DEPARTMENT OF CIVIL ENGINEERING

CE-222 STRUCTURAL MECHANICS I

Quiz-1 5/2/10

Problem 1

Draw the Axial Force, Shear Force, and Bending Moment Diagram for the frame shown in **Fig. 1.** Then, use this to sketch the Qualitative Deflected Shapes.

Problem 2

Draw the Influence Line diagram for bending moment at ***A*** for the frame shown in **Fig. 2**. Then use this to find the maximum positive and maximum negative bending moment at ***A*** due to the load train shown.

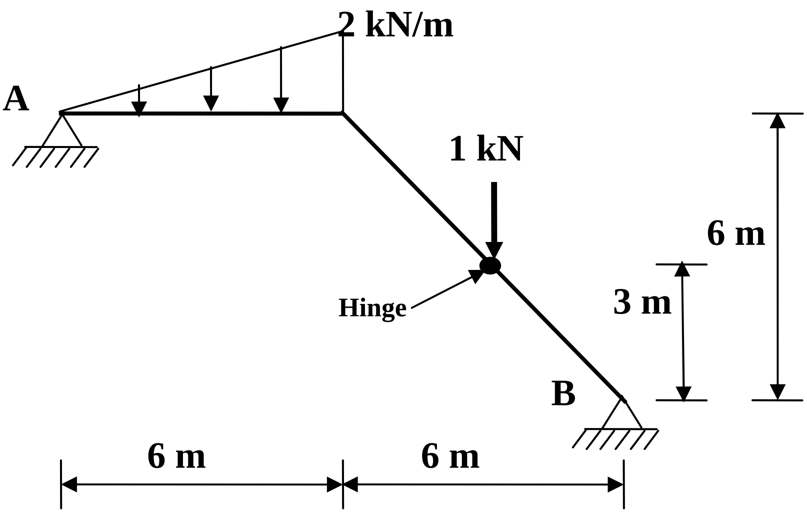


Figure 1

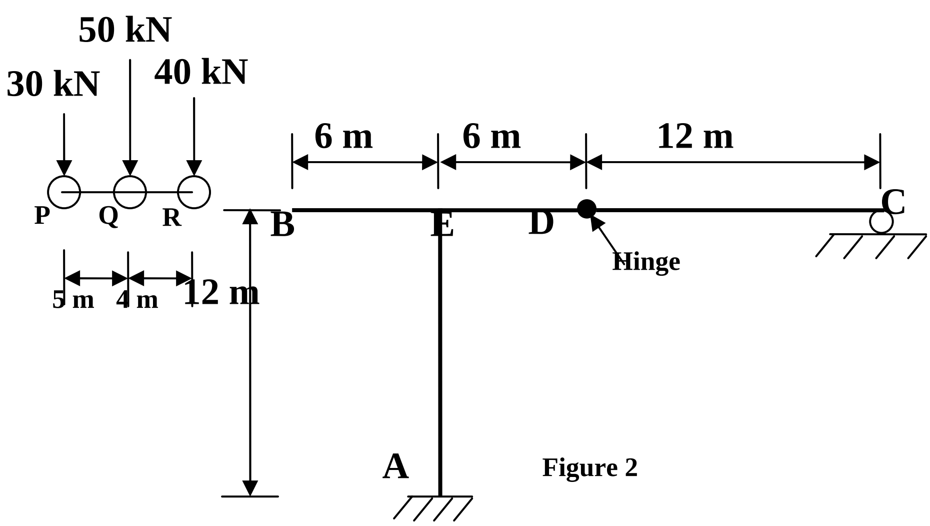
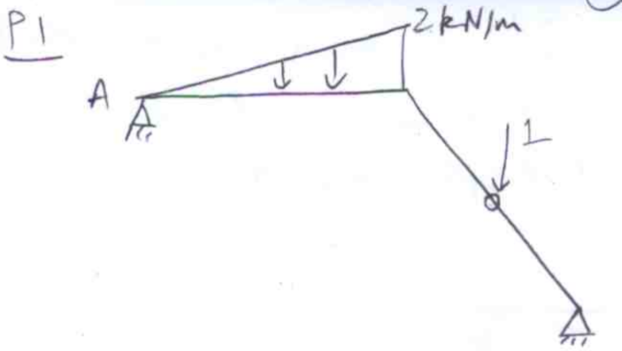
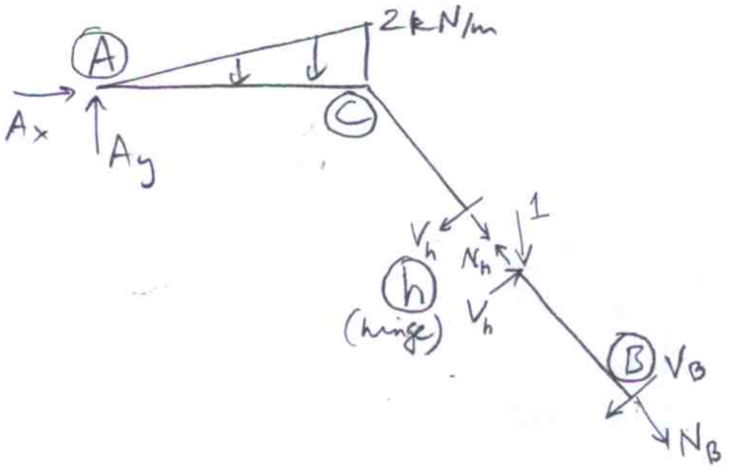


Figure 2

P1



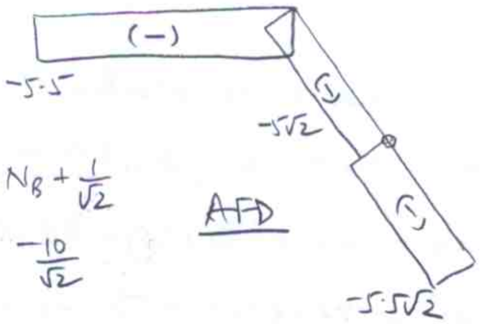


$$\Sigma M_B = 0 \Rightarrow V_h = \frac{1}{\sqrt{2}}$$

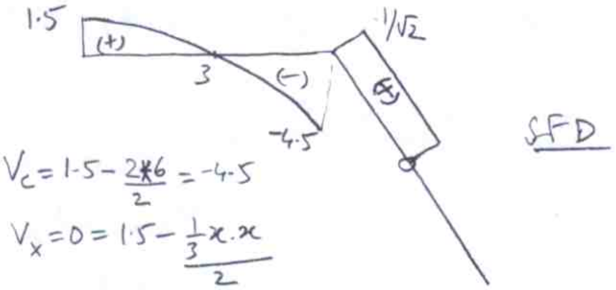
$$\Sigma M_A = 0 \Rightarrow \frac{6*2}{2}*4 + 1*9 - \frac{N_B}{\sqrt{2}}*6 + \frac{N_B}{\sqrt{2}}*12 = 0$$

$$\Rightarrow N_B = -5.5\sqrt{2}$$

$$A_x = -\frac{N_B}{\sqrt{2}} = 5.5, \quad A_y = \frac{6*2}{2} + 1 - \frac{5.5\sqrt{2}}{\sqrt{2}} = 1.5$$



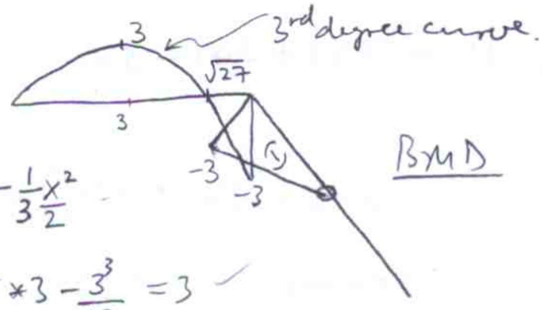
$$N_h = N_B + \frac{1}{\sqrt{2}} = -\frac{10}{\sqrt{2}}$$



$$V_C = 1.5 - \frac{2*6}{2} = -4.5$$

$$V_x = 0 = 1.5 - \frac{\frac{1}{3}x \cdot x}{2}$$

$$\Rightarrow x = 3$$

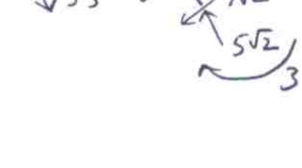


$$V = 1.5 - \frac{1}{3}\frac{x^2}{2}$$

$$M_3 = 1.5*3 - \frac{3^3}{18} = 3$$

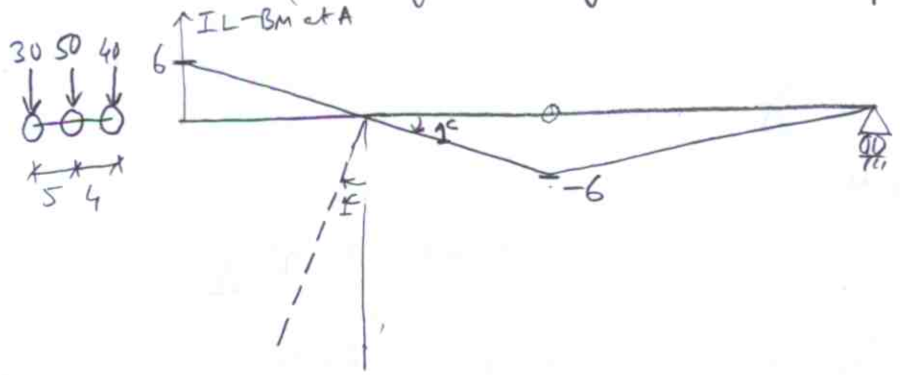
$$M = 0 = 1.5x - \frac{x^3}{18} \Rightarrow x = \sqrt{27}$$

check: $M_6 = 1.5*6 - \frac{6^3}{18} = -3.$



⇒ equil at C satisfied

(2) Use Muller Breslau principle. So give unit rotation at A, which is equivalent to giving unit rotation at E (∵ rigid body virtual displacements).



or by tables

load at	BM_A
B	6 (1*6)
E	0
D	-6 (-1*6)
C	0

Positions: 1 → 40 at peak, 2 → 50 at peak, 3 → 30 at peak

For max +ve BM:

Load moves → : obvious that max is for position 2

$M_{max} = M_2 = 50*6 + 40*2 = \boxed{380\ kN.m}$

Not reqd since 30 kN load farther behind 50 kN load than 40 kN is in front of it. { Load moves ← : $\Delta M_{1-2} = -40*6 + 4*1*(50+30) = 80$ ✓

$\Delta M_{2-3} = -50*6 + 5*1*30 = -150$ (no need for this ∵ obviously not critical)

So $M_{max} = M_2 = 50*6 + 30*1 = 330$ } Not reqd

For max -ve BM:

load moves → : $\Delta M_{1-2} = 4(0.5*40 + (-1)*[50+30]) = -240$ ✓

$\Delta M_{2-3} = 5(0.5*[40+50] + (-1)*[30]) = 75$

$M_{max} = M_2 = 50(-6) + 40(-4) + 30(-1) = \boxed{-490}$

load moves ← : $\Delta M_{1-2} = 4(1*40 + (-0.5)[50+30]) = 0$ ✓

$= 5(1*[40+50] + (-0.5)[30]) = 375$

$M_{max} = M_1$ or $M_2 = 40(-6) + 50(-4) + 30(-1.5) = -485$ ✓

So M_A max is 380 kN.m and -490 kN.m ✓