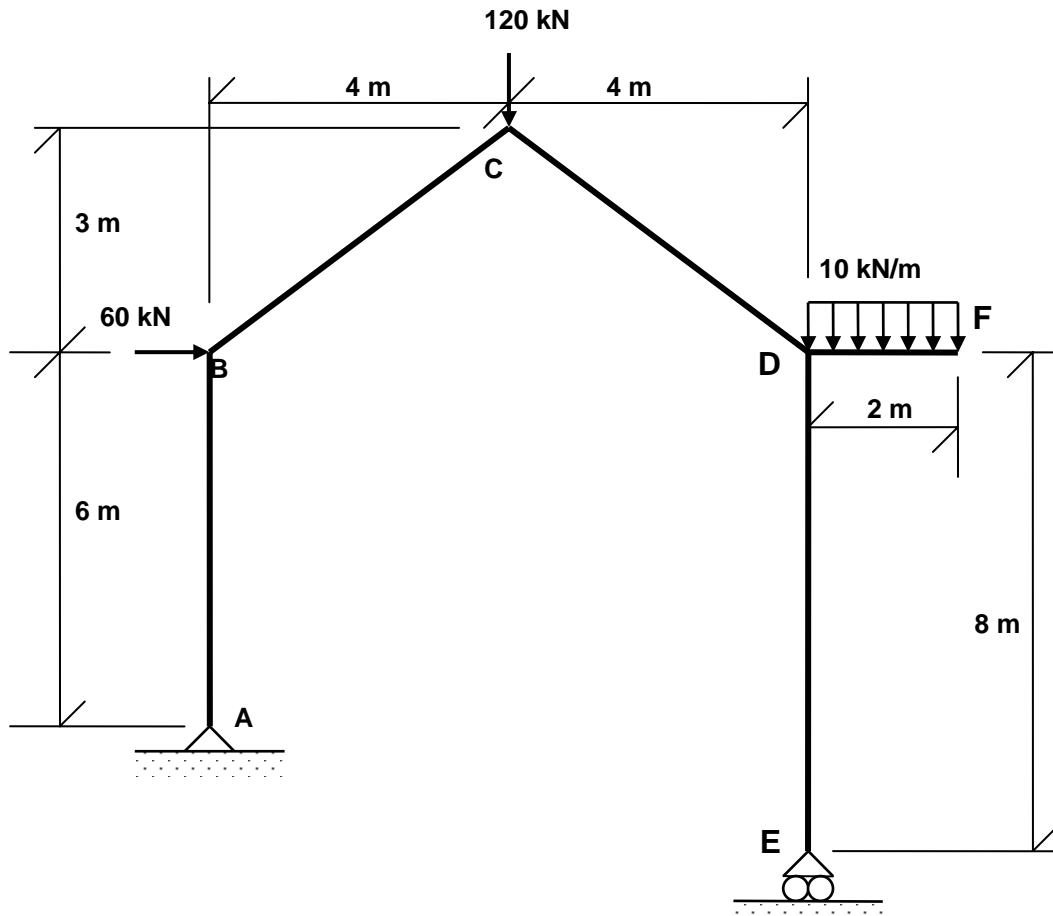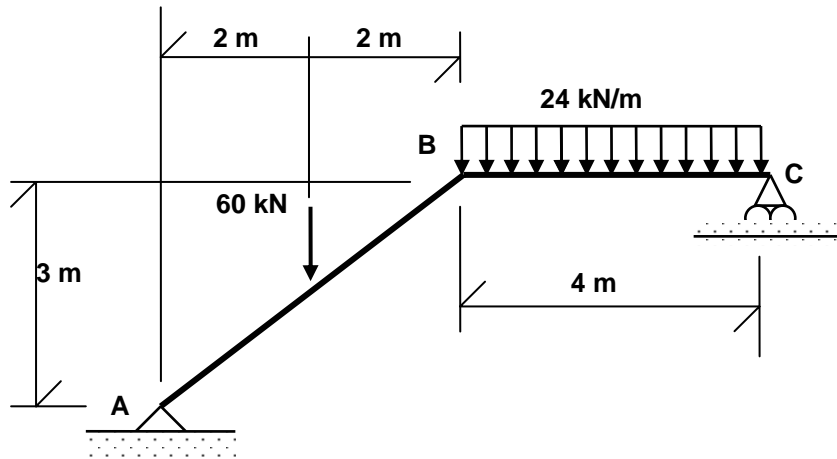# CE-222 STRUCTURAL MECHANICS I
DEPARTMENT OF CIVIL ENGINEERING
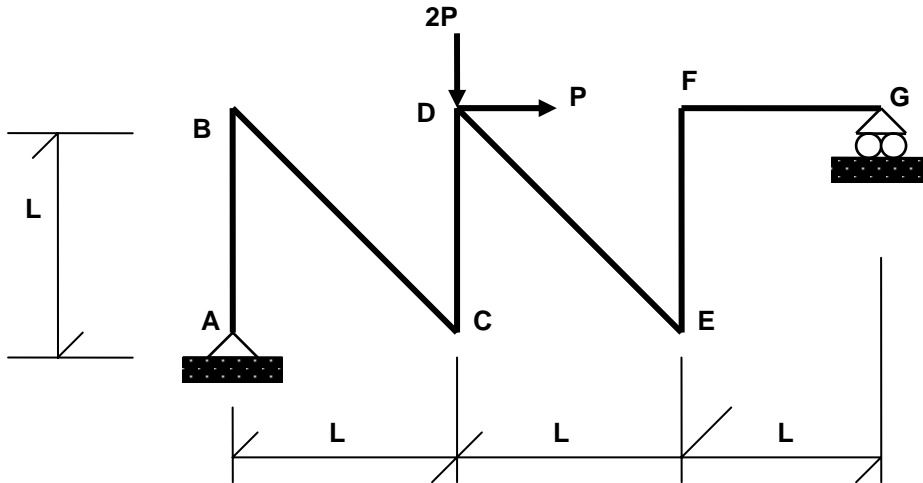## Tutorial Assignment # 3: AFD, SFD, BMD and QDS of Frames

**Problem 1**

Draw the **Axial Force, Shear Force and Bending Moment Diagrams** for the following systems. Also sketch the **Qualitative Deflected Shapes**.

## Problem 2

Draw the **Axial Force**, **Shear Force and Bending Moment Diagrams** for the following system. Sketch the **Qualitative Deflected Shape**.



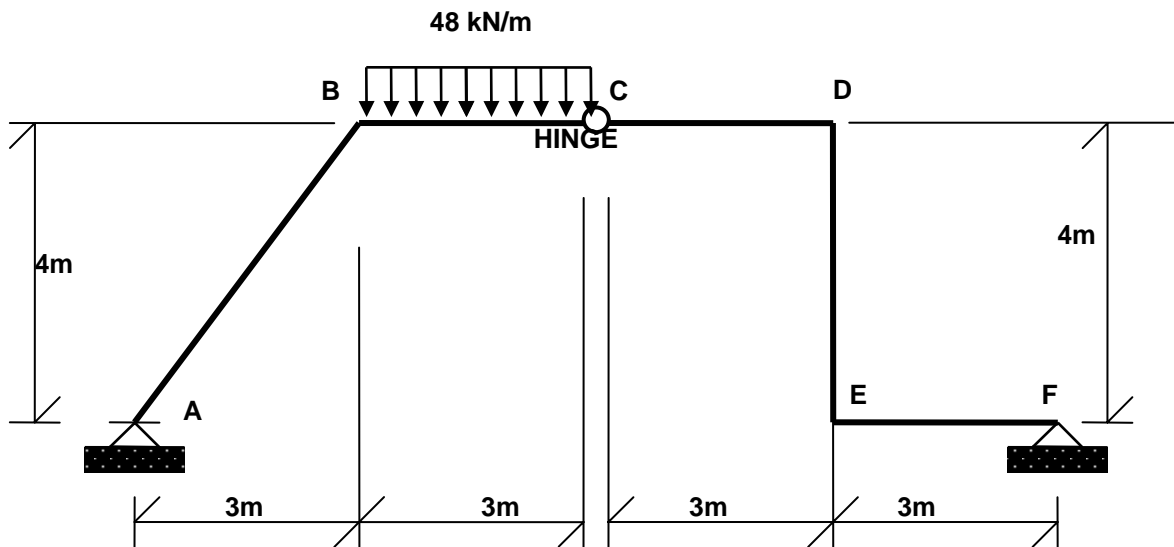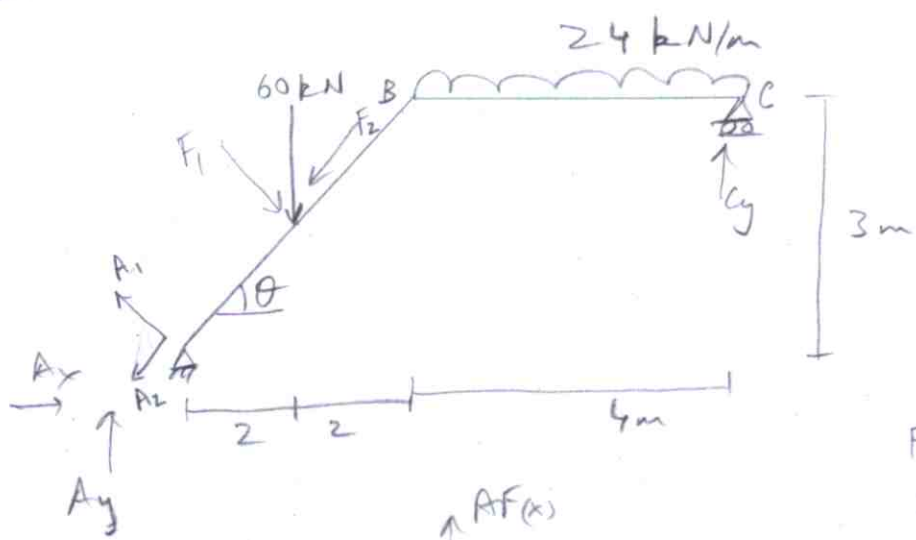## Problem 3

Draw the **Axial Force**, **Shear Force and Bending Moment Diagrams** for the following system. Sketch the **Qualitative Deflected Shape**.
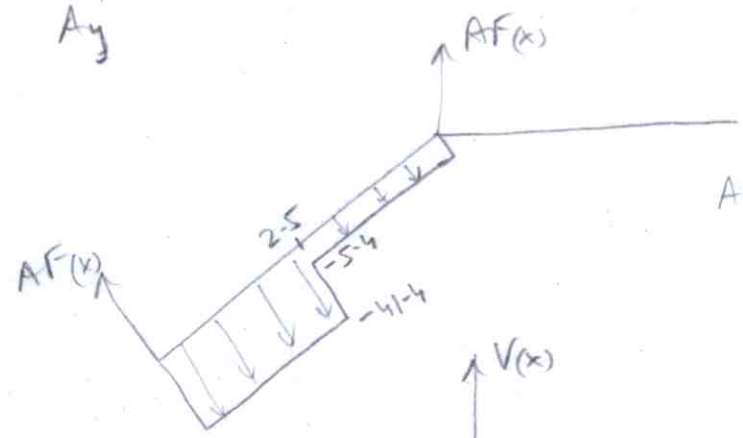
P.1



$$A_x = 0$$

$$C_y(8) = (60)(2) + 24(4)(6)$$

$$C_y = 87, \quad A_y = 69$$

$$A_1 = A_y \cos\theta = 69 \times \frac{4}{5} = 55.2$$

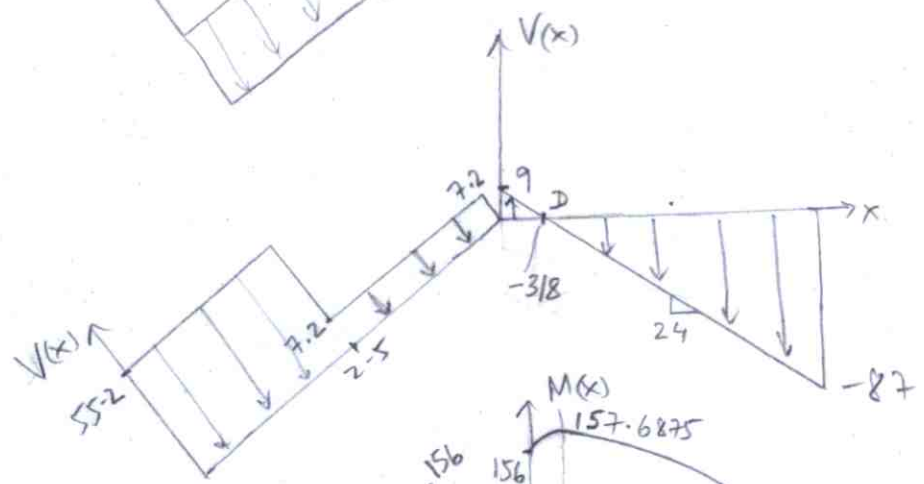$$A_2 = -A_y \sin\theta = -69 \times \frac{3}{5} = -41.4$$

$$F_1 = 60 \cos\theta = 60 \times \frac{4}{5} = 48$$
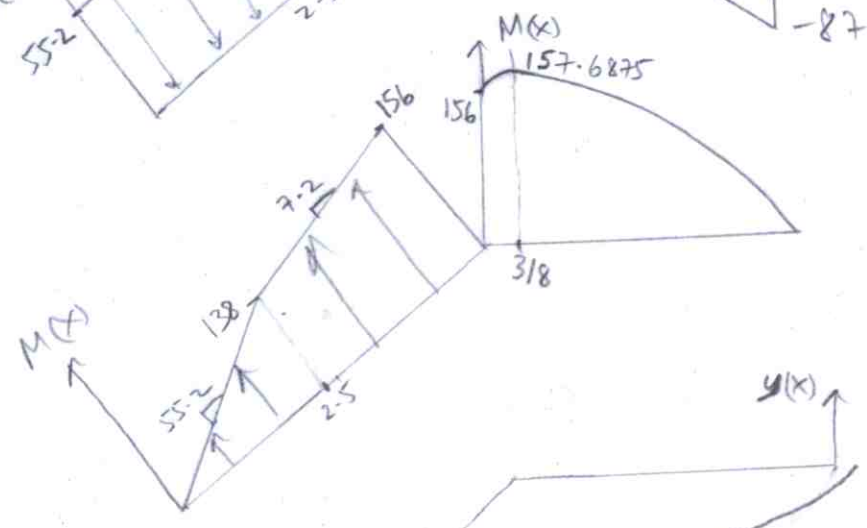
$$F_2 = 60 \sin\theta = 60 \times \frac{3}{5} = 36$$

$$AF(2.5) = -41.4 + 36 = -5.4$$

$$V(2.5) = 55.2 - 48 = 7.2$$

$$V(0) = -87 + 24 \times 4 = 9$$

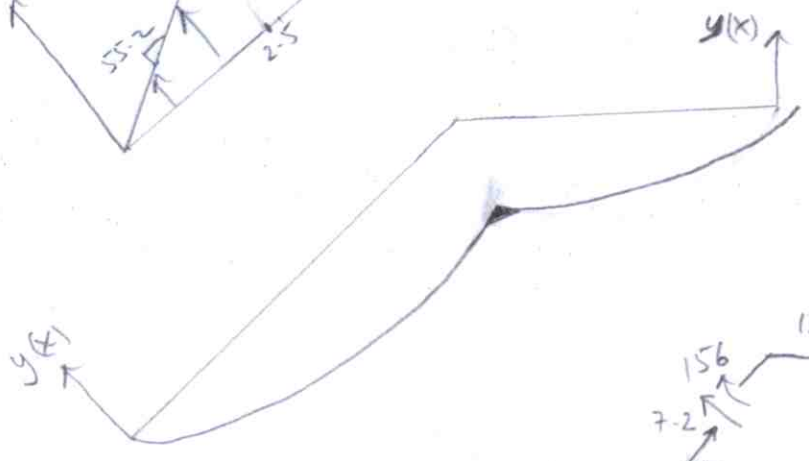$$M(2.5) = 0 + (55.2)(2.5)$$
$$= 138$$

$$M(5) = 138 + (7.2)(2.5) = 156$$

$$x_D = 3/8$$
$$M_D = \frac{87 \times (4 - 3/8)}{2} = 157.6875$$

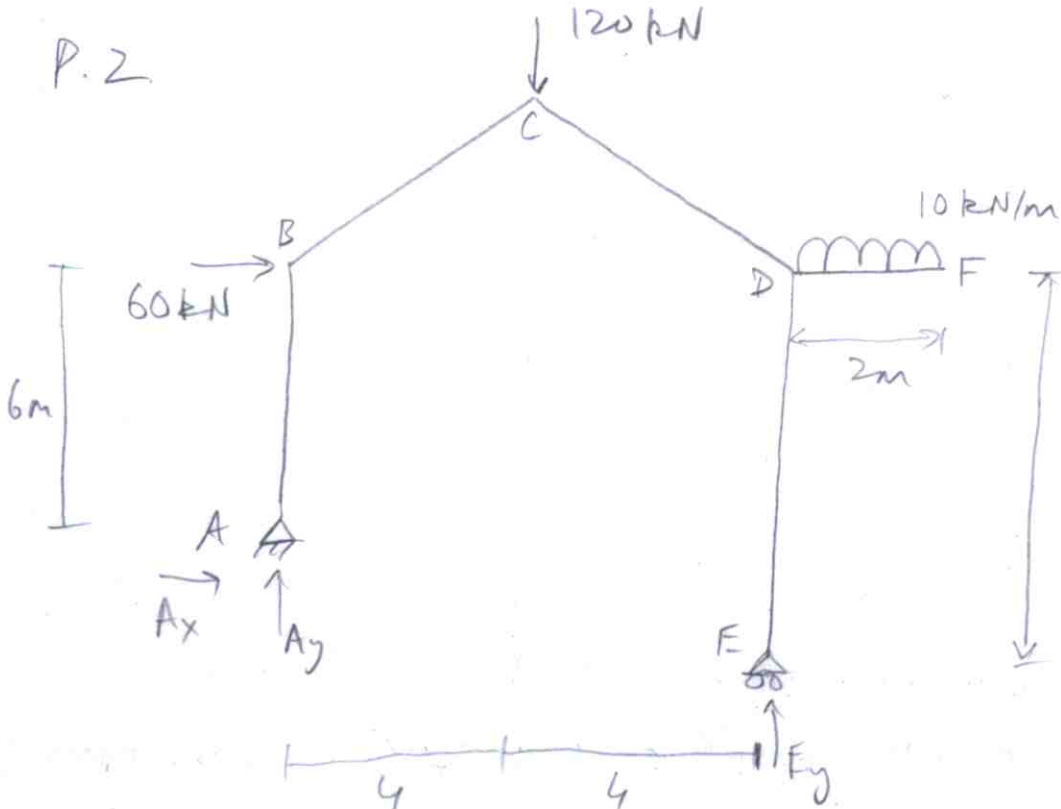$$M(0) = M_D - \frac{9 \times 3/8}{2} = 156.$$
(checks out)

Check equil at B:
$$(7.2)\left(\frac{3}{5}\right) - (5.4)\left(\frac{4}{5}\right) = 0 \checkmark$$

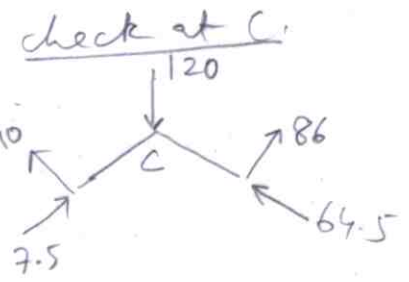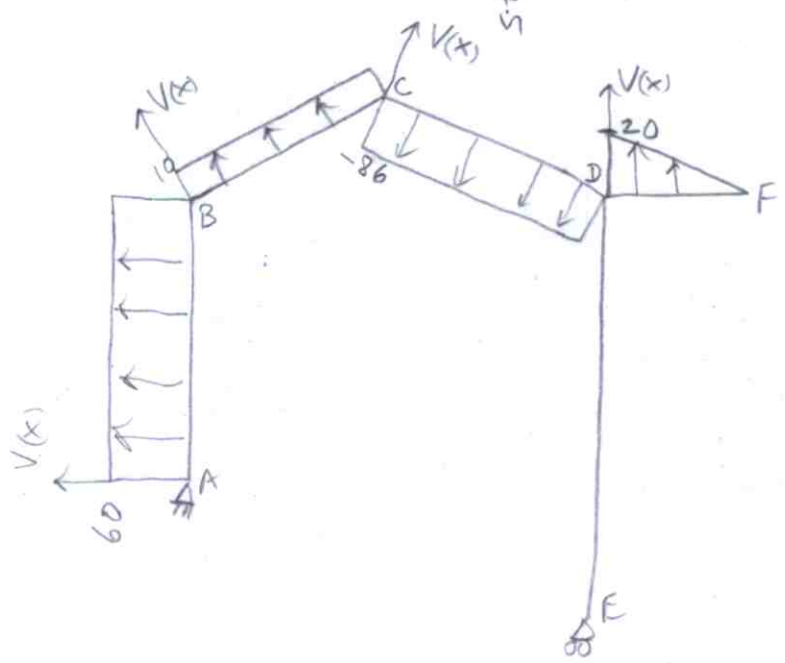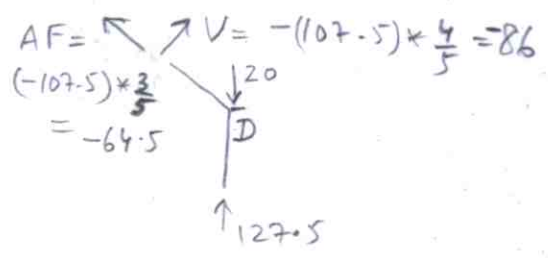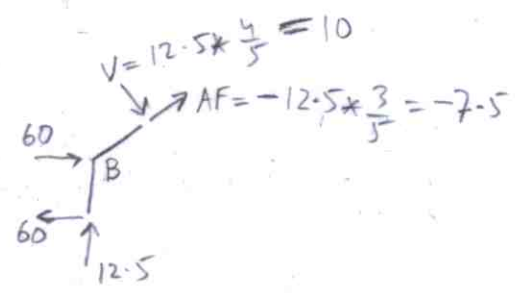$$(7.2)\left(\frac{4}{5}\right) + (5.4)\left(\frac{3}{5}\right) = 9 \checkmark$$

120 kN

C

10 kN/m

B

60 kN

D  F

2m

6m

8m

A

$A_x$

$A_y$

E

$E_y$

4    4

$$60)(6) + (120)(4)$$
$$3m \quad + (10)(2)(9) = E_y(8)$$

$$E_y = 127.5$$
$$A_y = 12.5$$
$$A_x = -60$$

AF(x)

AF(x)

-7.5

-64.5

F

AF(x)

AF(x)

-12.5

-127.5

$$V = 12.5 * \frac{4}{5} = 10$$
$$AF = -12.5 * \frac{3}{5} = -7.5$$
60 → B
60 ←
12.5 ↑

$$AF = (-107.5) * \frac{3}{5} = -64.5 \qquad V = -(107.5) * \frac{4}{5} = -86$$
120
D
↑ 127.5
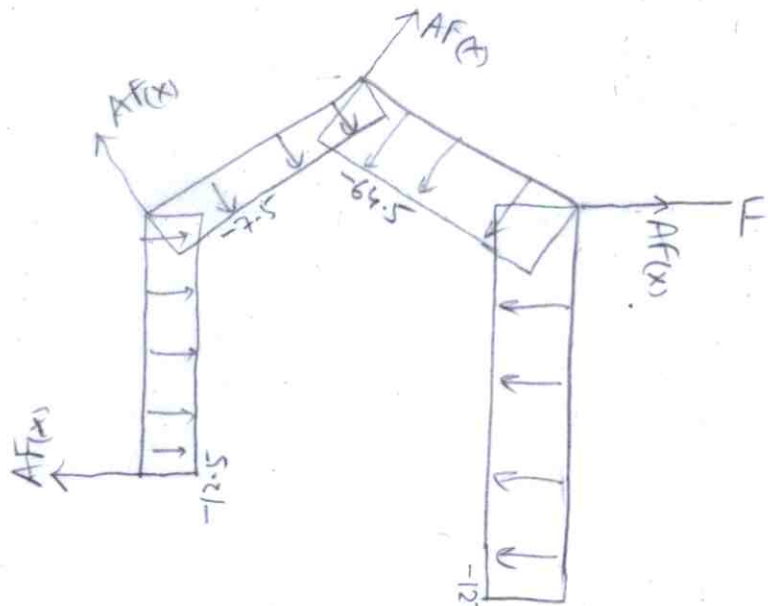
check at C:
120
10      C      86
7.5          64.5

$$(10)\left(\frac{4}{5}\right) + (7.5)\left(\frac{3}{5}\right) + (64.5)\left(\frac{3}{5}\right)$$
$$+ (86)\left(\frac{4}{5}\right) = 120 \checkmark$$

$$- (10)\left(\frac{3}{5}\right) + (7.5)\left(\frac{4}{5}\right) + (86)\left(\frac{3}{5}\right)$$
$$- (64.5)\left(\frac{4}{5}\right) = 0 \checkmark$$

V(x)
V(x)
C
10
-86
20
B
D
F

V(x)

60
A
E

410    410

10

360    (+)

360    (+)

360    60 (+)

(+)

4·767

(-)

-20    -20

check BM at E.

20    )20

a

P.3

④

$A_x = -P$

$G_y = \dfrac{2PL + PL}{3L} = P, \quad A_y = P$



BC:

$V = (-P + P) \cdot \dfrac{1}{\sqrt{2}} = 0$

$N = (P + P) \dfrac{1}{\sqrt{2}} = \sqrt{2}P$

CD:

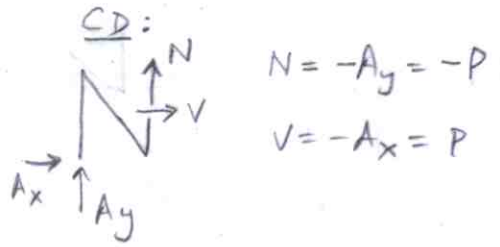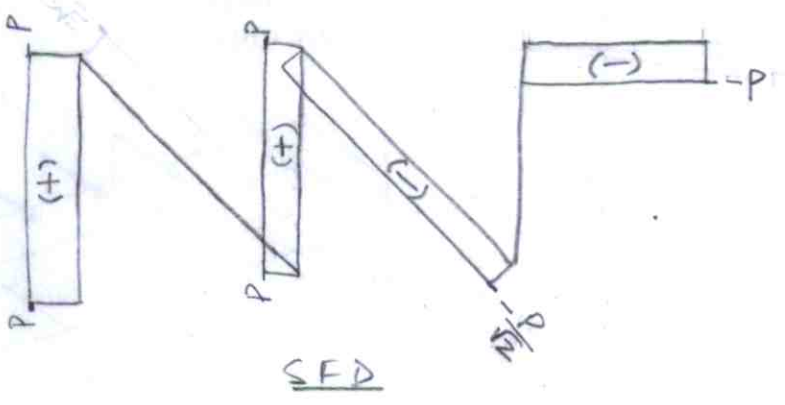$N = -A_y = -P$

$V = -A_x = P$

DE:

$V = (P - 2P) \cdot \dfrac{1}{\sqrt{2}} = \dfrac{-P}{\sqrt{2}}$

$N = (P - 2P) \dfrac{1}{\sqrt{2}} = \dfrac{-P}{\sqrt{2}}$

EF:

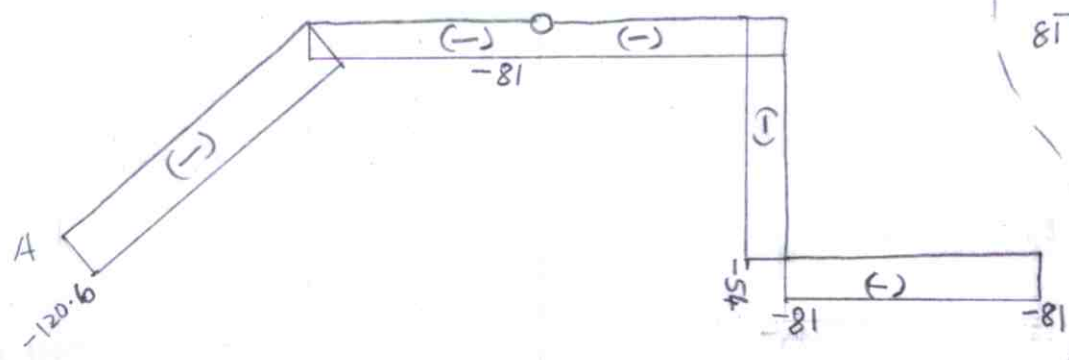$V = -A_x - P = 0$

$N = -A_y + 2P = P$

AFD

SFD

BMD.
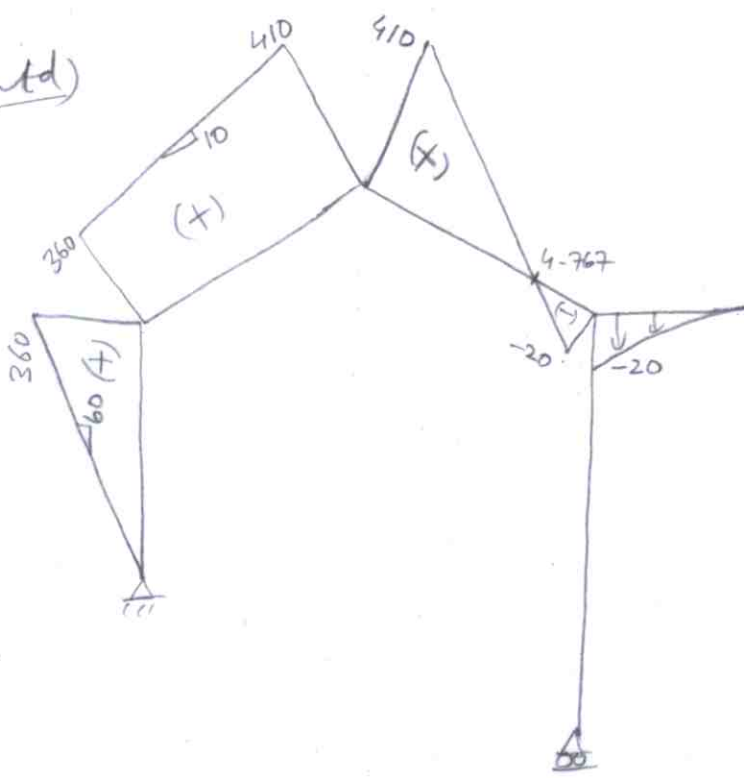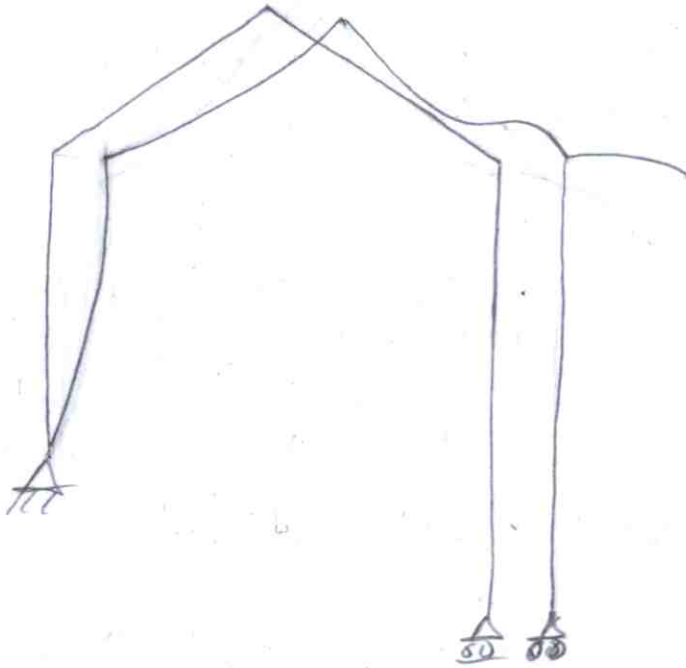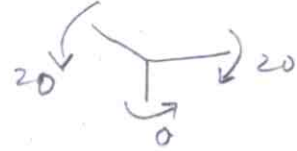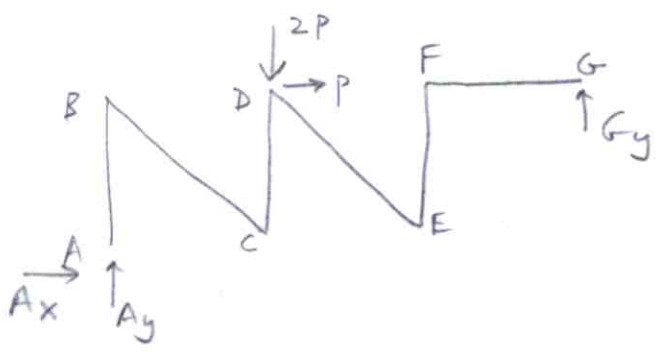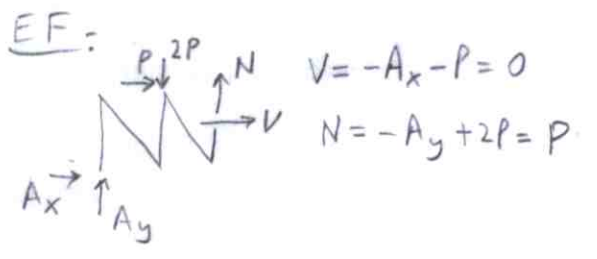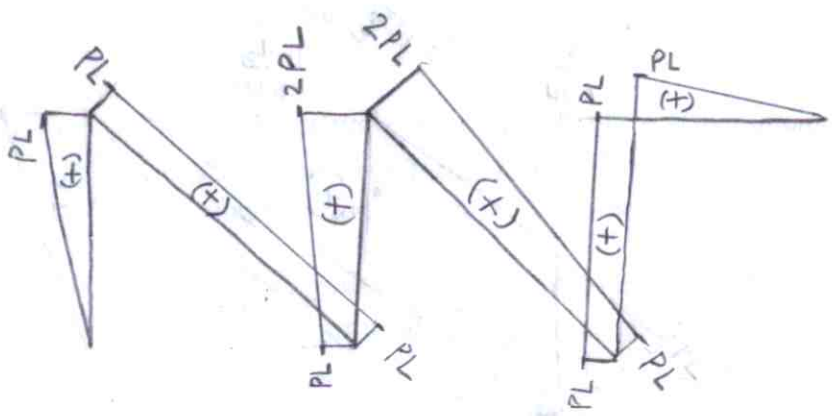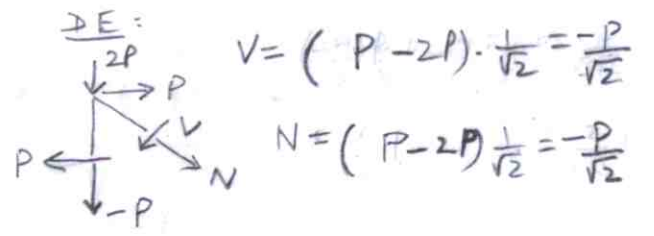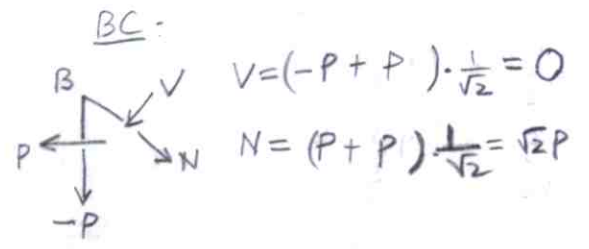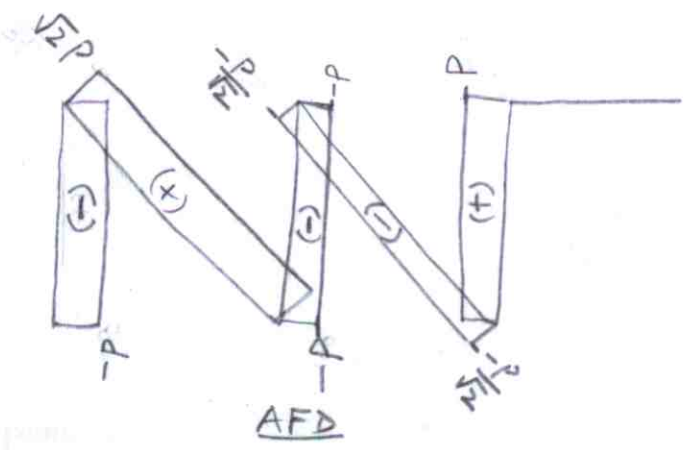
· For whole structure,

$\sum M_F = 0 \implies A_y(12) - (48)(3)(7.5) = 0 \implies A_y = 90$

For FBD to left of hinge C,

$\sum M_c = 0 \implies A_x(4) - (90)(6) + (48)(\frac{3^2}{2}) = 0 \implies A_x = 81$

AB:

$N = -81(\frac{3}{5}) - 90(\frac{4}{5})$
$= -120.6$

$V = 90(\frac{3}{5}) - 81(\frac{4}{5})$
$= -10.8$
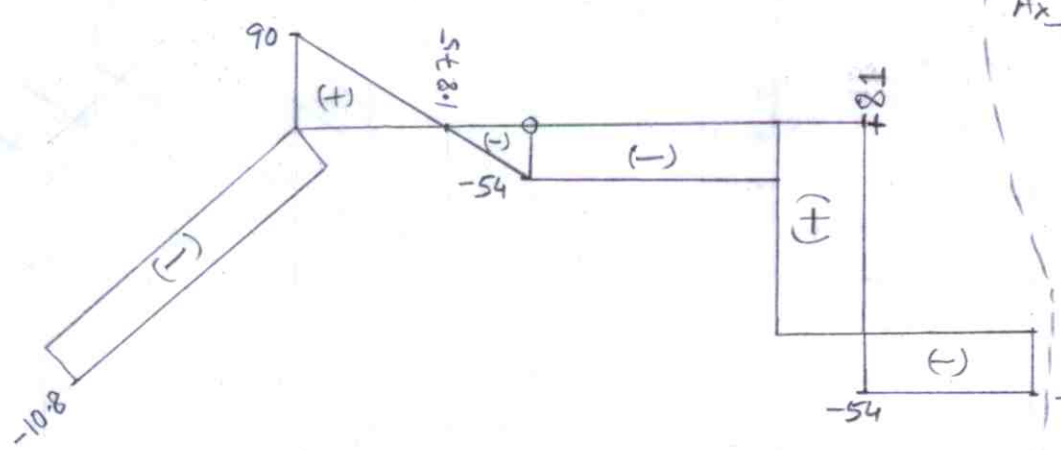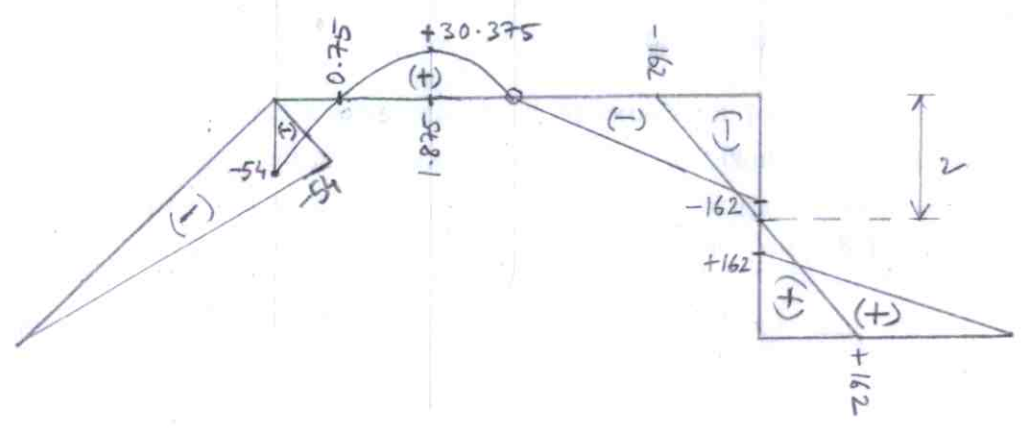
BC:

$N = -A_x = -81$

$V_B = A_y = 90$

$V = V_B - 48x$

$V_c = 90 - 48*3$
$= -54$

CD:

$N = -81, V = -54$

DE:

$V = 81$
$N = -54$
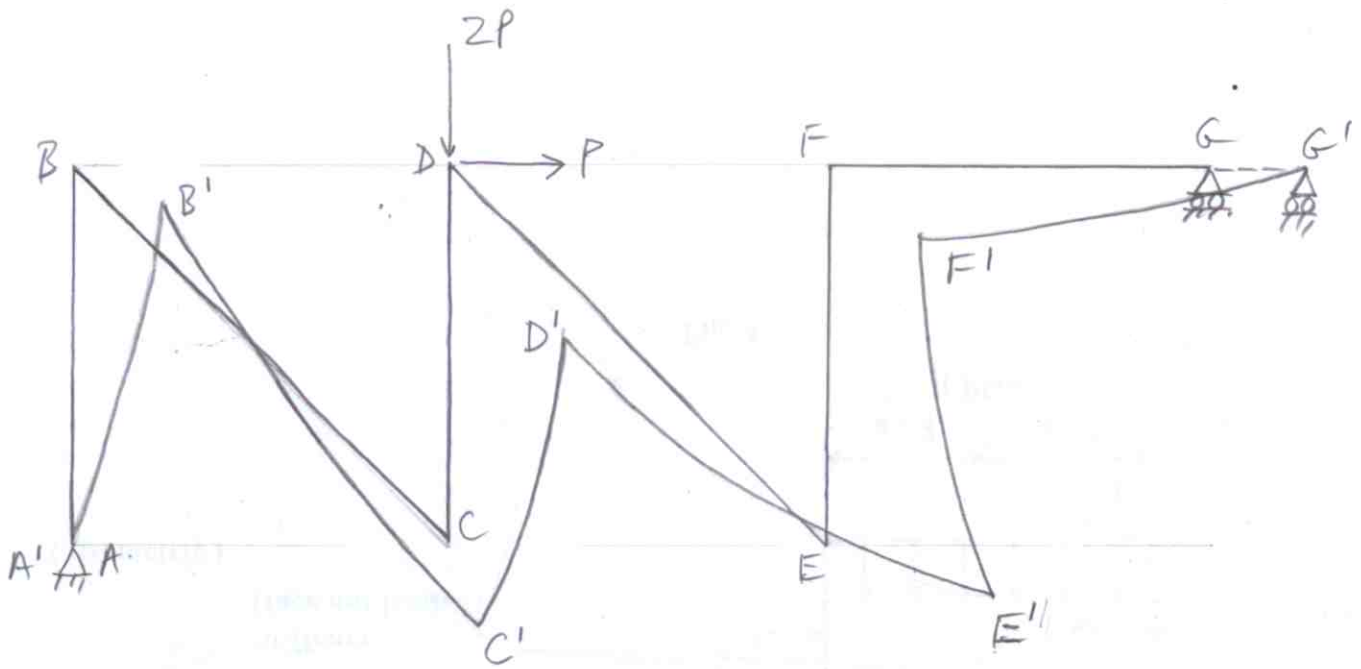
EF:

$N = -81$
$V = -54$

(-) −81

(-) −120.6

A

(-) −81

−54

(-) −81

90

(+) (−) −54 +81

(-)

(-) −10.8

+30.375

(-)

(+) (+)

(+) (+)

−54

+162

−162

+162

−162

+162

0.75

−1.828 ∼

2

Deflected shapes (approximate) for P.3, P.4.    ⑥

2P

B    B'    D →P    F    G    G'

P.4.

48 kN/m

B    C    hinge    D
B'    C'    hinge    D'
inflx    inflx
A    A'    E    F, F'
E'