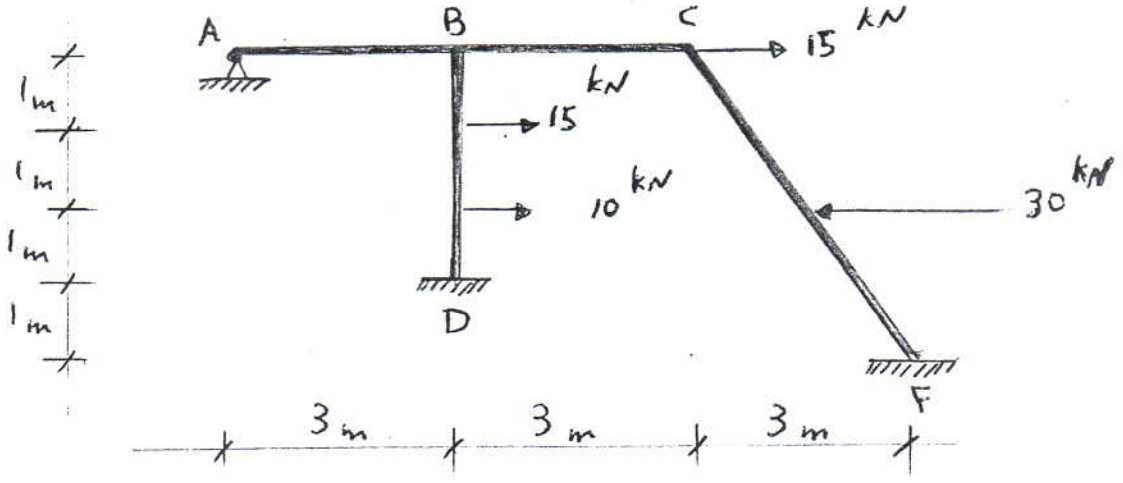


Q4/ Determine the ends moment for the plane continues beam shown in the fig. due to the yielding of support (A) = 0.02 rad. Ante clockwise & vertical settlement of (3 cm) at support (C) in addition to the load acting by the moment distribution method?

Given EI is constant

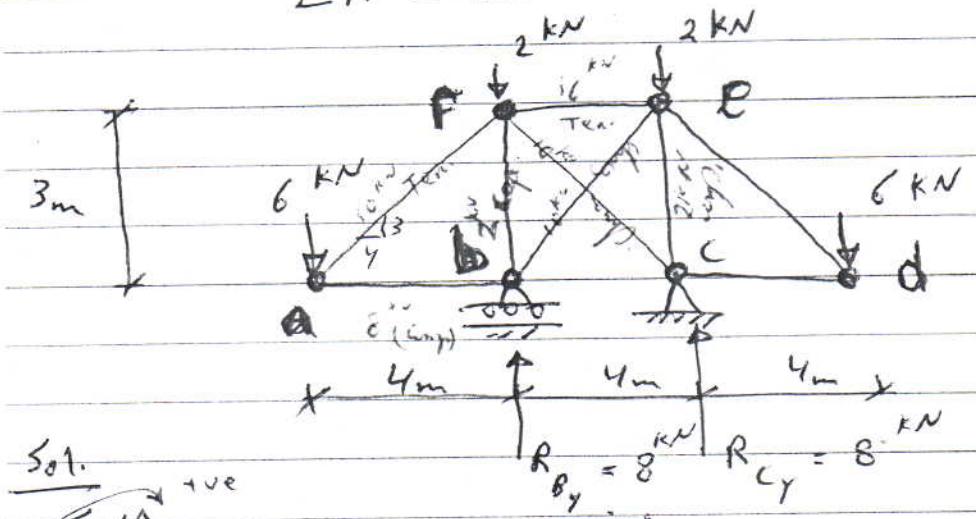


Q5/Determine the end moments by the slope-deflection method for the plane frame shown in the fig. ? Given EI = 300 kN.m^2 (constant) .



Q#/ For the plane loaded truss shown in the fig, find the rotation of member aF? Assume the gross section area of member (m^2) = A (Constant) & Modulus of elasticity of member (kN/m^2) = E (Constant)

$EA = 1000\ kN$



Sol.

$\sum M_b = 0$ (+ve)

$2 \times 4 + 6 \times 8 - R_C \times 4 - 6 \times 4 = 0$

$\therefore R_{C_y} = \frac{8 + 24}{4} = 8\ kN$

$\uparrow +ve \quad \sum F_y = 0 \qquad R_{C_y} + R_{B_y} = 16\ kN$

$\therefore R_{B_y} = 8\ kN$

joint A

$\sum F_y = 0 \qquad 0.6\, F_{af} = 6 \qquad \therefore F_{af} = 10\ kN$ (Ten.)

$\sum F_x = 0 \qquad 0.8\, F_{af} = 8 \qquad \therefore F_{ab} = 8\ kN$ (Comp.)

joint b

$\sum F_x = 0 \qquad \therefore 0.8\, F_{be} = 8\ kN \qquad F_{be} = 10\ kN$ (Comp.)

$\sum F_y = 0 \qquad F_{bf} = 2\ kN$ (Comp.)

joint f

$\sum F_y = 0 \qquad \therefore F_{fc} = 10\ kN$ (Comp.)

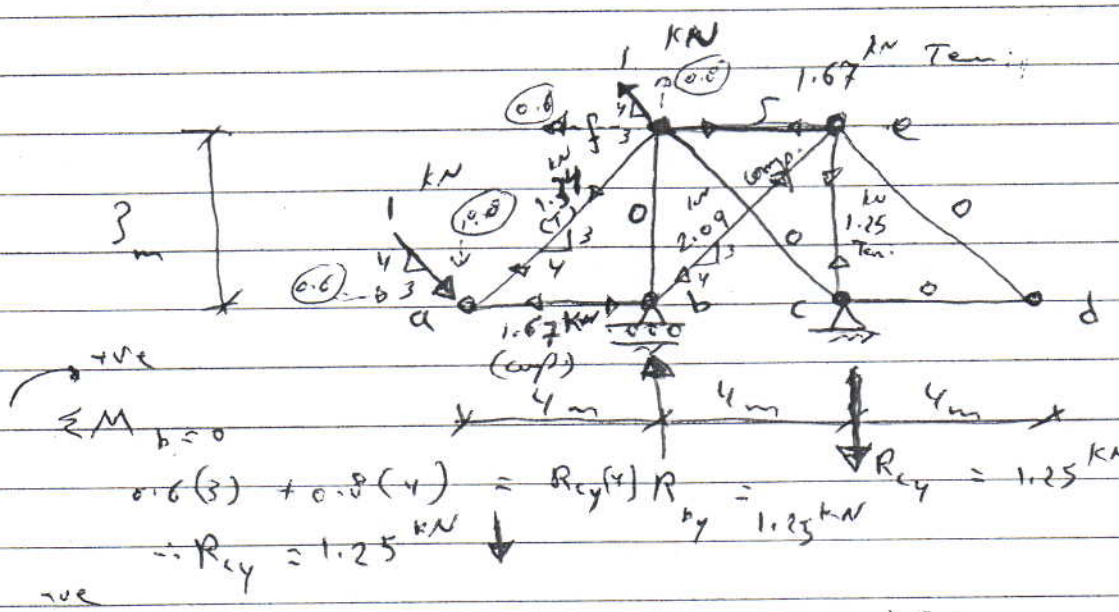
$\sum F_x = 0 \qquad F_{fE} = 16\ kN$ (Ten.)

$\theta_{af} = ?$ $\quad AE = 1000\ kN$

$\therefore \quad 1.\ \theta_{af} = \sum \frac{S.u.L}{AE}$

joint e

$\sum F_y = 0 \quad \therefore F_{ce} = 2^{kN}$ comp.



$\sum M_b = 0$

$0.6(3) + 0.8(4) = R_{cy}(4) \quad R_{by} = 1.25^{kN}$

$\therefore R_{cy} = 1.25^{kN}$

-ve

$\uparrow \sum F_y = 0 \quad \therefore R_{cy} = -R_{by} = 1.25^{kN} \uparrow$

joint a

$\sum F_y = 0 \quad 0.6\, F_{af} = 0.8 \quad \therefore F_{af} = 1.34^{kN}$ Ten.

$\sum F_x = 0 \quad 0.6 + 0.8(1.34) = F_{ab} = 1.67^{kN}$ Comp.

joint b

$\sum F_x = 0 \quad 1.67^{kN} = 0.8\, F_{be} \quad \therefore F_{be} = 2.09^{kN}$ Comp.

$\sum F_y = 0 \quad 1.25 - 0.6\, F_{be} = F_{bf} = 0$

joint c $\quad \sum F_y = 0 \quad \therefore F_{cb} = 1.25^{kN}$ Ten.

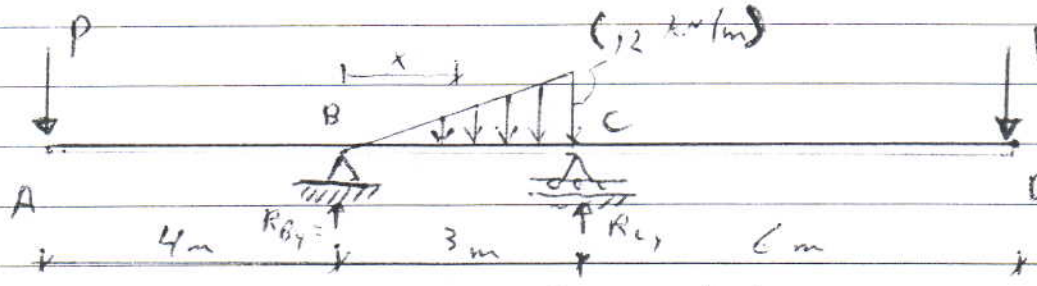
joint f $\quad \sum F_x = 0 \quad 0.6 + 0.8(1.34) = F_{fe} = 1.67^{kN}$

members	Length (m)	S (kN)	u (kN)	S.u.L
ab	4	-8	-1.67	53.44
af	5	10	1.34	67.0
fe	4	16	1.67	106.88
be	5	-10	-2.09	104.5
ce	4	-2	1.25	-10

$\sum S.u.L = 321.82 / EA = 0.3218$ rad.

Q_2 /

Find the value of Load (P) as shown in the fig which cause a vertical deflection at (A) & (D) equal to (2.25 mm) ? Given $EI = 1 \times 10^3$ kN.m² (constant)



$\sum M_C = 0 \quad P(6) + R_{B_y}(3) - P(7) - \frac{12 \times 3}{2}(1) = 0$

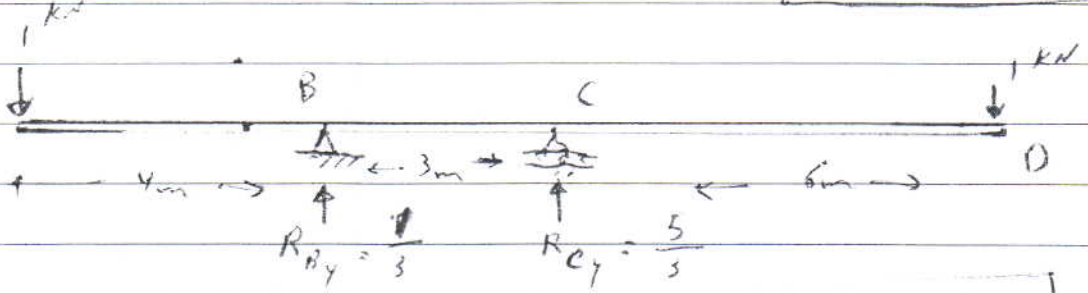
$\therefore \boxed{R_{B_y} = \frac{P + 18}{3}}$

$\frac{y}{x} = \frac{12}{3}$

$\boxed{y = 4x}$

$+\uparrow \sum F_y = 0 \quad R_{B_y} + R_{C_y} = 2P + 18$

$\therefore R_{C_y} = \frac{2P + 18}{1} - \frac{P + 18}{3} = \frac{6P + 54 - P - 18}{3} = \boxed{\frac{5P + 36}{3} = R_{C_y}}$



$\sum M_C = 0 \quad 1(6) + R_{B_y}(3) - 1(7) = 0 \quad \therefore \boxed{R_{B_y} = \frac{1}{3} \text{ kN}}$

$\sum F_y = 0 \quad R_{B_y} + R_{C_y} = 2 \quad \therefore \boxed{R_{C_y} = \frac{5}{3} \text{ kN}}$

Sec.	origin	Limit	EI	M	m
AB	A	0 – 4	Const.	$-Px$	$-x$
BC	B	0 – 3	"	$-P(4+x) + \left(\frac{P+18}{3}\right)x - \boxed{\left(\frac{xy}{2}\right)\frac{x}{3}}$	$-1(4+x) + \frac{x}{3}$
CD	D	0 – 6	"	$-Px$	$-x$

M

$-4P - xP + \frac{xP}{3} + 6x - \frac{2}{3}x^3$

$\left(-4P - \frac{2}{3}xP + 6x - \frac{2}{3}x^3\right)$

m

$-4 - x + \frac{x}{3}$

$\left(-4 - \frac{2}{3}x\right)$

$M_m = +16P + \frac{8}{3}xP - 24x + \frac{8}{3}x^3 + \frac{8}{3}xP + \frac{4}{9}x^2P - 4x^2 + \frac{4}{9}x^4$

$\therefore \quad 1.\Delta = \int_0^L \frac{M \cdot m}{EI}\, dx$

$(1.\Delta)EI = \int_0^L M.m\, dx$

$\left(\frac{2.25}{1000}\right)\times 10^3 = \int_0^4 P_x^2\, dx + \int_0^3 16P\, dx + \int_0^3 \frac{8}{3}xP\, dx - \int_0^3 24x\, dx + \int_0^3 \frac{8}{3}x^3\, dx + \int_0^3 \frac{8}{3}xP\, dx + \int_0^3 \frac{4}{9}Px^2\, dx - \int_0^3 4x^2\, dx + \int_0^3 \frac{4}{9}x^4\, dx + \int_0^6 P_x^2\, dx$

$22.5 = \frac{Px^3}{3}\Big|_0^4 + 16Px\Big|_0^3 + \frac{8}{6}Px^2\Big|_0^3 - 12x^2\Big|_0^3 + \frac{2}{3}x^4\Big|_0^3 + \frac{8P}{6}x^2\Big|_0^3 + \frac{4}{27}Px^3\Big|_0^6 - \frac{4}{3}x^3\Big|_0^3 + \frac{4x^5}{45}\Big|_0^6 + \frac{P}{3}x^3\Big|_0^6$

$= 21.333P + 48P + 12P - 108 + 54 + 12P + 4P - 36 + 21.6 + 72P$

$= 169.333P - 68.4$

$90.9 = 169.333P$

$\therefore \quad P = 0.5368\ kN$