



University Of Technology
Building and Construction Eng. Dept.
Final Exam/1st Attempt -2014/2015
Subject : Theory of Structures



Class: third
Division: Sanitary & Env. Eng.

Time : 180 Mints*
Date :28/ 5/ 2015

Answer Four Questions Only

Q1) For the loaded frame shown in fig.(1):

- A- Check determinacy and stability.
B- Draw shear force and bending moment diagrams. (25 Marks)

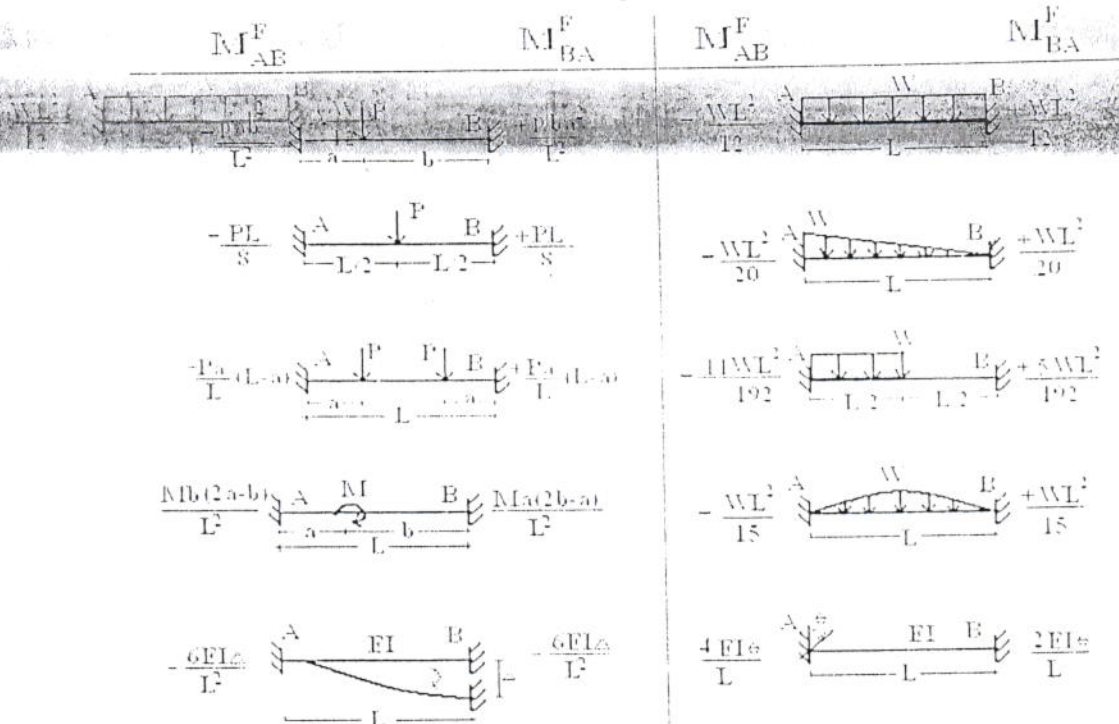
Q2) For the truss shown in fig.(2):

- A- Check determinacy and stability.
B- Determine the supports reactions and forces in all members, using the joint method (25 Marks)

Q3) For the beam shown in fig.(3) plot influence lines for R_A , R_B , R_C , V_D and $V_{B(Left)}$. (25 Marks)

Q4) Determine the end moments in the members of the portal frame shown in fig.(4) by the slope deflection method. (25 marks)

Q5) Analyze the beam shown in fig.(5).by using the moment distribution method, also draw the shear force and bending moment diagrams. (25 marks)



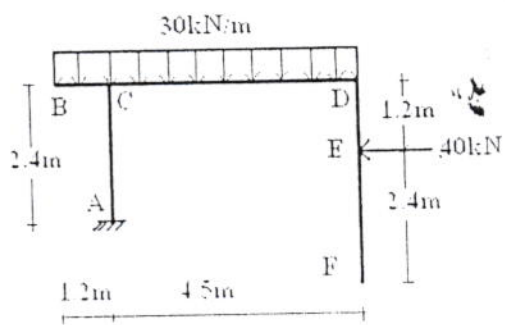


Fig.(1)

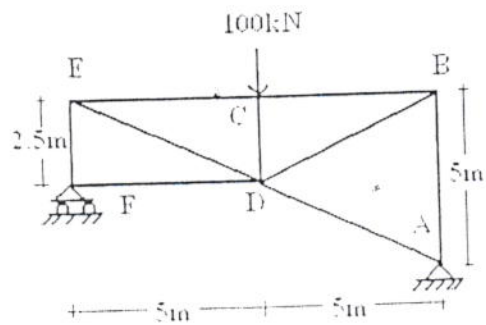


Fig.(2)

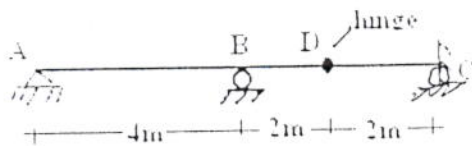


Fig.(3)

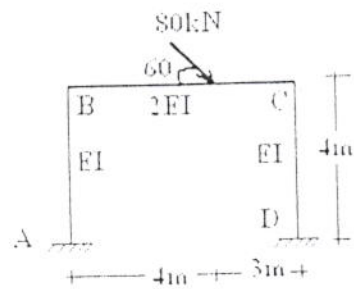


Fig.(4)

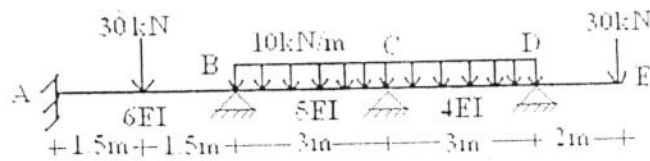


Fig.(5)

Q.11
 Determine if stable
 $3m + r = 3j + c$

$$m = 4$$

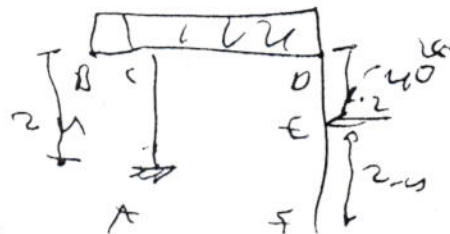
$$r = 3$$

$$j = 5$$

$$c = 0$$

$$3(4) + 3 = 3(5) + 0$$

$15 = 15$ Determinate
 & stable



b. Reactions

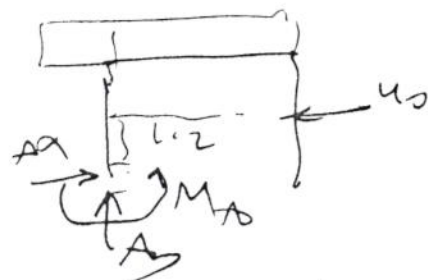
$$\sum F_x = 0 \Rightarrow A_x = 40 \text{ kN} \rightarrow$$

$$\sum F_y = 0 \Rightarrow A_y = 171 \text{ kN} \uparrow$$

$$\sum M_A = 0$$

$$-M_A + 30(4.5)(2.25) - 30(1.2)(0.6) - 40(0.6) = 0$$

$$M_A = 234.15 \text{ kNm} \uparrow$$

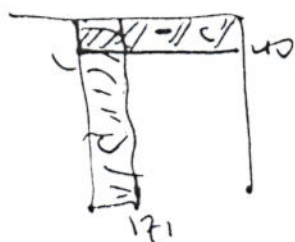


c. Draw

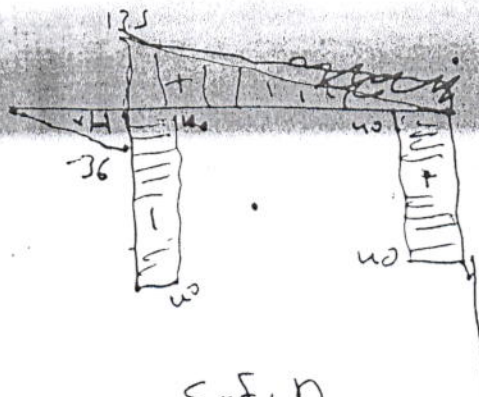
(a) (b) \uparrow

$\begin{array}{c|c} + & + \\ \hline - & - \end{array}$

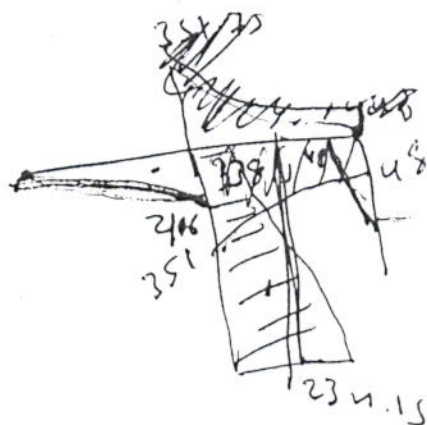
c. \rightarrow



A-F.P



S.F.D



Determinacy stops 2nd
life

$$m = 9$$

$J = 6$

$$m + r = \cancel{2J} \quad 2J$$

$$9 + 3 = 2(6) = 12 \quad \text{Determinate \& Stable}$$

② reactions

$$\sum F_x = 0 \Rightarrow \boxed{A_x = 0}$$

$$\sum M_F = 0 \Rightarrow (100 \text{ kN}) + A_3(10) = 0 \Rightarrow A_3 = -10 \text{ kN} \uparrow$$

$$4 \text{ C F}_3 < 0 \Rightarrow 50 - 100 + F_3 = 0 \Rightarrow \boxed{F_3 = 50 \text{ kN } \uparrow}$$

② $\sin \theta \in (0, \frac{1}{2}]$

55 Joint (f)

$$\{f_y = 0 \Rightarrow \text{Bf.}$$

$$\{f_A \neq 0$$

Join the

Join t_E so $\uparrow E$

$\rightarrow \Sigma F_y = 0 \Rightarrow EF - ED \left(\frac{4}{\sqrt{5}} \right) = 0$

(11.8)

$$4 \rightarrow \sum f_x = 0 \Rightarrow E_D \left(\frac{2}{J_S} \right) - E_C = 0$$

Joint c

$C_F = 0 \Rightarrow$

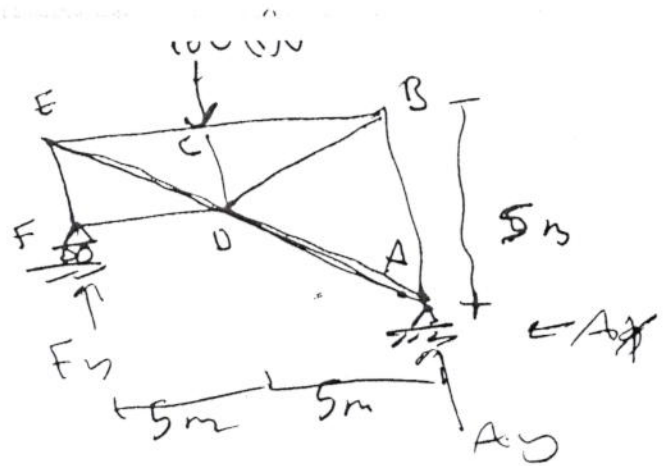
$$\{f_k = 0$$

Joint B

$$\rightarrow \sum f_x = 0$$

$$100 - 180 \frac{2}{51} = 0$$

$$1 E f_y = 0 \Rightarrow A D - B D \frac{1}{\sqrt{3}} = 0$$



~~Q = 100 kW~~

$$\Sigma f = 50 \text{ kN}$$

$$E_D = 0$$

$$E_D = 11.8 \text{ eV}$$

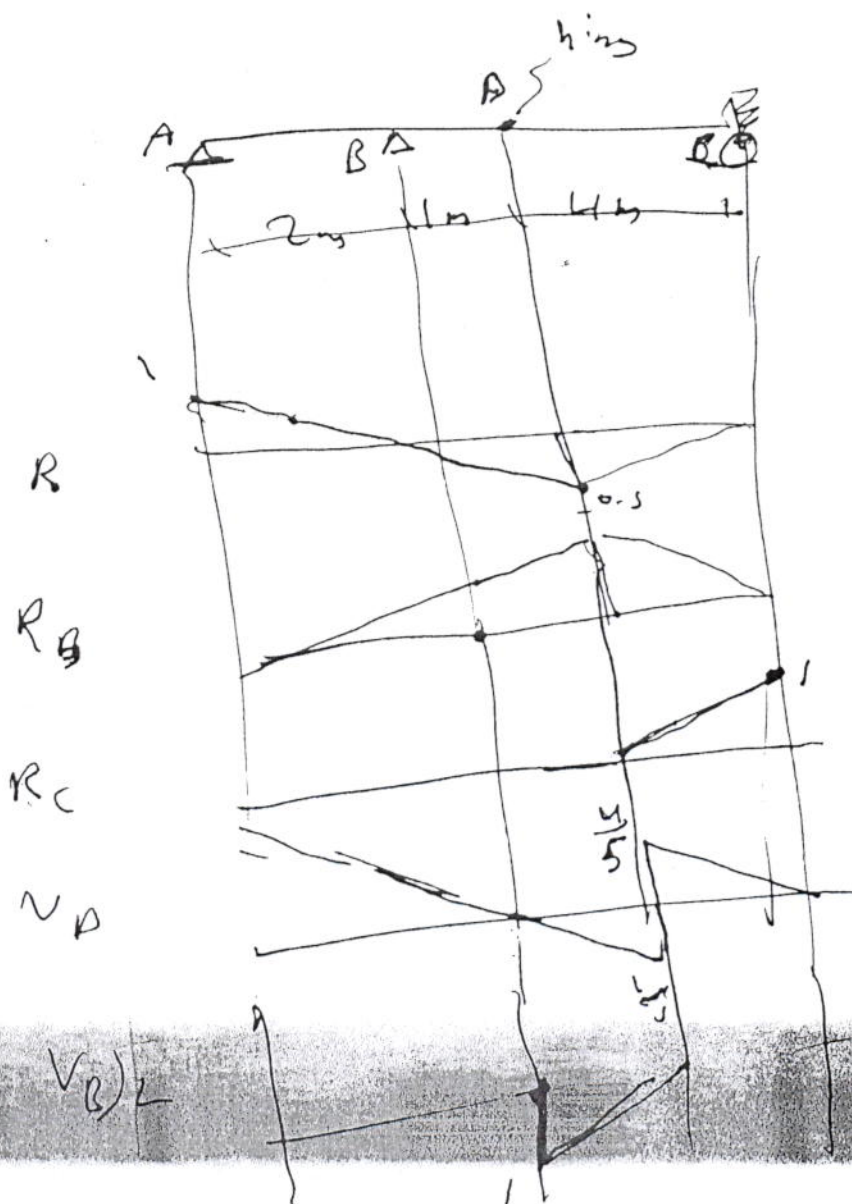
$$EC = 100 \text{ kN}$$

ED ELODENC

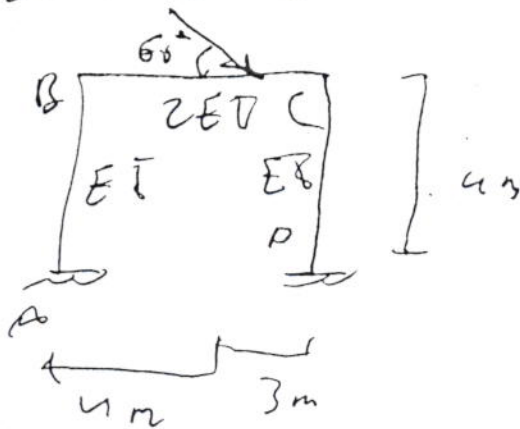
CB = 1008 mC

(BD = 111.8 kN T)

$$AB = 50 \text{ kN C}$$



slope 80° W



~~Joint~~ ~~Members~~ ~~AB~~ ~~BA~~ ~~BC~~ ~~CB~~

Span	AB	BC	CD
$\frac{I}{L}$	$\frac{I}{4}$	$\frac{2I}{7}$	$\frac{I}{4}$
K	7	8	7

$\times \frac{28}{I}$

$$\left. \begin{array}{l} \frac{\Delta}{L} \\ \frac{\Delta}{4} - \frac{\Delta}{4} \end{array} \right\} \times 4$$

$$\left. \begin{array}{l} 7 \\ 7 \end{array} \right\} \Delta - \Delta$$



F.E.M

$M_{AB} = M_{BA}$ $M_{CB} = M_{BC}$ $M_{CD} = 0$

$80 \sin 60 = 69.282 \text{ kN}$

$$M_{BC}^F = -\frac{PL}{8} = -\frac{69.282(7)}{8} = -60.62 \text{ kN}$$

$$M_{CB}^F = +60.62 \text{ kN}$$

slope def. eq

unknown $\left\{ \begin{array}{l} \theta_A = 0 \quad \theta_D = 0 \\ \theta_B, \theta_C, \Delta \end{array} \right.$

$$M_{AB} = M_{AB}^F + 7(\theta_B - \Delta) = 7\theta_B - 7\Delta$$

$$M_{BA} = 14\theta_B - 7\Delta$$

$$M_{BC} = -60.62 + 8(2\theta_B + \theta_C) = 16\theta_B + 8\theta_C - 60.62$$

$$M_{CB} = 60.62 + 8(\theta_B + 2\theta_C) = 8\theta_B + 16\theta_C + 60.62$$

$$\dots \Delta - 7\Delta$$

point conditions

Joint B

$$M_{BA} + M_{BC} = 0 \quad / \quad 30\theta_B + 8\theta_C - 7\Delta - 60.62 = 0 \quad \text{--- (1)}$$

~~30\theta_B~~

Joint C

$$M_{CB} + M_{CD} = 0 \quad / \quad 8\theta_B + 30\theta_C - 7\Delta + 60.62 = 0 \quad \text{--- (2)}$$

$$80 \cos 60 = 40 \text{ kN}$$

shear condition

$$\sum F_x = 0$$

$$V_A + V_D = 40 \text{ kN}$$

$$\sum M_B = 0 \quad \frac{-M_{AB} + M_{BA}}{4}$$

$$V_D = \frac{M_{CD} - M_{DC}}{4}$$

$$M_{AB} + M_{BA} + \frac{M_{CD} - M_{DC}}{4} = -40 \quad \text{--- (3)}$$

$$M_{AB} + M_{BA} + M_{CD} + M_{DC} = -160$$

$$21\theta_B + 21\theta_C - 28\Delta = -160$$

$$30 \quad 8 \quad -7 \quad 60.62$$

$$8 \quad 30 \quad -7 \quad -60.62$$

$$21 \quad 21 \quad -28 \quad -160$$

$$30 \quad 8 \quad -7 \quad 60.62$$

$$0 \quad 27.867 \quad -5.133 \quad -76.785$$

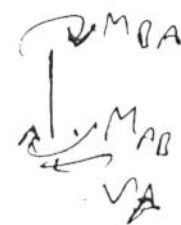
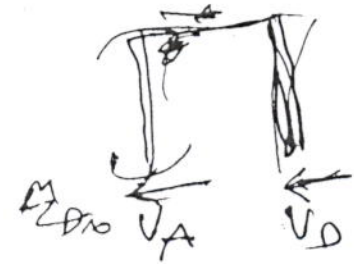
$$0 \quad 15.4 \quad -23.1 \quad -202.434$$

$$\begin{array}{cccc} 30 & 8 & -7 & 60.62 \\ 0 & 27.867 & -5.133 & -76.785 \\ 0 & 0 & -20.263 & -160 \end{array}$$

$$\theta_B = 4.21 \text{ rad}$$

$$\theta_C = -1.3 \text{ rad}$$

$$\Delta = 7.8962 \text{ m}$$



$$M_{AB} = -25.8 \text{ kN.m}$$

$$M_{BA} = 3.667 \text{ kN.m}$$

$$M_{BC} = -3.66 \text{ kN.m}$$

$$M_{CB} = 73.5 \text{ kN.m}$$

$$M_{CD} = -73.5 \text{ kN.m}$$

$$M_{DC} = -64.37 \text{ kN.m}$$

S M. D. M

D. F

Joint A

$$D.F. = 0$$

Joint B

$$D.F. = 1$$

Joint B

BA BC

$$K = \frac{6I}{L} \quad \frac{5I}{3} \quad \frac{4I}{3}$$

$$D.F. = \frac{6}{11} = \frac{5}{11}$$

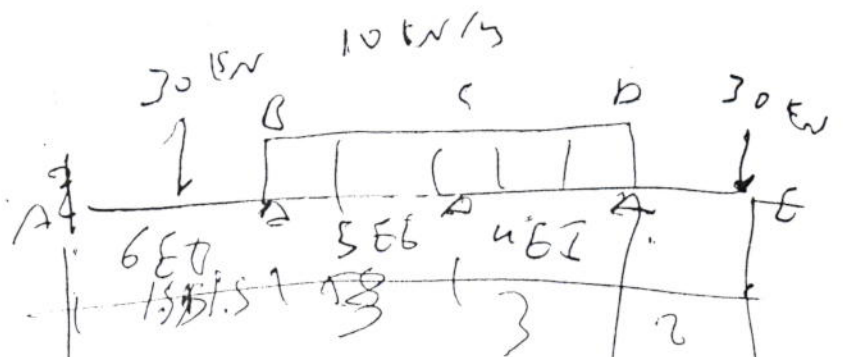
$$D.F. = \begin{bmatrix} 0.545 & 0.455 \end{bmatrix}$$

Joint C

CB CD

$$\frac{5I}{3} \quad \frac{4I}{3} \quad \frac{3}{I}$$

$$\frac{5}{9} = 0.555 \quad \frac{4}{9} = 0.444$$



F.E.M

$$M_{AB}^F = -\frac{PL}{8} = -\frac{30 \times 8}{8} = -11.25 \text{ kNm}$$

$$M_{BA}^F = +11.25 \text{ kNm}$$

$$M_{BC}^F = -\frac{wL^2}{12} = -\frac{10 \times 12^2}{12} = -7.5$$

$$M_{CB}^F = +7.5$$

$$M_{CD}^F = -7.5$$

$$M_{DC}^F = +7.5$$

Point	A		B		C		P
member	AB	BA	BC	CB	CD	DC	
D.F	0	0.5454	0.4545	0.555	0.444	0.555	
F.E.M	-11.5	11.5	-7.5	7.5	-7.5	7.5	
D.M	0	-2.182	-1.82	-	-	52.5	
C.D.F	-1.091	-	-	-0.91	26.25	-	
D.M	-	-	-	-14.07	-11.261	-	
C.D.F	-	-	-7.04	-	-	-5.63	
D.M	-	3.84	3.2	-	-	5.63	
C.D.F	-1.92	-	-	1.6	2.815	-	
D.M	-	-	-	-2.453	-1.962	-	
C.D.F	-	-	-1.227	-	-	-0.98	
D.S	-	0.67	0.56	-	-	0.98	
D.M	0.335	-	-	0.28	0.49	-	
D.M	-	-	-	-0.43	-0.342	-	
D.M	-10.336	13.83	-13.83	-8.48	8.49	-	