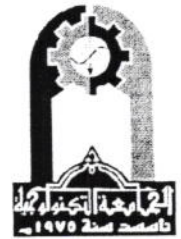




University Of Technology
Building and Construction Eng. Dept.
Final Exam/1st Attempt –2014/2015
Subject :Theory of Structures



Class: third
Division: Geomatic

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):

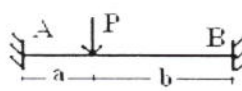
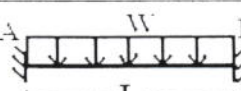
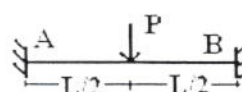
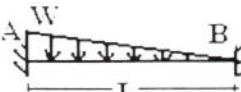
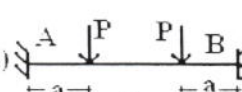
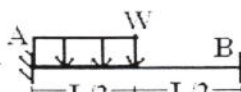
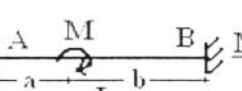
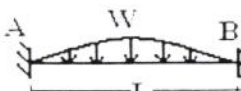
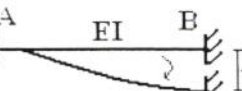
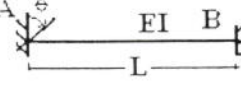
A- Check determinacy and stability.

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 $V_{B\text{left}}$. (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)

M_{AB}^F	M_{BA}^F	M_{AB}^F	M_{BA}^F
$-\frac{pa^2b^2}{L^2}$ 	$+\frac{pba^2}{L^2}$	$-\frac{WL^2}{12}$ 	$+\frac{WL^2}{12}$
$-\frac{PL}{8}$ 	$+\frac{PL}{8}$	$-\frac{WL^2}{20}$ 	$+\frac{WL^2}{20}$
$-\frac{Pa}{L}(L-a)$ 	$+\frac{Pa}{L}(L-a)$	$-\frac{11WL^2}{192}$ 	$+\frac{5WL^2}{192}$
$\frac{Mb(2a-b)}{L^2}$ 	$\frac{Ma(2b-a)}{L^2}$	$-\frac{WL^2}{15}$ 	$+\frac{WL^2}{15}$
$-\frac{6EI\Delta}{L^2}$ 	$-\frac{6EI\Delta}{L^2}$	$\frac{4EI\theta}{L}$ 	$\frac{2EI\theta}{L}$

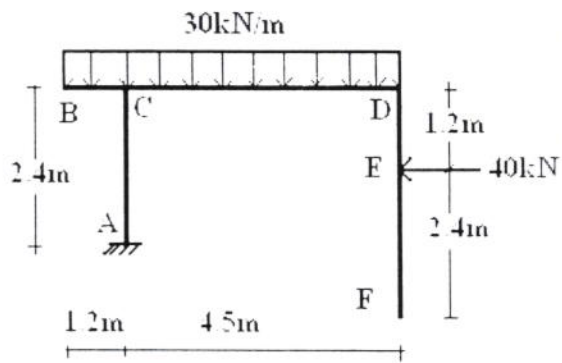


Fig.(1)

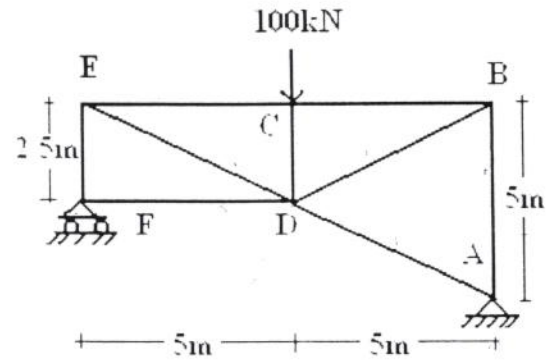


Fig.(2)

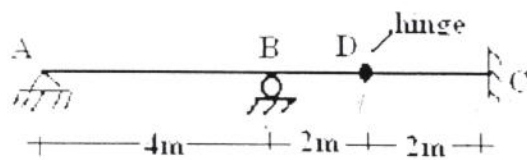


Fig.(3)

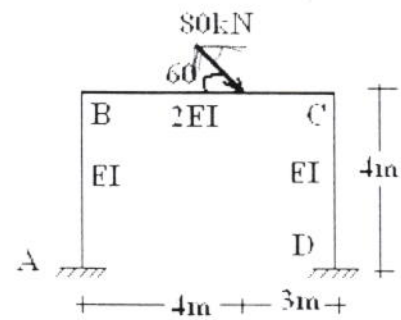


Fig.(4)

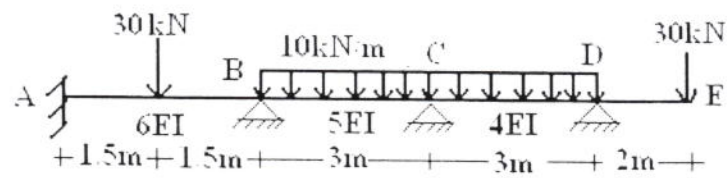


Fig.(5)

Q11) Determine if stable
 $3m + r = 3j + c$

$$m = 4$$

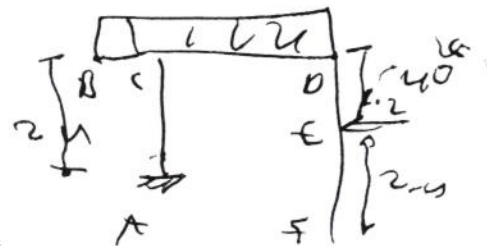
$$r = 3$$

$$j = 5$$

$$c = 0$$

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

15 = 15 Determinate
 & stable



b. Reactions

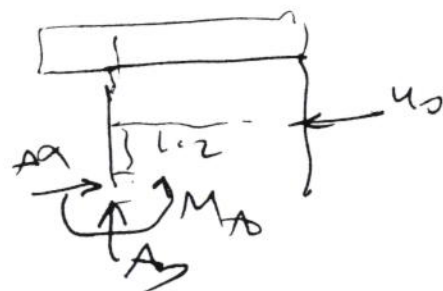
$$\sum F_x = 0 \Rightarrow A_x = 40 \text{ kN} \rightarrow$$

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

$$\sum M_A = 0$$

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

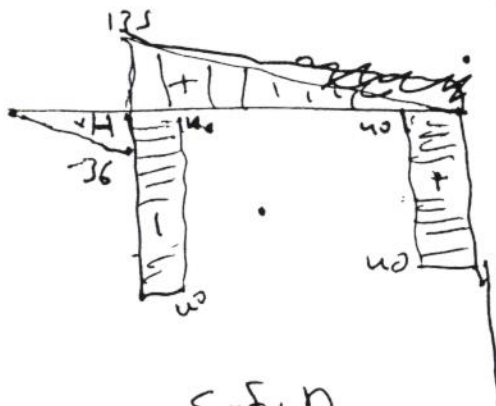
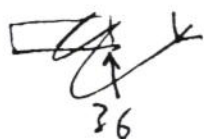
$$M_A = 234.15 \text{ kNm} \uparrow$$



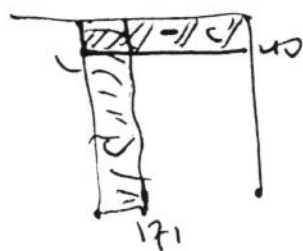
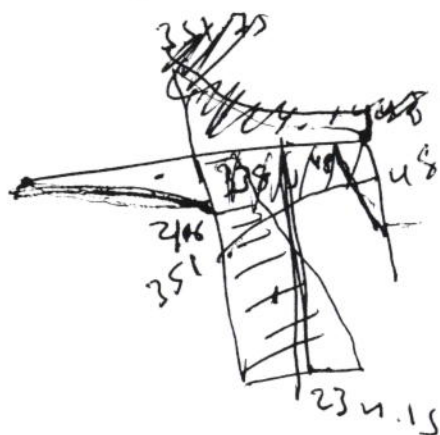
c) Draw

(+) (-) $\uparrow \downarrow$

$\begin{array}{c|c} + & + \\ \hline + & 1 + \end{array} -$



S.F.D



A-F.P

2

Determinacy & stability

$$r = 3$$

$$m = 9$$

$$J = 6$$

$$m + r = 2J$$

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

Reactions

$$\sum F_x = 0 \Rightarrow A_x = 0$$

$$\sum M_F = 0 \Rightarrow 100(5) + A_y(10) = 0 \Rightarrow A_y = 50 \text{ kN } \uparrow$$

$$\sum F_y = 0 \Rightarrow 50 - 100 + F_y = 0 \Rightarrow F_y = 50 \text{ kN } \uparrow$$

Joint F

Joint F

$$\sum F_y = 0 \Rightarrow F_y = 50 \text{ kN } \uparrow$$

$$\sum F_x = 0$$

Joint E

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

$$\sum F_x = 0 \Rightarrow ED \left(\frac{3}{5} \right) - EC = 0$$

Joint C

$$\sum F_y = 0 \Rightarrow EC = 100$$

$$\sum F_x = 0$$

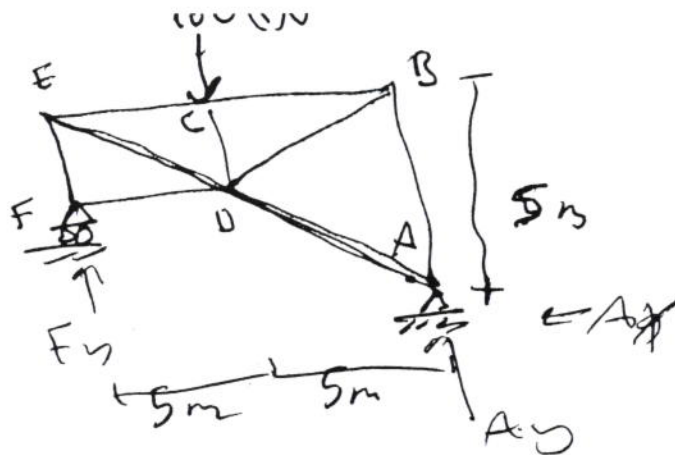
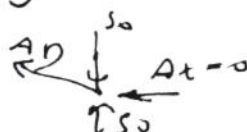
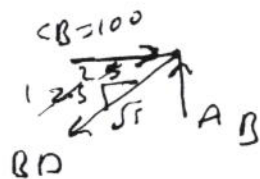
Joint B

$$\sum F_x = 0 \Rightarrow 100 - BD \frac{2}{5} = 0$$

$$\sum F_y = 0 \Rightarrow AB - BD \frac{4}{5} = 0$$

Joint A

$$\sum F_x = 0$$



$$\sum F = 50 \text{ kN } \uparrow$$

$$FD = 0$$

$$CD = 100 \text{ kN } \uparrow$$

$$ED = 111.8 \text{ kN } T$$

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

$$ED = 100 \text{ kN } C$$

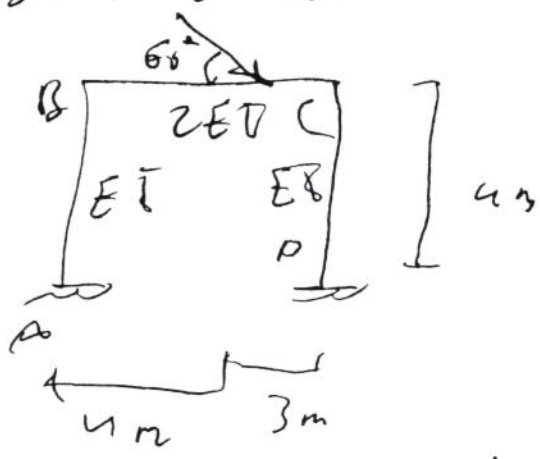
$$CB = 100 \text{ kN } C$$

$$BD = 111.8 \text{ kN } T$$

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

$$AD = 0$$

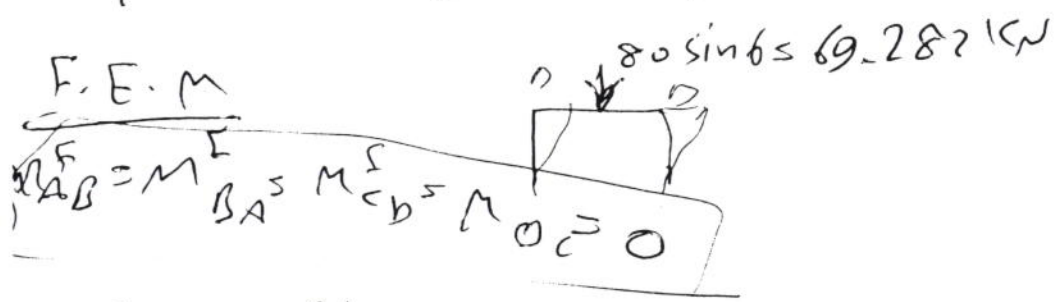
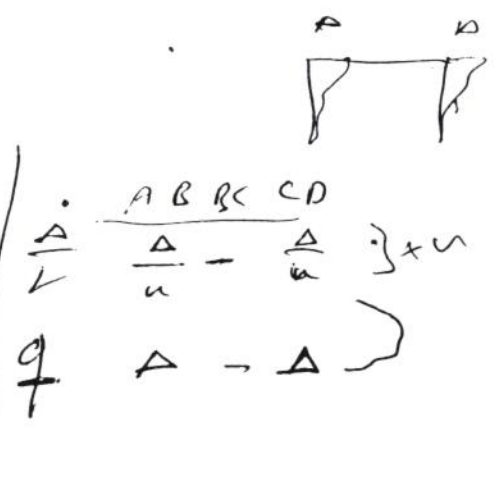
1) slope 80 kN



~~Joint~~ A B C D
~~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

$\times \frac{28}{4}$



$$M_{BC}^F = -\frac{PL}{8} = -\frac{69.28(7)}{8} = -60.62 \text{ kNm}$$

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

slope def. eq unknown $\theta_B = 0$ $\theta_D = 0$
 $\theta_B, \theta_C, \Delta$

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

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

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

$$M_{CD} = 0 + 7(2\theta_C - \Delta) = 14\theta_C - 7\Delta$$

$$M_{DC} = 0 + 7(\theta_C - \Delta) = 7\theta_C - 7\Delta$$

Joint 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

$$\sum F_x = 0$$

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

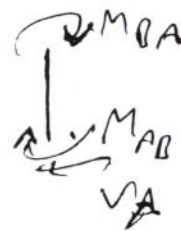
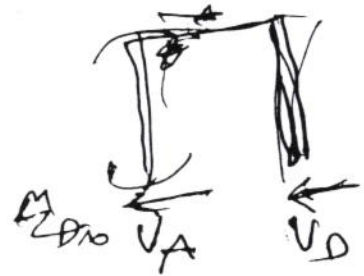
$$\sum M_B = 0 \quad \frac{-M_{AB} + M_{BA}}{4}$$

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

$$\frac{M_{AB} + M_{BA}}{4} + \frac{M_{CD} + M_{DC}}{4} = -40 \quad \times 4$$

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

$$24\theta_B + 21\theta_C - 28\Delta = -160$$



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

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

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

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

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

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

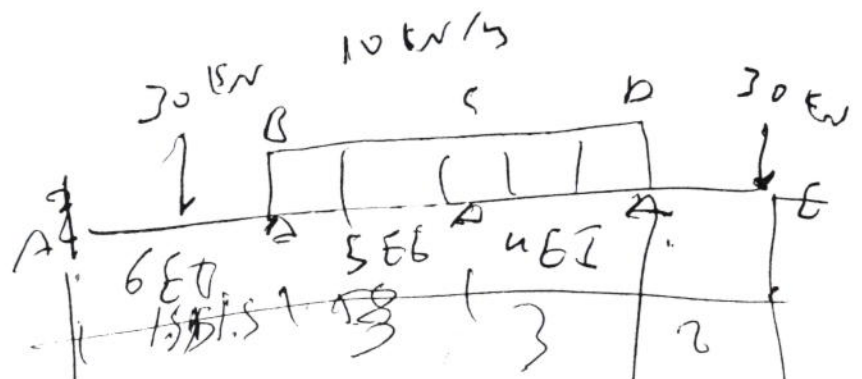
$$\begin{array}{rrrr} 30 & 8 & -7 & 60.62 \\ 0 & 27.867 & -5.133 & -76.785 \\ 0 & 0 & -20.263 & -160 \end{array}$$

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

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

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

S M. D. M
D. F



Joint A

$$D.F. = 0$$

Joint B

$$D.F. = 1$$

Joint C

BA BC

$$K = \frac{6EI}{L^3} \cdot \frac{6EI}{3} \cdot \frac{5EI}{3} \cdot \frac{4EI}{3}$$

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

$$D.F. = \begin{bmatrix} 0.5454 & 0.4545 \end{bmatrix}$$

Joint D

CB CD

$$K = \frac{5EI}{L^3} \cdot \frac{4EI}{3} \cdot \frac{3}{EI}$$

$$\frac{5}{9} = 0.5555 \quad \frac{4}{9} = 0.4444$$

F.E.M

$$M_{AB}^F = -\frac{PL}{8} = -\frac{30 \times 6}{8} = -11.25 \text{ kNm}$$

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

$$M_{BC}^F = -\frac{wL^2}{12} = -\frac{10 \times 5^2}{12} = -7.5$$

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

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

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

Joint	A	B		C		P
Members	AB	BA	BC	CB	CD	DC
D.F	0	0.545u	0.455u	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.C	-	0.67	0.56	-	-	0.98
C.D.F	0.335	-	-	0.28	0.49	-
D.M	-	-	-	-0.43	-0.342	-
M	-10.334	13.83	-13.83	-8.48	8.49	-