

Calculation of Support Reaction:-

$$\sum F_x = 0$$

$$R_{ax} - 5 - 10 = 0$$

$$R_{ax} = 15 \text{ kN}$$

$$\sum M_A = 0$$

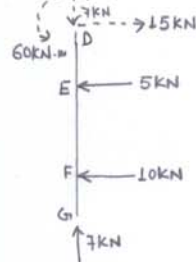
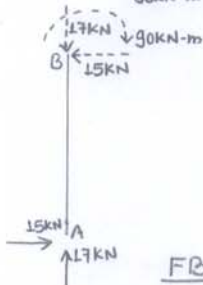
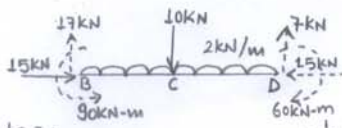
$$7R_{gy} + 10 \times 1 + 5 \times 4 - 10 \times 3 - 2 \times 7 \times \frac{7}{2} = 0$$

$$R_{gy} = 7 \text{ kN}$$

$$\sum F_y = 0$$

$$R_{ay} + R_{gy} - 10 - 2 \times 7 = 0$$

$$R_{ay} = 17 \text{ kN}$$



Calculation of AF, SF and BM:-

For member AB:

$$AF_{AB} = -17 \text{ kN}$$

$$V_{AL} = 0$$

$$V_{AR} = -15 \text{ kN}, V_B = V_{AR} = -15 \text{ kN}$$

$$M_A = 0, M_B = -15 \times 6 = -90 \text{ kN-m}$$

For member BD

$$AF_{BD} = -15 \text{ kN}$$

$$V_{BL} = 0, V_{BR} = 17 \text{ kN}, V_{CL} = V_{BR} - 2 \times 3 = 11 \text{ kN}$$

$$V_{CR} = V_{CL} - 10 = 1 \text{ kN}, V_D = V_{CR} - 2 \times 4 = -7 \text{ kN}$$

$$M_{BL} = 0, M_{BR} = -90 \text{ kN-m}$$

$$M_C = -90 + 17 \times 3 - \frac{2 \times 3 \times 3}{2} = -48 \text{ kN-m}$$

$$M_D = -90 + 17 \times 7 - 2 \times 7 \times \frac{7}{2} - 10 \times 4 = -60 \text{ kN-m}$$

For member DG

$$AF_{DG} = -7 \text{ kN}$$

$$V_{DL} = 0, V_{DR} = 15 \text{ kN}, V_{EL} = V_{DR} = 15 \text{ kN}$$

$$V_{ER} = V_{EL} - 5 = 10 \text{ kN}, V_{FL} = V_{ER} = 10 \text{ kN}$$

$$V_{FR} = V_{FL} - 10 = 0, V_G = 0$$

$$M_{DL} = 0, M_{DR} = -60 \text{ kN-m}$$

$$M_E = -60 + 15 \times 2 = -30 \text{ kN-m}$$

$$M_F = -60 + 15 \times 5 - 5 \times 3 = 0$$

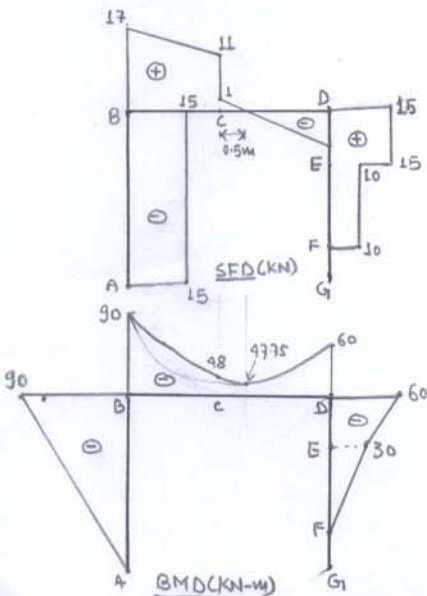
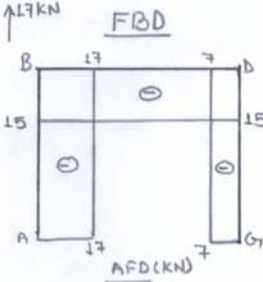
$$M_G = -60 + 15 \times 6 + 5 \times 4 - 10 \times 1 = 0$$

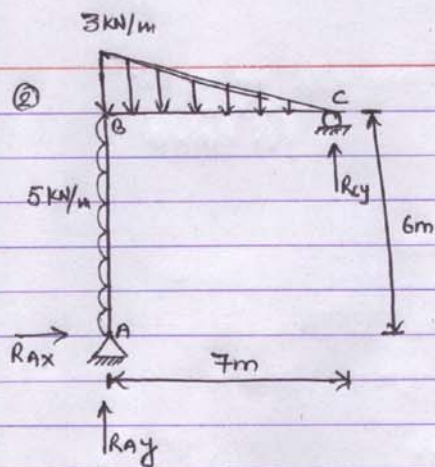
For SF zero point in member BD

$$\frac{x}{1} = \frac{4-x}{7} \Rightarrow x = 0.50 \text{ m}$$

$$\therefore \text{max}^m \text{ BM} = -90 + 17 \times 3.5 - \frac{2 \times 3.5 \times 3.5}{2} - 10 \times 0.5 = -47.75 \text{ kN-m}$$

$$M_{bc, \text{mid}} = -90 + 17 \times 1.5 - \frac{2 \times 1.5 \times 1.5}{2} = -66.75 \text{ kN-m}$$





Calculation of Support Reaction:-

$$\sum F_x = 0$$

$$R_{Ax} + 5 \times 6 = 0$$

$$R_{Ax} = -30 \text{ kN}$$

$$\text{i.e. } R_{Ax} = 30 \text{ kN } (\leftarrow)$$

$$\sum M_A = 0$$

$$7R_{Cy} - \frac{1}{2} \times 7 \times 3 \times \frac{1}{3} \times 7 + 5 \times 6 \times \frac{6}{2} = 0$$

$$R_{Cy} = 16.36 \text{ kN}$$

$$\sum F_y = 0$$

$$R_{Ay} + R_{Cy} - \frac{1}{2} \times 3 \times 7 = 0$$

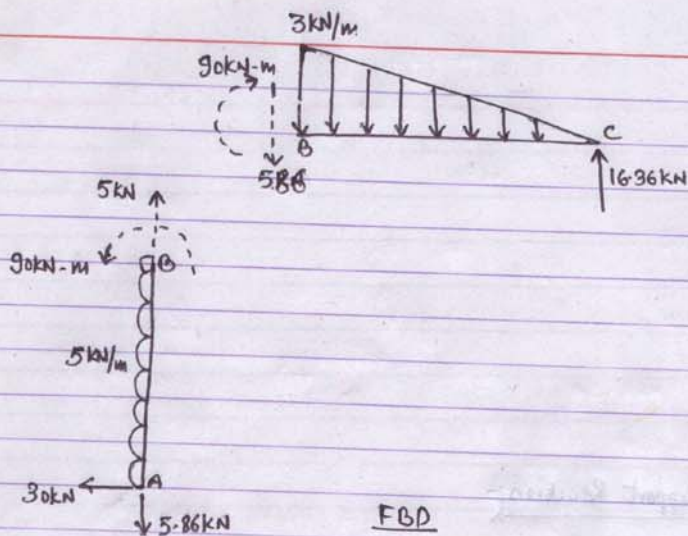
$$R_{Ay} = -5.86 \text{ kN}$$

$$= 5.86 \text{ kN } (\downarrow)$$

Prepared By: Hem Raj Pant

Lecturer

KEC, Kalimati



Calculation of AF, SF and BM:

For member AB

$$AF_{AB} = 5.86 \text{ kN}$$

$$V_{AL} = 0, V_{AR} = 30 \text{ kN}$$

$$V_B = V_{AR} - 5 \times 6 = 0$$

$$M_A = 0, M_B = 30 \times 6 - 5 \times 6 \times \frac{6}{2} = 90 \text{ kN-m}$$

$$M_{AB, \text{mid}} = 30 \times 3 - 5 \times 3 \times \frac{3}{2} = 67.5 \text{ kN-m}$$

For member BC

$$AF_{BC} = 0$$

$$V_{BL} = 0, V_{BR} = -5.86 \text{ kN}$$

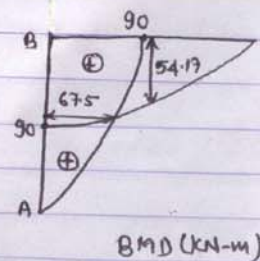
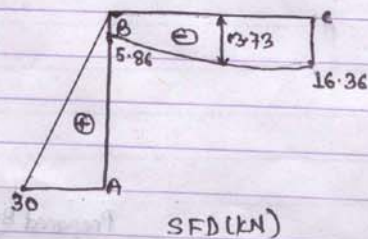
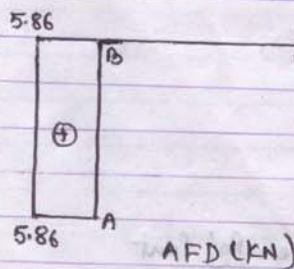
$$V_C = V_{BR} - \frac{1}{2} \times 3 \times 7 = -16.36 \text{ kN}$$

$$M_{BC, \text{mid}} = -5.86 - 1.5 \times \frac{7}{2} - \frac{1}{2} \times 1.5 \times \frac{7}{2} = -13.73 \text{ kN-m}$$

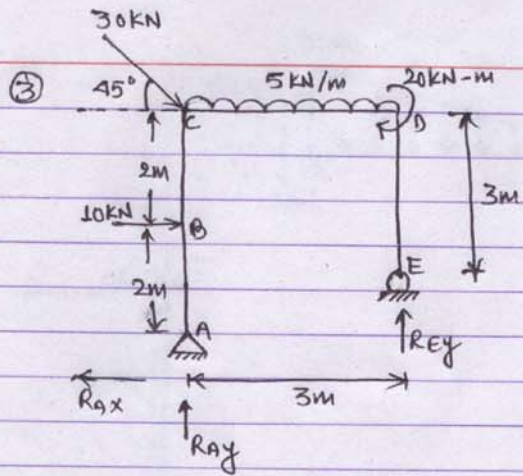
$$M_{BL} = 0, M_{BR} = 90 \text{ kN-m}$$

$$M_C = 90 - 5.86 \times 7 - \frac{1}{2} \times 3 \times 7 \times \frac{2}{3} \times 7 = 0$$

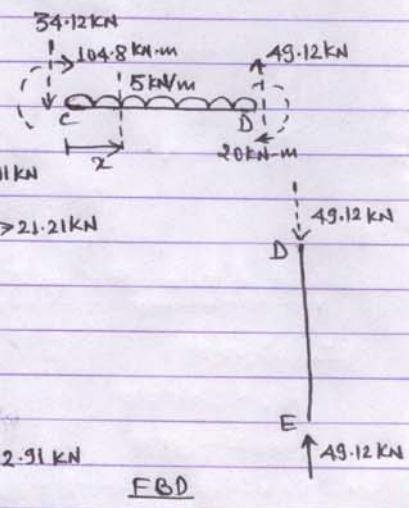
$$M_{BC, \text{mid}} = 90 - 5.86 \times 3.5 - 1.5 \times 3.5 \times \frac{3.5}{2} - \frac{1}{2} \times 1.5 \times 3.5 \times \frac{2}{3} \times 3.5 = 54.17 \text{ kN-m}$$



Prepared By: Hem Raj Pant
KEC, Kalimati



Prepared By: Hem Raj Pant
Lecturer
KEC, Kalimati



Calculation of Reaction:-

$(\rightarrow) \sum F_x = 0$
 $-R_{Ax} + 10 + 30 \cos 45 = 0$
 $R_{Ax} = 31.21 \text{ kN}$

$(\uparrow) \sum M_A = 0$
 $3R_{Ey} - 5 \times 3 \times \frac{3}{2} - 20 - 10 \times 2 - 21.21 \times 4 = 0$
 $R_{Ey} = 49.12 \text{ kN}$

$(\uparrow) \sum F_y = 0$
 $R_{Ay} + 49.12 - 21.21 - 5 \times 3 = 0$
 $R_{Ay} = -12.91 \text{ kN}$
 $= 12.91 \text{ kN} (\downarrow)$

AE, SF and BM calculation:-

For member AC

$A F_{AC} = 12.91 \text{ kN}$
 $V_{AL} = 0, V_{AR} = 31.21 \text{ kN}$
 $V_{BL} = V_{AR} = 31.21 \text{ kN}$
 $V_{BR} = V_{BL} - 10 = 21.21 \text{ kN}$
 $M_A = 0$
 $M_B = 31.21 \times 2 = 62.42 \text{ kN-m}$
 $M_C = 31.21 \times 4 - 10 \times 2 = 104.84 \text{ kN-m}$

For member CD

$A F_{CD} = 0$
 $V_{CL} = 0, V_{CR} = -34.12 \text{ kN}$
 $V_D = V_{CR} - 5 \times 3 = -49.12 \text{ kN}$
 $M_{CL} = 0, M_{CR} = 104.8 \text{ kN-m}$
 $M_D = 104.8 - 34.12 \times 3 - 5 \times 3 \times \frac{3}{2}$
 $= -20 \text{ kN-m}$

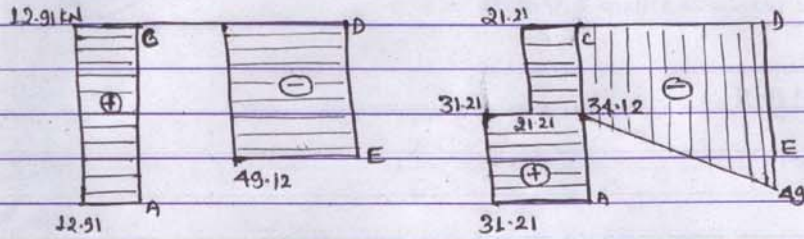
For member DE

$A F_{DE} = -49.12 \text{ kN}$
 $V_D = 0, V_E = 0, M_D = 0, M_E = 0$

For point of contraflexure in member CD:

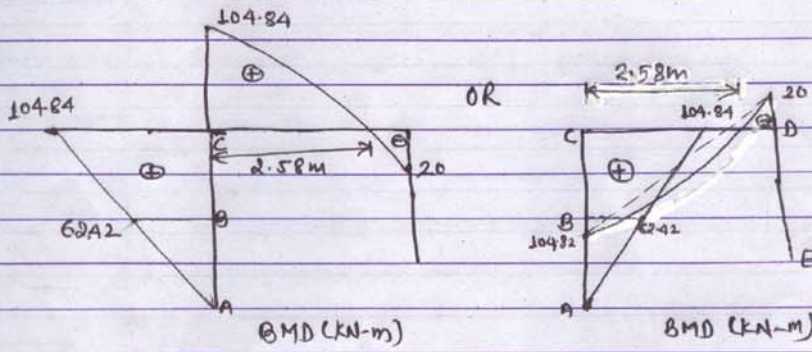
$M_x = 104.8 - 34.12x - 5 \times x \times \frac{x}{2} = 0$
 $\Rightarrow x = 2.58 \text{ m}$

$M_{CD, \text{mid}} = 48.04 \text{ kN-m}$



AFD (kN)

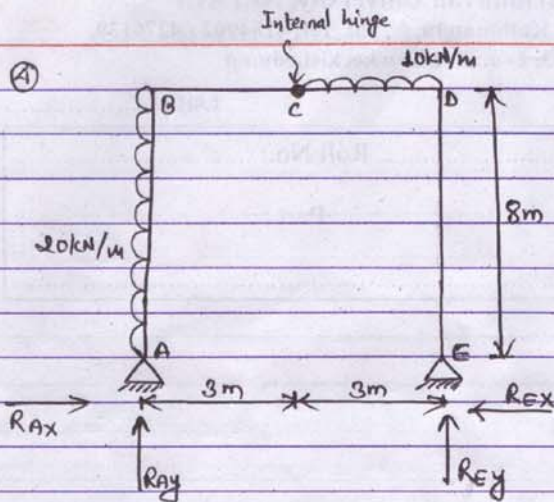
SFD (kN)



BMD (kN-m)

BMD (kN-m)

Prepared By: Hem Raj Pant
Lecturer
K.E.C, Kathimati



Calculation of Support Reaction:-

$$(+\curvearrowright) \sum M_A = 0$$

$$-20 \times 8 \times 4 - 10 \times 3 \times (8 + \frac{3}{2}) + 6 R_{Ey} = 0$$

$$R_{Ey} = 129.17 \text{ kN } (\uparrow)$$

$$(+\uparrow) \sum F_y = 0$$

$$R_{Ay} + R_{Ey} - 10 \times 3 = 0$$

$$R_{Ay} = -99.17 \text{ kN}$$

$$= 99.17 \text{ kN } (\downarrow)$$

$$(+\curvearrowright) \sum M_{C, \text{Left}} = 0$$

$$8 R_{Ax} + 20 \times 8 \times 4 + (-99.17) \times 3 = 0$$

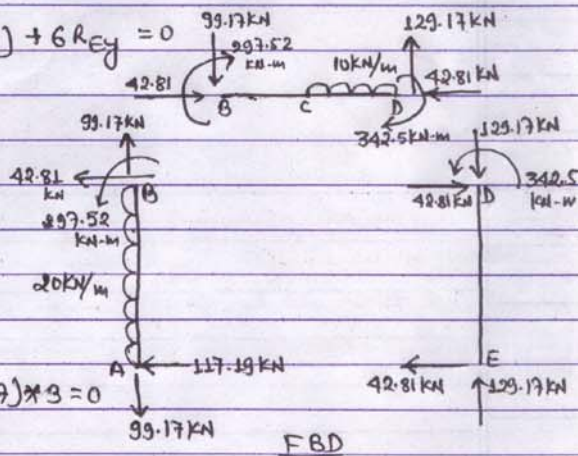
$$R_{Ax} = -117.19 \text{ kN}$$

$$= 117.19 \text{ kN } (\leftarrow)$$

$$(\rightarrow) \sum F_x = 0$$

$$R_{Ax} - R_{Ex} + 20 \times 8 = 0$$

$$R_{Ex} = -117.19 + 20 \times 8 = 42.81 \text{ kN } (\leftarrow)$$



Prepared By: Hem Raj Pant
Lecturer
KEC, Kalimati

Calculation of AF, SF & BM:

For member AB

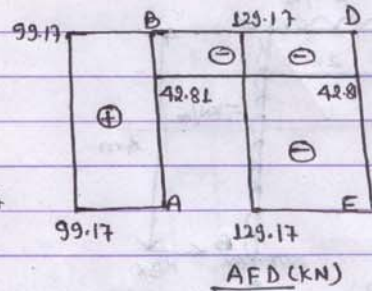
$$AF_{AB} = 99.17 \text{ kN}$$

$$V_{AL} = 0, V_{AR} = 117.19 \text{ kN}$$

$$M_A = 0, M_B = 117.19 \times 8 - 20 \times 8 \times 4 = 297.52 \text{ kN-m}$$

$$V_B = V_{AR} - 8 \times 20 = -42.81 \text{ kN}$$

$$M_{AB, \text{mid}} = 117.19 \times 4 - 20 \times 4 \times 2 = 308.76 \text{ kN-m}$$



Calculation for member BD

$$AF_{BD} = -42.81 \text{ kN}$$

$$V_{BL} = 0, V_{BR} = -99.17 \text{ kN}$$

$$V_C = V_{BR} = -99.17 \text{ kN}$$

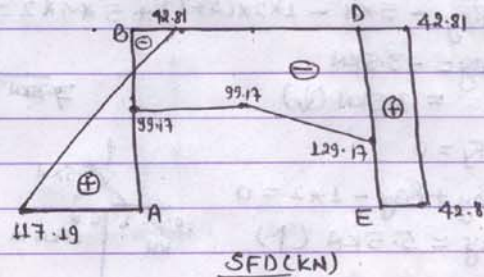
$$V_D = V_C - 10 \times 3 = -129.17 \text{ kN}$$

$$M_{BL} = 0, M_{BR} = 297.52 \text{ kN-m}$$

$$M_C = 297.52 - 99.17 \times 3 = 0$$

$$M_D = 297.52 - 99.17 \times 6 - 10 \times 3 \times \frac{3}{2} = -342.5 \text{ kN-m}$$

$$M_{CD, \text{mid}} = +297.52 - 99.17 \times (3 + \frac{3}{2}) - 10 \times 1.5 \times \frac{1.5}{2} = -160 \text{ kN-m}$$



For member DE :-

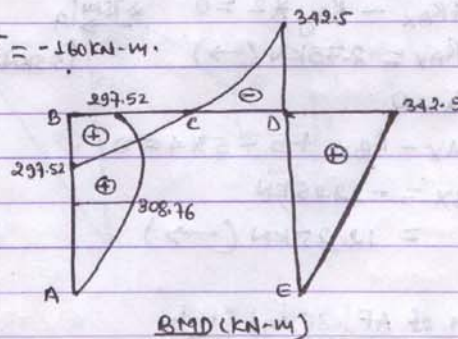
$$AF_{DE} = -129.17 \text{ kN}$$

$$V_{DL} = 0, V_{DR} = 42.81 \text{ kN}$$

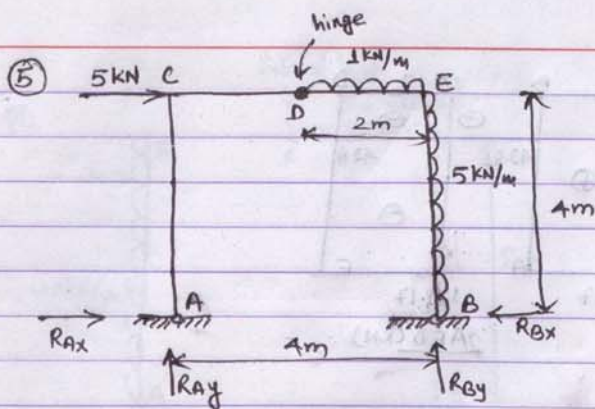
$$V_E = 42.81 \text{ kN}$$

$$M_{DL} = 0, M_{DR} = -342.5 \text{ kN-m}$$

$$M_E = -342.5 + 42.81 \times 8 = 0$$



Prepared By: Hem Raj Pant
Lecturer
KEC, Kalimati



$$(+\curvearrowright) \sum M_A = 0$$

$$4R_{By} - 5 \times 4 - 1 \times 2 \times (2+1) + 5 \times 4 \times 2 = 0$$

$$R_{By} = -3.5 \text{ kN} \\ = 3.5 \text{ kN } (\downarrow)$$

$$(+\uparrow) \sum F_y = 0$$

$$R_{Ay} + R_{By} - 1 \times 2 = 0$$

$$R_{Ay} = 5.5 \text{ kN } (\uparrow)$$

$$(+\curvearrowright) \sum M_{D, \text{Left}} = 0$$

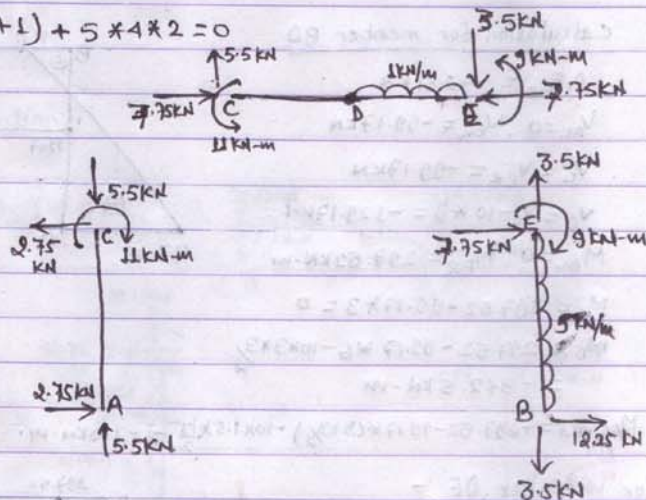
$$4R_{Ax} - R_{Ay} \times 2 = 0$$

$$R_{Ax} = 2.75 \text{ kN } (\rightarrow)$$

$$(\rightarrow) \sum F_x = 0$$

$$R_{Ax} - R_{Bx} + 5 - 5 \times 4 = 0$$

$$R_{Bx} = -12.25 \text{ kN} \\ = 12.25 \text{ kN } (\rightarrow)$$



Calculation of AF, SF and BM:-

For member AC

$$AF_{AC} = -5.5 \text{ kN}$$

$$V_{AL} = 0, V_{AR} = -2.75 \text{ kN}$$

$$V_C = -2.75 \text{ kN}, M_A = 0$$

$$M_C = -2.75 \times 4 = -11 \text{ kN-m}$$

Prepared By: Hem Raj Pant
KEC, Kalimati

For member CE

$$AF_{CE} = -7.75 \text{ kN}$$

$$V_{CL} = 0 \text{ kN}, V_{CR} = 5.5 \text{ kN}$$

$$V_D = V_R = 5.5 \text{ kN}$$

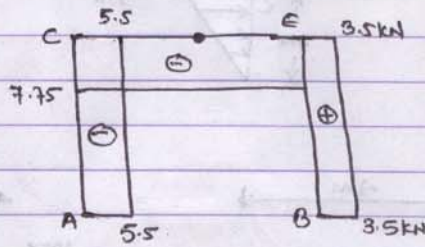
$$V_E = V_D - 1 \times 2 = 3.5 \text{ kN}$$

$$M_{CL} = 0, M_{CR} = -11 \text{ kN}\cdot\text{m}$$

$$M_D = -11 + 5.5 \times 2 = 0$$

$$M_E = -11 + 5.5 \times 4 - 1 \times 2 \times 1 = 9 \text{ kN}\cdot\text{m}$$

$$M_{DE, \text{mid}} = -11 + 5.5 \times 3 - 1 \times 1 \times 1 = 5 \text{ kN}\cdot\text{m}$$



AFD (kN)

For member EB

$$AF_{EB} = 3.5 \text{ kN}$$

$$V_{EL} = 0, V_{ER} = 7.75 \text{ kN}$$

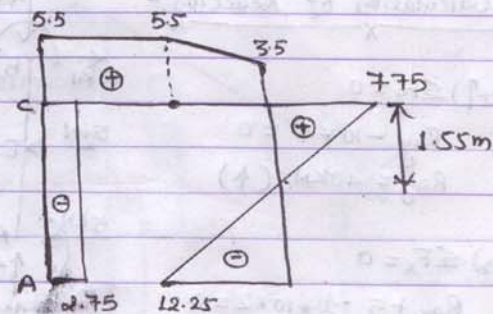
$$M_{EL} = 0, M_{ER} = 9 \text{ kN}\cdot\text{m}$$

$$M_B = 9 + 7.75 \times 4 - 5 \times 4 \times 2 = 0$$

$$V_{BL} = V_{ER} - 5 \times 4 = -12.25 \text{ kN}$$

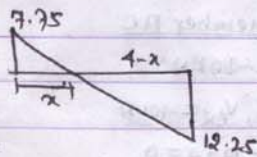
$$V_{BR} = V_{BL} + 12.25 = 0$$

$$M_{EB, \text{mid}} = 7.75 \times 2 + 9 - 5 \times 2 \times 1 = 14.5 \text{ kN}\cdot\text{m}$$



SFD (kN)

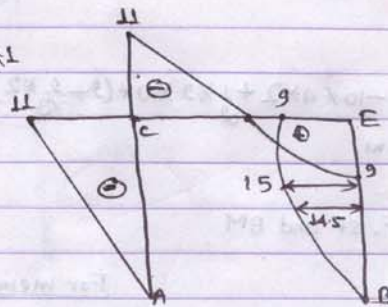
For SF zero point



$$\frac{x}{7.75} = \frac{4-x}{12.25}$$

$$x = 1.55 \text{ m}$$

$$\therefore \text{max}^m \text{ BM} = 9 + 7.75 \times 1.55 - 5 \times 1.55^2 = 15 \text{ kN}\cdot\text{m}$$

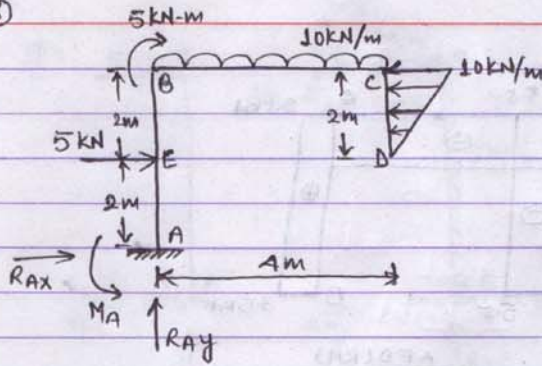


BMD (kN·m)

prepared By: Hem Raj Pout
Lecturer
KEC, Kalimati

6

Prepared By: Hemraj Paut
Lecturer
KEG, Kalimati

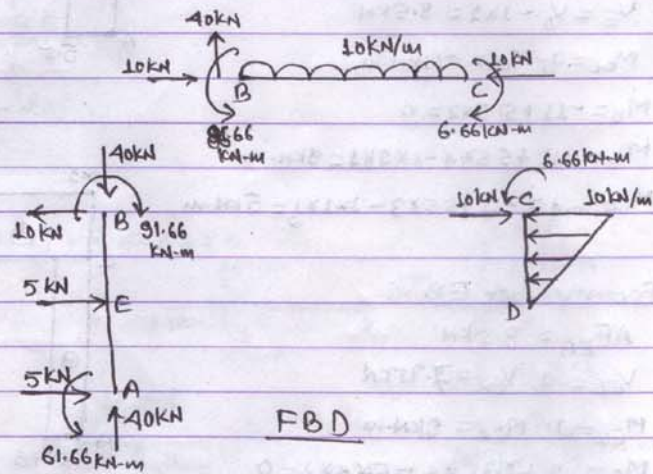


Calculation of Reaction:-

$$\begin{aligned} \uparrow \sum F_y &= 0 \\ R_{ay} - 10 \times 4 &= 0 \\ R_{ay} &= 40 \text{ kN } (\uparrow) \end{aligned}$$

$$\begin{aligned} \rightarrow \sum F_x &= 0 \\ R_{ax} + 5 - \frac{1}{2} \times 10 \times 2 &= 0 \\ R_{ax} &= 5 \text{ kN } (\rightarrow) \end{aligned}$$

$$\begin{aligned} \curvearrowright \sum M_A &= 0 \\ M_A - 5 - 5 \times 2 - 10 \times 4 \times 2 + \frac{1}{2} \times 2 \times 10 \times (2 + \frac{2}{3} \times 2) &= 0 \\ M_A &= 61.66 \text{ kN-m} \end{aligned}$$



Calculation of AF, SF and BM

For member AB

$$\begin{aligned} AF_{AB} &= -40 \text{ kN} \\ V_{AL} &= 0, V_{AR} = -5 \text{ kN} \\ M_{AL} &= 0, M_{AR} = -61.66 \text{ kN-m} \\ V_{EL} &= V_{AR} = -5 \text{ kN} \\ V_{ER} &= V_{EL} - 5 = -10 \text{ kN} \\ V_B &= V_{ER} = -10 \text{ kN} \\ M_E &= -61.66 - 5 \times 2 = -71.66 \text{ kN-m} \\ M_B &= -61.66 - 5 \times 4 - 5 \times 2 = -91.66 \text{ kN-m} \end{aligned}$$

For member BC

$$\begin{aligned} AF_{BC} &= -10 \text{ kN} \\ V_{BL} &= 0, V_{BR} = 40 \text{ kN} \\ V_C &= V_{BR} - 10 \times 4 = 0 \\ M_{BL} &= 0, M_{BR} = -96.66 \text{ kN-m} \\ M_C &= -96.66 + 40 \times 4 - 10 \times 4 \times 2 \\ &= -36.66 \text{ kN-m} \\ M_{BC, \text{mid}} &= -96.66 + 40 \times 2 - 10 \times 2 \times 2 \\ &= -36.66 \text{ kN-m} \end{aligned}$$

For member CD

$$AF_{CD} = 0$$

$$V_{CL} = 0, V_{CR} = 10 \text{ kN}$$

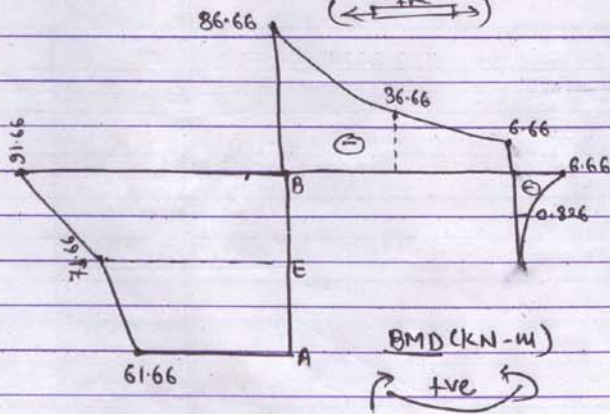
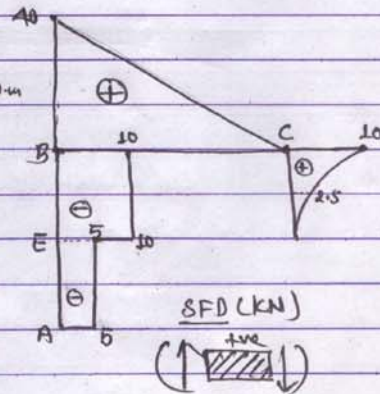
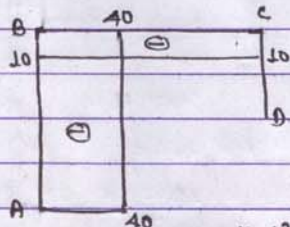
$$M_{CL} = 0, M_{CR} = -6.66 \text{ kN-m}$$

$$V_D = V_{CR} - \frac{1}{2} \times 2 \times 10 = 0$$

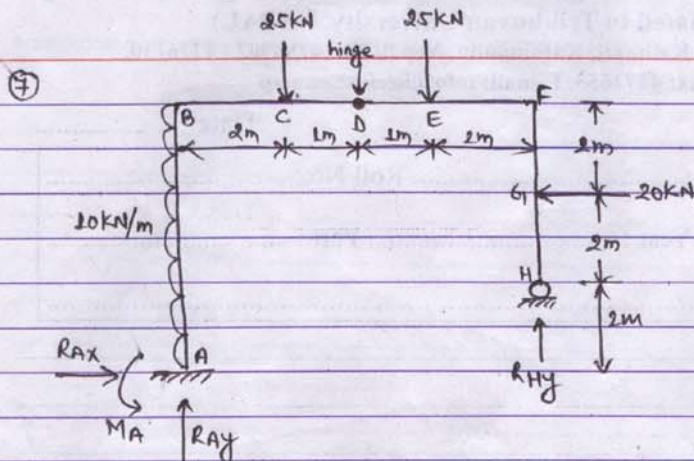
$$M_D = -6.66 + 10 \times 2 - \frac{1}{2} \times 2 \times 10 \times \frac{2}{3} \times 2 = 0$$

$$V_{CD, \text{mid}} = 10 - 5 \times 1 - \frac{1}{2} \times 1 \times 5 = 2.5 \text{ kN}$$

$$M_{CD, \text{mid}} = -6.66 + 10 \times 1 - 5 \times 1 \times \frac{1}{2} - \frac{1}{2} \times 1 \times 5 \times \frac{2}{3} \times 1 = -0.826 \text{ kN-m}$$



Prepared By: Hem Raj Pant
Lecturer
KEC, Kalimati



$$(\uparrow) \sum M_{D, \text{right}} = 0$$

$$3 R_{Hy} - 25 \times 1 - 20 \times 2 = 0$$

$$R_{Hy} = 21.67 \text{ kN } (\uparrow)$$

$$(\uparrow) \sum F_y = 0$$

$$R_{Ay} + R_{Hy} - 25 - 25 = 0$$

$$R_{Ay} = 28.33 \text{ kN } (\uparrow)$$

$$(\rightarrow) \sum F_x = 0$$

$$R_{Ax} + 10 \times 6 - 20 = 0$$

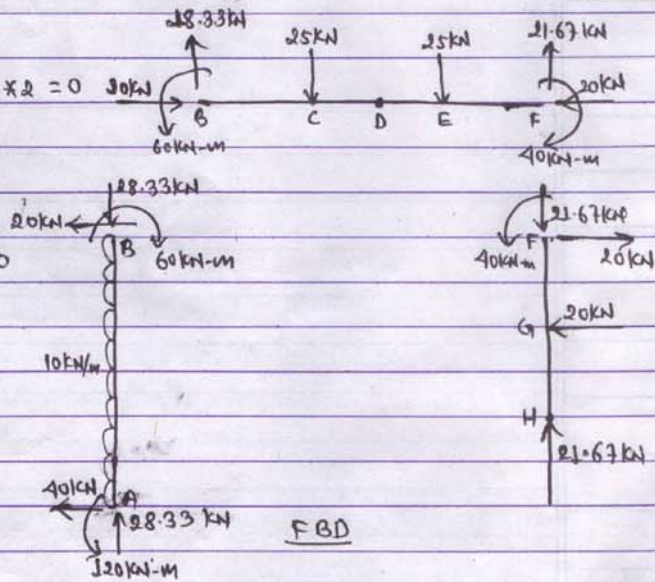
$$R_{Ax} = -40 \text{ kN}$$

$$\text{i.e. } R_{Ax} = 40 \text{ kN } (\leftarrow)$$

$$(\rightarrow) \sum M_{D, \text{left}} = 0$$

$$M_A + 10 \times 6 \times 3 + 25 \times 1 - 28.33 \times 3 + 6 \times (-40) = 0$$

$$M_A = 120 \text{ kN-m } (\curvearrowright)$$



Prepared By: Hem Raj Pant
Lecturer
KEE, Kalimati

Calculation of AF, SF and BM:-

For member AB

$$AF_{AB} = -28.33 \text{ kN}$$

$$V_{AL} = 0, V_{AR} = 40 \text{ kN}$$

$$V_B = V_{AR} - 10 \times 6 = -20 \text{ kN}$$

$$M_{AL} = 0, M_{AR} = -120 \text{ kN-m}$$

$$M_B = -120 + 40 \times 6 - 10 \times 6 \times 3 \\ = -60 \text{ kN-m}$$

$$M_{AB, \text{mid}} = -120 + 40 \times 3 - 10 \times 3 \times 1.5 \\ = -45 \text{ kN-m}$$

For member BF

$$AF_{BF} = -20 \text{ kN}$$

$$V_{BL} = 0, V_{BR} = 28.33 \text{ kN}$$

$$V_{CL} = V_{BR} = 28.33 \text{ kN}$$

$$V_{CR} = V_{CL} - 25 = 3.33 \text{ kN}$$

$$V_{EL} = 3.33 \text{ kN}$$

$$V_{ER} = V_{EL} - 25 = -21.67 \text{ kN}$$

$$V_F = V_{ER} = -21.67 \text{ kN}$$

$$M_{BL} = 0, M_{BR} = -60 \text{ kN-m}$$

$$M_C = -60 + 28.33 \times 2 = -3.33 \text{ kN-m}$$

$$M_D = -60 + 28.33 \times 3 - 25 \times 1 = 0$$

$$M_E = -60 + 28.33 \times 4 - 25 \times 2 = 3.33 \text{ kN-m}$$

$$M_F = -60 + 28.33 \times 6 - 25 \times 4 - 25 \times 2 = -40 \text{ kN-m}$$

For member FH:-

$$AF_{FH} = -21.67 \text{ kN}$$

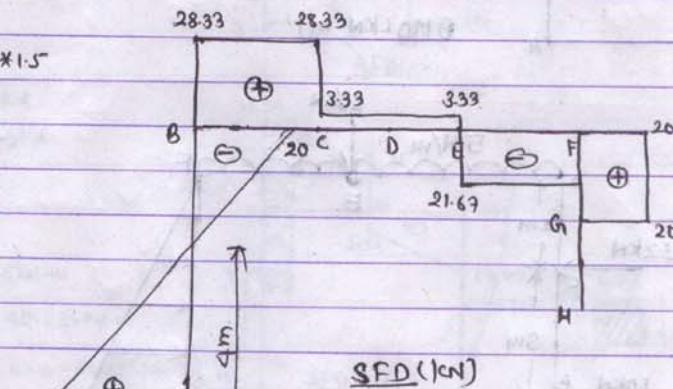
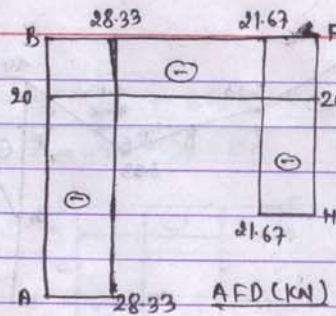
$$V_{FL} = 0, V_{FR} = 20 \text{ kN}$$

$$V_{GL} = V_{FR} = 20 \text{ kN}$$

$$V_{GR} = V_{GL} - 20 = 0$$

$$V_H = 0, M_{FL} = 0, M_{FR} = -40 \text{ kN-m}$$

$$M_G = -40 + 20 \times 2 = 0, M_H = -40 + 20 \times 4 - 20 \times 2 = 0$$



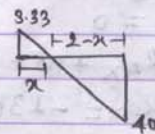
For zero SF point in member AB

$$\frac{x}{40} = \frac{6-x}{20} \Rightarrow x = 4 \text{ m}$$

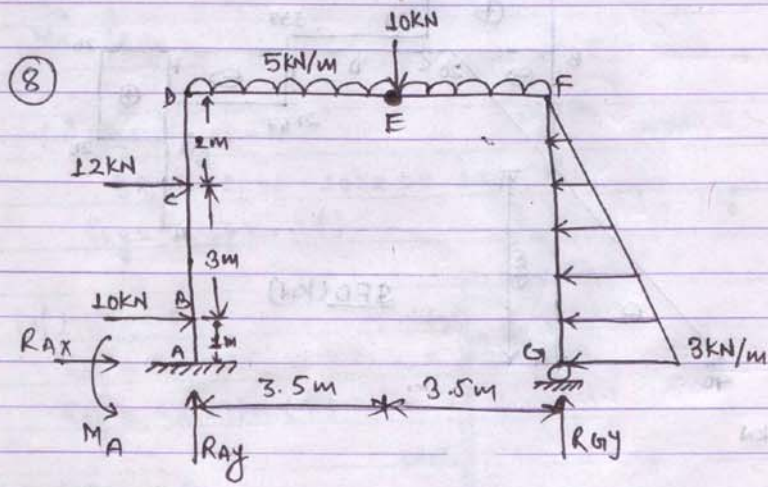
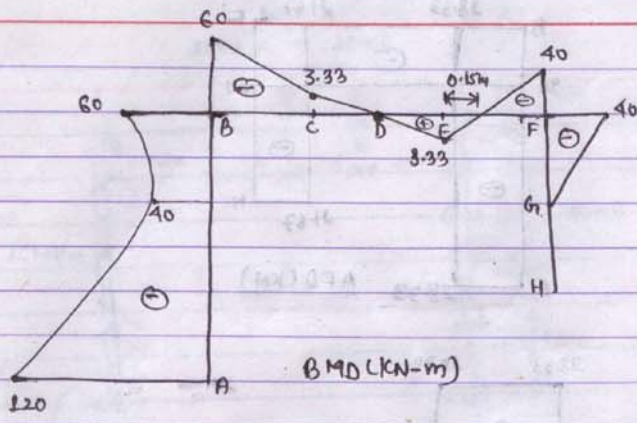
$$\therefore \text{max BM} = -120 + 40 \times 4 - 10 \times 4 \times \frac{4}{2} \\ = -40 \text{ kN-m}$$

For point of contraflexure in member EF

$$\frac{x}{3.33} = \frac{2-x}{40} \Rightarrow x = 0.15 \text{ m}$$



Prepared By: Hem Raj Pant
Lecturer
KEC, Kalimati

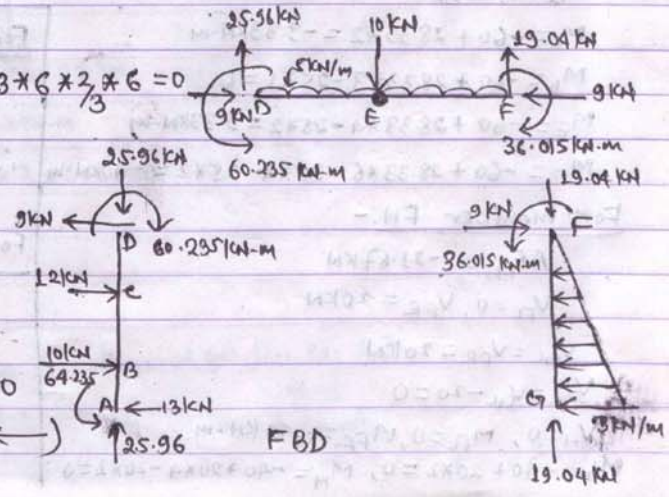


Calculation of Reaction :-

$(\uparrow) \sum M_{E, \text{right}} = 0$
 $3.5 R_{Gy} - 5 \times 3.5 \times 3.5 - \frac{1}{2} \times 3 \times 6 \times \frac{2}{3} \times 6 = 0$
 $R_{Gy} = 19.04 \text{ kN} (\uparrow)$

$(\uparrow) \sum F_y = 0$
 $R_{Ay} + R_{Gy} - 10 - 5 \times 7 = 0$
 $R_{Ay} = 25.96 \text{ kN} (\uparrow)$

$(\rightarrow) \sum F_x = 0$
 $R_{Ax} + 10 + 12 - \frac{1}{2} \times 3 \times 6 = 0$
 $R_{Ax} = -13 \text{ kN} = 13 \text{ kN} (\leftarrow)$



$$(+^{\circ}) \sum M_E, \text{left} = 0$$

$$M_A - 3.5R_{Ax} + 10 \times 5 + 12 \times 2 + 5 \times 3.5 \times \frac{3.5}{2} + 6R_{Ax} = 0$$

$$\text{or } M_A - 3.5 \times 25.96 + 50 + 24 + 30.625 + 6 \times (-13) = 0$$

$$\Rightarrow M_A = 64.235 \text{ kN-m (}\odot\text{)}$$

Calculation of AF, SF and BM

For member AD

$$AF_{AD} = -25.96 \text{ kN}$$

$$V_{AL} = 0, V_{AR} = 13 \text{ kN}$$

$$V_{DL} = V_{AR} = 13 \text{ kN}, V_{DR} = V_{DL} - 10 = 3 \text{ kN}$$

$$V_{CL} = V_{DR} = 3 \text{ kN}, V_{CR} = V_{CL} - 2 = 1 \text{ kN}$$

$$V_D = V_{CR} = 1 \text{ kN}, M_{AL} = 0$$

$$M_{AR} = -64.235 \text{ kN-m}$$

$$M_B = -64.235 + 13 \times 1 = -51.235 \text{ kN-m}$$

$$M_C = -64.235 + 13 \times 4 - 10 \times 3 = -42.235 \text{ kN-m}$$

$$M_D = -64.235 + 13 \times 6 - 10 \times 5 - 12 \times 2 = -60.235 \text{ kN-m}$$

For member DF:-

$$AF_{DF} = -9 \text{ kN}$$

$$V_{DL} = 0, V_{DR} = 25.96 \text{ kN}$$

$$V_{EL} = 25.96 - 5 \times 3.5 = 8.46 \text{ kN}$$

$$V_{ER} = V_{EL} - 10 = -1.54 \text{ kN}$$

$$V_F = V_{ER} - 5 \times 3.5 = -19.04 \text{ kN}$$

$$M_{DL} = 0, M_{DR} = -60.235 \text{ kN-m}$$

$$M_E = -60.235 + 25.96 \times 3.5 - 5 \times 3.5 \times \frac{3.5}{2} = 0$$

$$M_F = -60.235 + 25.96 \times 7 - 5 \times 7 \times \frac{7}{2} - 10 \times 3.5 = -36.015 \text{ kN-m}$$

For member FG

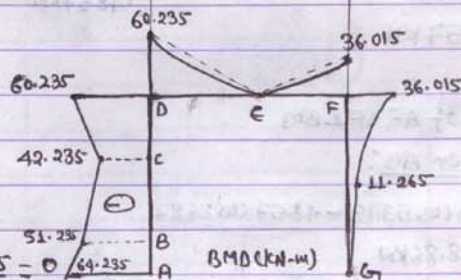
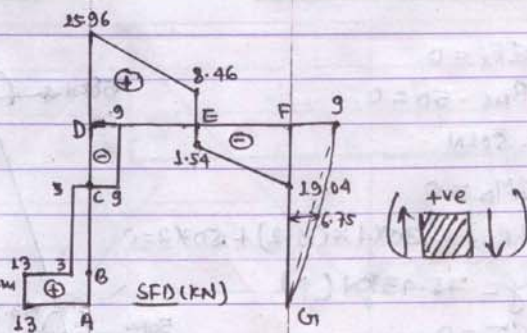
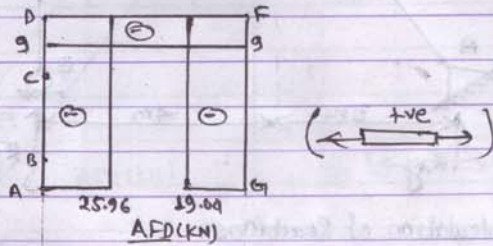
$$AF_{FG} = -19.04 \text{ kN}, V_{FL} = 0, V_{FR} = 9 \text{ kN}$$

$$V_G = 9 - 1 \times 3 \times 6 = 0$$

$$M_{FL} = 0, M_{FR} = -36.015 \text{ kN-m}$$

$$M_G = -36.015 + 9 \times 6 - 1 \times 3 \times 6 \times \frac{6}{2} = 0$$

$$V_{FG, \text{mid}} = 9 - \frac{1}{2} \times 3 \times 1.5 = 6.75 \text{ kN}, M_{FG, \text{mid}} = -36.015 + 9 \times 3 - \frac{1}{2} \times 3 \times 1.5 \times \frac{1}{2} \times 3 = -11.265 \text{ kN-m}$$



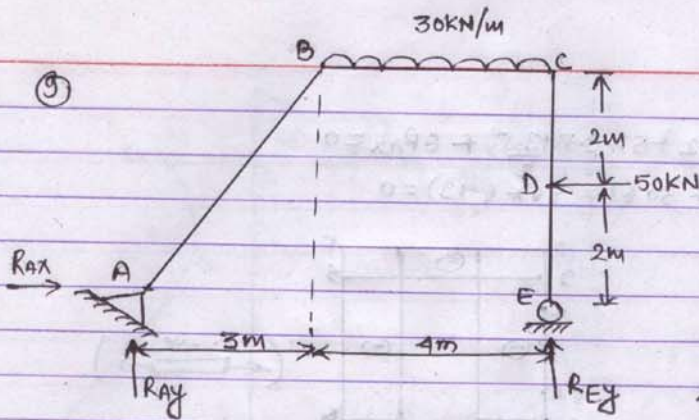
$$M_{DE, \text{mid}} = -60.235 + 25.96 \times \frac{3.5}{2} - 5 \times \left(\frac{3.5}{2}\right) \times \frac{1}{2} \times \left(\frac{3.5}{2}\right)$$

$$= -22.461 \text{ kN-m}$$

$$M_{EF, \text{mid}} = -60.235 + 25.96 \times 5.25 - 5 \times 5.25 \times \frac{5.25}{2} - 10 \times 1.75$$

$$= -10.35 \text{ kN-m}$$

Prepared By: Hew Raj Pant
Lecturer
KJEC, Kalmati



Calculation of Reactions:

$$(\rightarrow) \sum F_x = 0$$

$$R_{ax} - 50 = 0$$

$$R_{ax} = 50 \text{ kN}$$

$$(\uparrow) \sum M_A = 0$$

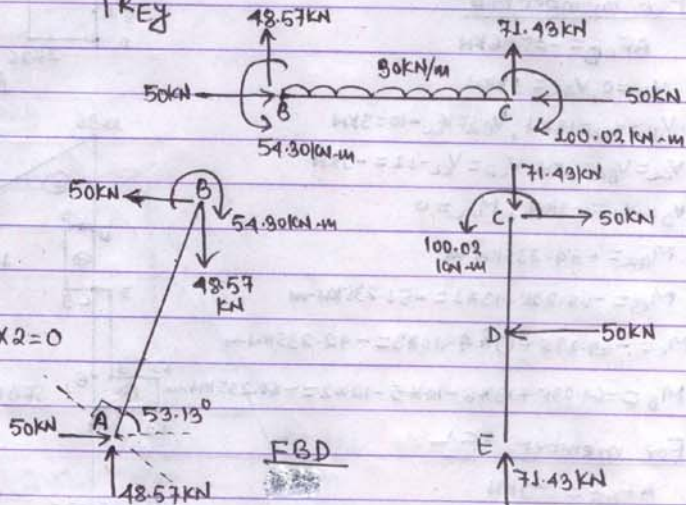
$$7R_{ey} - 30 \times 4 \times (3+2) + 50 \times 2 = 0$$

$$R_{ey} = 71.43 \text{ kN} (\uparrow)$$

$$(\rightarrow) \sum F_y = 0$$

$$R_{ay} + R_{ey} - 30 \times 4 = 0$$

$$R_{ay} = 48.57 \text{ kN}$$



Calculation of AF, SF & BM

For member AB:

$$AF_{AB} = -50 \cos 53.13 - 48.57 \cos 36.87$$

$$= -68.86 \text{ kN}$$

$$V_{AL} = 0, V_{AR} = -50 \sin 53.13 + 48.57 \sin 36.87$$

$$= -10.86 \text{ kN}$$

$$V_B = -10.86 \text{ kN}$$

$$M_A = 0, M_B = -50 \sin 53.13 \times 5 + 48.57 \sin 36.87 \times 5$$

$$= -54.30 \text{ kN-m}$$

$$\text{OR } M_B = -10.86 \times 5 = -54.30 \text{ kN-m}$$

For member BC

$$AF_{BC} = -50 \text{ kN}$$

$$V_{BL} = 0, V_{BR} = 48.57 \text{ kN}$$

$$V_C = 48.57 - 30 \times 4 = -71.43 \text{ kN}$$

$$M_{BL} = 0, M_{BR} = -54.30 \text{ kN-m}$$

$$M_C = -54.3 + 48.57 \times 4 - 30 \times 4 \times 2$$

$$= -100.02 \text{ kN-m}$$

$$M_{C, \text{mid}} = -54.3 + 48.57 \times 2$$

$$- 30 \times 2 \times 1 = -17.16 \text{ kN-m}$$

For member CE:

$$A_{FE} = -71.43 \text{ kN}$$

$$V_{CL} = 0, V_{CE} = 50 \text{ kN}$$

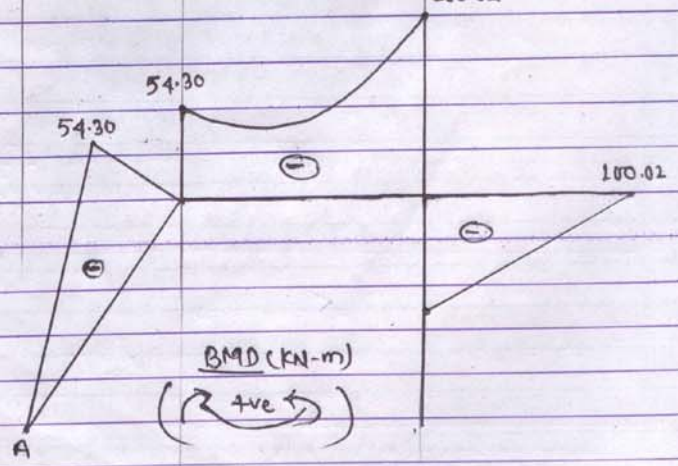
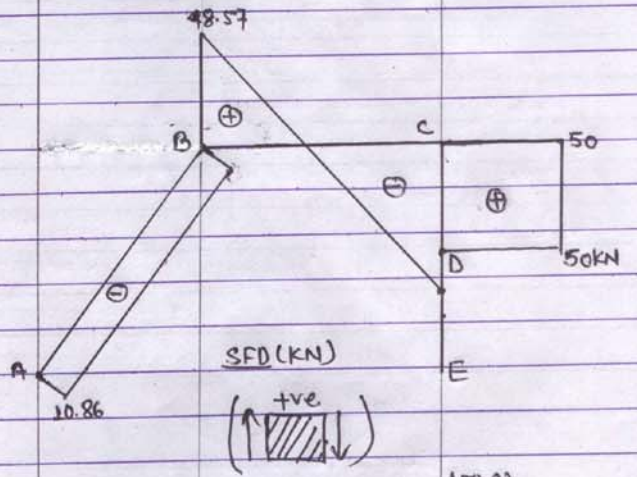
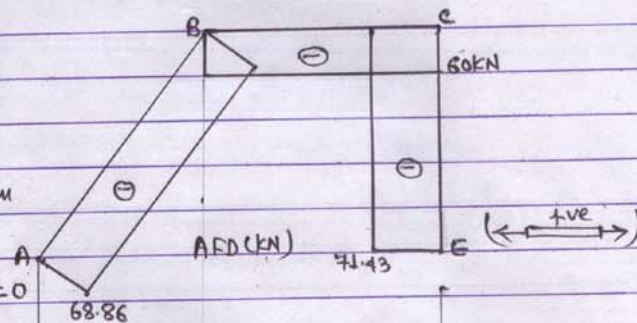
$$V_{DL} = 50 \text{ kN}, V_{DR} = 0$$

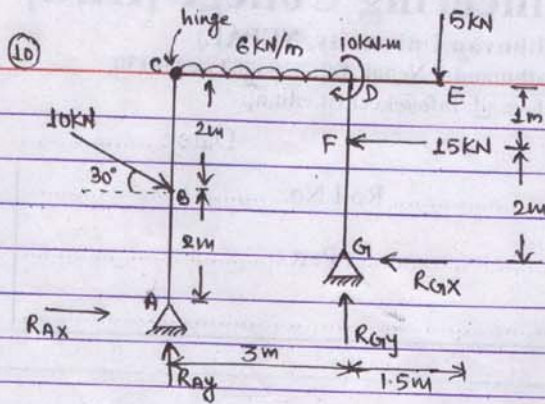
$$V_E = 0$$

$$M_{CL} = 0, M_{CE} = -100.02 \text{ kNm}$$

$$M_D = -100.02 + 50 \times 2 = 0$$

$$M_E = -100.02 + 50 \times 4 - 50 \times 2 = 0$$





Calculation of AF, SF & BM :-

For member AC

$$AF_{AB} = -13.84 \text{ kN}$$

$$AF_{BC} = -13.84 + 10 \sin 30 \\ = -8.84 \text{ kN}$$

$$V_{AL} = 0, V_{AR} = 4.33 \text{ kN}$$

$$V_{BL} = 4.33 \text{ kN}, V_{BR} = -4.33 \text{ kN}$$

$$V_C = -4.33 \text{ kN}$$

$$M_A = 0, M_B = 4.33 \times 2 = 8.66 \text{ kN-m}$$

$$M_C = 4.33 \times 4 - 10 \cos 30 \times 2 \\ = 0$$

For member CD

$$AF_{CD} = 4.33 \text{ kN}$$

$$V_L = 0, V_{CR} = 8.84 \text{ kN}$$

$$V_D = 8.84 - 6 \times 3 = -9.16 \text{ kN}$$

$$M_C = 0$$

$$M_D = 8.84 \times 3 - 6 \times 3 \times \frac{3}{2} \\ = +0.48 \text{ kN-m}$$

For member DE

$$V_{ER} = 0, V_{DL} = 5 \text{ kN}$$

$$V_D = 5 \text{ kN}$$

$$AF_{DE} = 0$$

$$M_E = 0, M_D = -5 \times 1.5 \\ = -7.5 \text{ kN-m}$$

Calculation of Reactions:-

$$(+\curvearrowright) \sum M_C, \text{ left} = 0$$

$$4 R_{Ax} + 10 \cos 30 \times 2 = 0$$

$$R_{Ax} = -4.33 \text{ kN} = 4.33 \text{ kN} (\leftarrow)$$

$$(\pm \rightarrow) \sum F_x = 0$$

$$R_{Ax} - R_{Gx} + 10 \cos 30 - 15 = 0$$

$$R_{Gx} = -10.67 \text{ kN} = 10.67 \text{ kN} (\rightarrow)$$

$$(+\curvearrowright) \sum M_C, \text{ right} = 0$$

$$-15 \times 1 - 6 \times 3 \times 1.5 - 10 - 5 \times 4.5 + 3 R_{Gy} - 3 R_{Gx} = 0$$

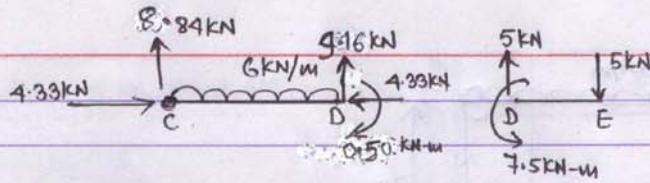
$$\text{or } -15 - 27 - 10 - 22.5 + 3 R_{Gy} - 3 \times (-10.67) = 0$$

$$\therefore R_{Gy} = 14.163 \text{ kN} (\uparrow)$$

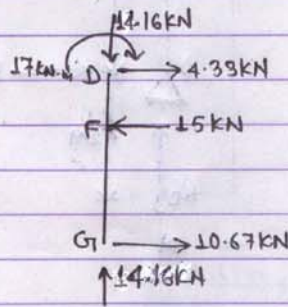
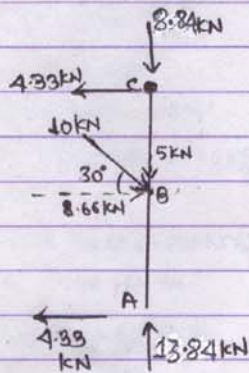
$$(+\uparrow) \sum F_y = 0$$

$$R_{Ay} + R_{Gy} - 6 \times 3 - 5 - 10 \sin 30 = 0$$

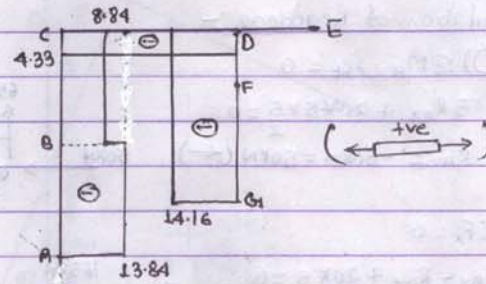
$$R_{Ay} = 13.84 \text{ kN} (\uparrow)$$



Prepared By: Hen Rij Pant
Lecturer
KEC, Kalimati



FBD



For member DG

$$AF_{DG} = -14.16 \text{ kN}$$

$$V_{DL} = 0, V_{DR} = 4.33 \text{ kN}$$

$$M_{DL} = 0, M_{DR} = 17 \text{ kN-m}$$

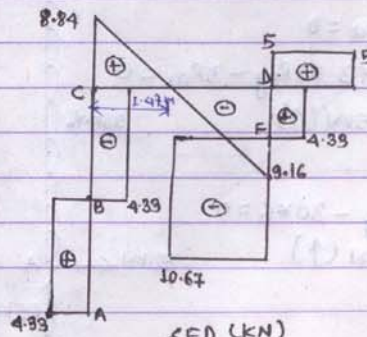
$$V_{FL} = 4.33 \text{ kN}, V_{FR} = 4.33 - 15 = -10.67 \text{ kN}$$

$$V_{GE} = -10.67 \text{ kN}$$

$$M_F = 4.33 \times 1 + 17 = 21.33 \text{ kN-m}$$

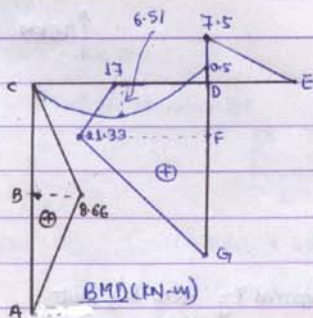
$$M_{GE} = 4.33 \times 3 - 15 \times 2 + 17 = 0$$

AFD (kN)



SFD (kN)

(↑ +ve ↓)

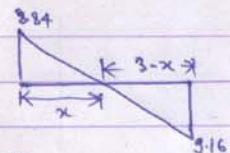


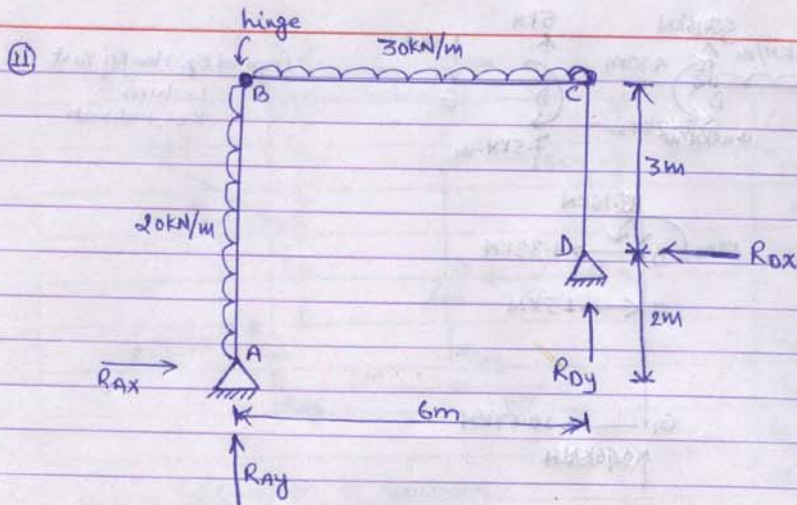
BMD (kN-m)

For SF zero point in member CD

$$\frac{x}{8.84} = \frac{3-x}{9.16} \Rightarrow x = 1.473 \text{ m}$$

$$\therefore \text{max BM} = 8.84 \times 1.473 - 6 \times 1.473 \times 1.473 = 6.51 \text{ kN-m}$$





Calculation of reactions :-

$$(\sum \curvearrowright) \leq M_{B, \text{left}} = 0$$

$$5R_{Ax} + 20 \times 5 \times \frac{5}{2} = 0$$

$$R_{Ax} = -50 \text{ kN} = 50 \text{ kN} (\leftarrow)$$

$$(\sum \rightarrow) \leq F_x = 0$$

$$R_{Ax} - R_{Dx} + 20 \times 5 = 0$$

$$R_{Dx} = 50 \text{ kN} (\leftarrow)$$

$$(\sum \curvearrowright) \leq M_{B, \text{right}} = 0$$

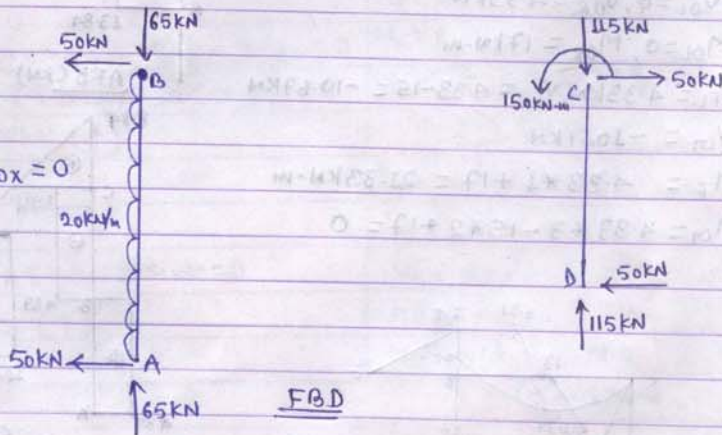
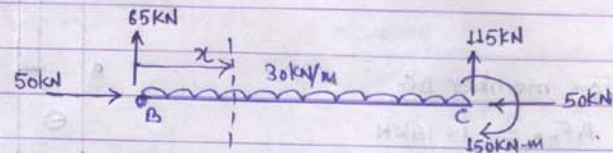
$$-30 \times 6 \times 3 + 6R_{Dy} - 3R_{Dx} = 0$$

$$R_{Dy} = 115 \text{ kN} (\uparrow)$$

$$(\sum \uparrow) \leq F_y = 0$$

$$R_{Ay} + R_{Dy} - 30 \times 6 = 0$$

$$R_{Ay} = 65 \text{ kN} (\uparrow)$$



Prepared By: Hem Raj Pant
Lecturer
KEC, Kalimati

Calculation of AF, SF and BM:

For member AB:

$$AF_{AB} = -65 \text{ kN}$$

$$V_{AL} = 0, V_{AR} = 50 \text{ kN}$$

$$V_B = 50 - 20 \times 5 = -50 \text{ kN}$$

$$M_A = 0, M_B = 50 \times 5 - 20 \times 5 \times \frac{5}{2} = 0$$

$$M_{AB, \text{mid}} = 50 \times 2.5 - 20 \times 2.5 \times \frac{2.5}{2} = 62.5 \text{ kN-m}$$

For member BC:

$$AF_{BC} = -50 \text{ kN}$$

$$V_{BL} = 0, V_{BR} = 65 \text{ kN}$$

$$V_C = 65 - 30 \times 6 = -115 \text{ kN}$$

$$M_x = 65x - 30x \times \frac{x}{2} \quad (\text{origin at B})$$

$$\text{At } x=0, M_B = 0$$

$$\text{at } x=6\text{m}, M_C = 65 \times 6 - 30 \times 6 \times \frac{6}{2} = -150 \text{ kN-m}$$

For member CD:

$$AF_{CD} = -115 \text{ kN}$$

$$V_{CL} = 0, V_{CR} = 50 \text{ kN}$$

$$M_{CL} = 0, M_{CD} = -150 \text{ kN-m}$$

$$V_D = 50 \text{ kN}$$

$$M_D = 50 \times 3 - 150 = 0$$

For SF zero point in member BC

$$\frac{x}{65} = \frac{6-x}{115}$$

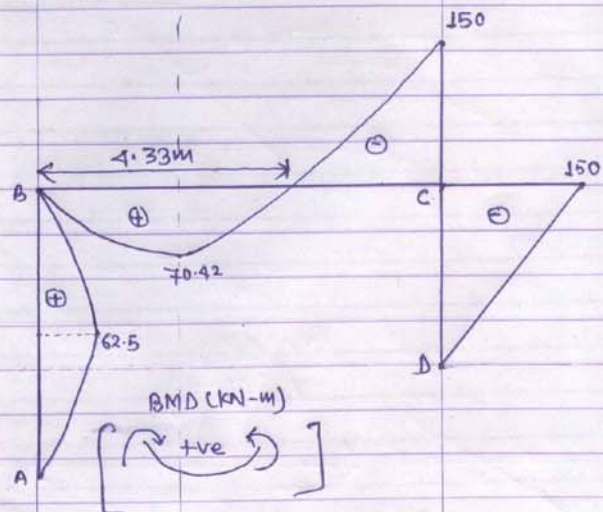
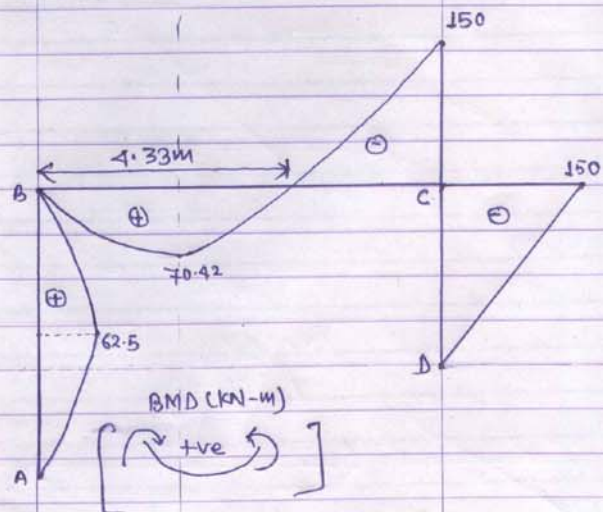
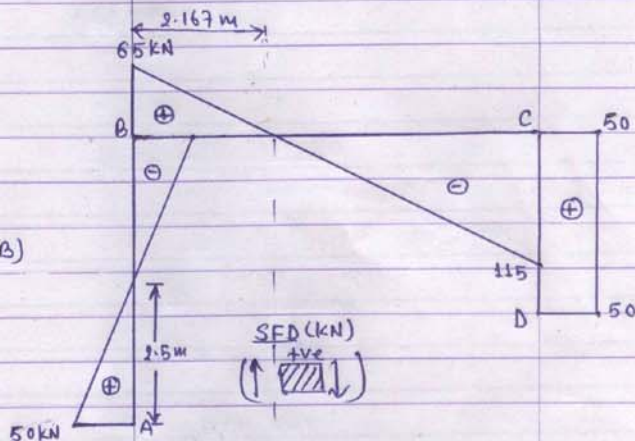
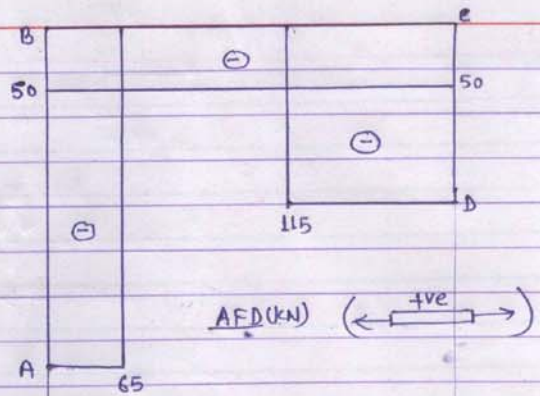
$$\Rightarrow x = 2.167 \text{ m}$$

$$\therefore \text{max. BM } (M_{2.167}) = 65 \times 2.167 - 30 \times 2.167 \times \frac{2.167}{2} = 70.42 \text{ kN-m}$$

For point of contraflexure in BC

$$M_x = 0 \quad \text{or} \quad 65x - 30x \times \frac{x}{2} = 0$$

$$\Rightarrow x = 4.33 \text{ m}$$





Kathmandu Engineering College [KEC]

(Affiliated to Tribhuvan University, NEPAL)

P.O. Box 3928, Kalimati, Kathmandu, Nepal. Tel: 4284902 / 4276130,

Fax: 4272653, E-mail: info@keckist.edu.np

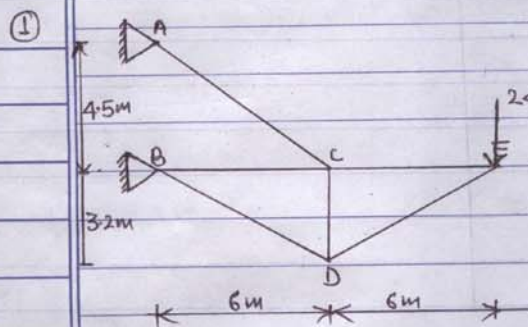
Date :

Name : Roll No. :

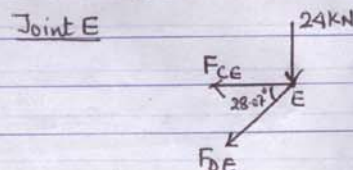
Subject : Year : Part :

Institute :

Prepared By: Hem Raj Pant
Lecturer
KEC, Kalimati



Calculation of member forces :-



Joint E

$$\sum F_y = 0$$

$$-24 - F_{DE} \sin 28.07^\circ = 0$$

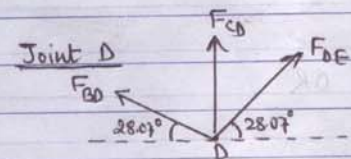
$$F_{DE} = -51 \text{ kN}$$

i.e. $F_{DE} = 51 \text{ kN (C)}$

$$\sum F_x = 0$$

$$-F_{CE} - F_{DE} \cos 28.07^\circ = 0$$

$$F_{CE} = 45 \text{ kN (T)}$$



Joint D

$$\sum F_x = 0$$

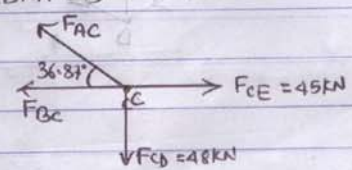
$$-F_{BD} \cos 28.07^\circ + F_{DE} \cos 28.07^\circ = 0$$

$$F_{BD} = -51 \text{ kN} = 51 \text{ kN (C)}$$

$$\sum F_y = 0$$

$$F_{BD} \sin 28.07^\circ + F_{DE} \sin 28.07^\circ + F_{CD} = 0$$

$$F_{CD} = 48 \text{ kN (T)}$$



Joint C

$$\sum F_y = 0$$

$$F_{AC} \sin 36.87^\circ - F_{CD} = 0$$

$$F_{AC} = 80 \text{ kN (T)}$$

Signature

Marks:

$$\sum F_x = 0$$

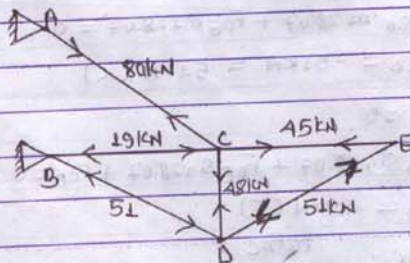
$$-F_{AC} \cos 36.87^\circ - F_{BC} + F_{CE} = 0$$

$$\text{or } F_{BC} = -19 \text{ kN}$$

$$\text{i.e., } F_{BC} = 19 \text{ kN (C)}$$

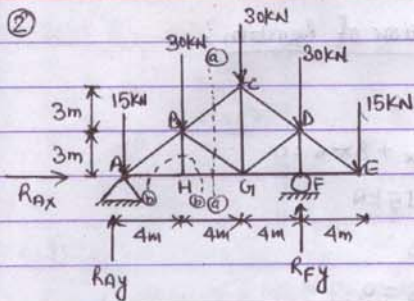
SN	Member	Force (kN)	Nature
1	AC	80	T
2	BC	19	C
3	BD	51	C
4	CE	45	T
5	CD	48	T
6	DE	51	C

OR



Prepared By: H.R. Pant
Lecturer
KEC, Katimati

Prepared By: Hem Raj Pout
Lecturer
KEC, Kalimati



Calculation of Reactions

$(\rightarrow) \sum F_x = 0$

$R_{Ax} = 0$

$(\uparrow) \sum M_A = 0$

$-30 \times 4 - 30 \times 8 - 30 \times 12 - 15 \times 16 + 12 R_{Fy} = 0$

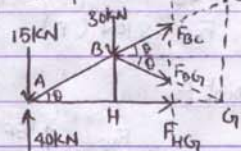
i.e. $R_{Fy} = 80 \text{ kN } (\uparrow)$

$(\uparrow) \sum F_y = 0$

$R_{Ay} + R_{Fy} - 15 - 30 - 30 - 30 - 15 = 0$

$R_{Ay} = 40 \text{ kN } (\uparrow)$

Passing section @-@ as shown in fig and considering left portion of it.



$(\uparrow) \sum M_A = 0$

$-30 \times 4 - F_{bc} \cos \theta \times 3 - F_{bc} \sin \theta \times 4 = 0$

$F_{bc} = -25 \text{ kN} = 25 \text{ kN } (T)$

$(\rightarrow) \sum F_x = 0$

$F_{bc} \sin \theta - F_{cg} \sin \theta - 30 - 15 + 40 = 0$

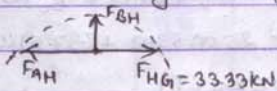
$F_{bc} = -16.67 \text{ kN} = 16.67 \text{ kN } (C)$

$(\rightarrow) \sum F_x = 0$

$F_{hg} + F_{cg} \cos \theta + F_{bc} \cos \theta = 0$

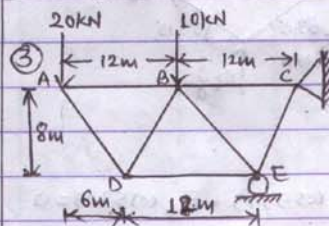
$F_{hg} = 33.33 \text{ kN } (T)$

again passing section @-@ as shown in fig and considering lower portion of it



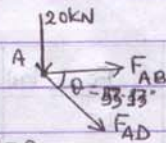
$(\uparrow) \sum F_y = 0$

$F_{BH} = 0$



Calculation of member forces:-

Joint A



$(\uparrow) \sum F_y = 0$

$-20 - F_{AD} \sin 53.13 = 0$

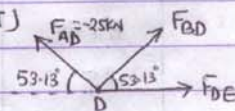
$F_{AD} = -25 \text{ kN} = 25 \text{ kN } (C)$

$(\rightarrow) \sum F_x = 0$

$F_{AB} + F_{AD} \cos 53.13 = 0$

$F_{AB} = 15 \text{ kN } (T)$

Joint D



$(\uparrow) \sum F_y = 0$

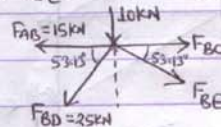
$F_{AD} \sin 53.13 + F_{BD} \sin 53.13 = 0$

$F_{BD} = 25 \text{ kN } (T)$

$(\rightarrow) \sum F_x = 0$ or $-F_{AD} \cos 53.13 + F_{BD} \cos 53.13 + F_{DE} = 0$

$\Rightarrow F_{DE} = -30 \text{ kN} = 30 \text{ kN } (C)$

Joint B



$(\uparrow) \sum F_y = 0$ or $-10 - 25 \sin 53.13 - F_{BE} \sin 53.13 = 0$

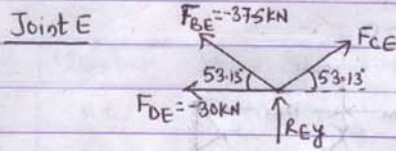
$F_{BE} = -37.5 \text{ kN}$

$$(\rightarrow) \sum F_x = 0$$

$$-F_{AB} + F_{BC} - F_{BD} \cos 53.13 + F_{BE} \cos 53.13 = 0$$

$$\text{or } -15 + F_{BC} - 25 \cos 53.13 + (37.5) \cos 53.13 = 0$$

$$\text{or } F_{BC} = 52.5 \text{ kN (T)}$$



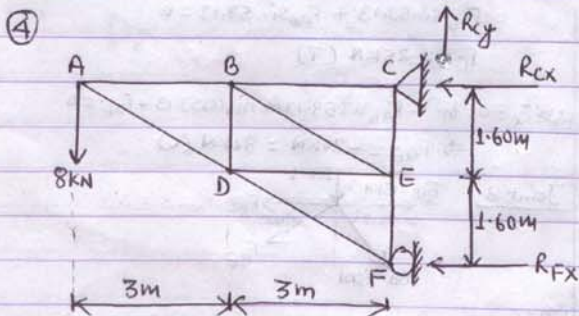
$$(\rightarrow) \sum F_x = 0$$

$$-F_{DE} - F_{BE} \cos 53.13 + F_{CE} \cos 53.13 = 0$$

$$\text{or } 30 + 37.5 \cos 53.13 + F_{CE} \cos 53.13 = 0$$

$$\Rightarrow F_{CE} = -87.5 \text{ kN} = 87.5 \text{ kN (C)}$$

Member	Force(kN)	Nature
AB	15	T
BC	52.50	T
AD	25	C
DE	30.0	C
BE	37.5	C
CE	87.50	C
BD	25	T



Calculation of Reaction:

$$\sum M_c = 0$$

$$-3 \cdot 2 R_{Fx} + 8 \times 6 = 0$$

$$R_{Fx} = 15 \text{ kN}$$

$$(\uparrow) \sum F_y = 0$$

$$R_{Cy} - 8 = 0$$

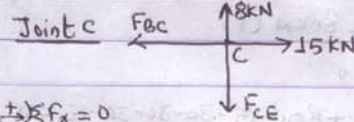
$$R_{Cy} = 8 \text{ kN}$$

$$(\rightarrow) \sum F_x = 0$$

$$-R_{Fx} - R_{Cx} = 0$$

$$R_{Cx} = -15 \text{ kN} = 15 \text{ kN } (\rightarrow)$$

Calculation of member forces



$$(\rightarrow) \sum F_x = 0$$

$$-F_{BC} + 15 = 0$$

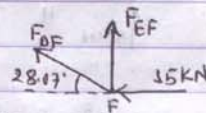
$$\text{or } F_{BC} = 15 \text{ kN (T)}$$

$$(\uparrow) \sum F_y = 0$$

$$-F_{CE} + 8 = 0$$

$$F_{CE} = 8 \text{ kN (T)}$$

Joint F



$$(\rightarrow) \sum F_x = 0$$

$$-F_{DF} \cos 28.07 - 15 = 0$$

$$F_{DF} = -17 \text{ kN} = 17 \text{ kN (C)}$$

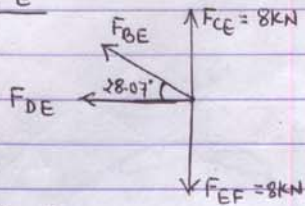
$$(\uparrow) \sum F_y = 0$$

$$F_{DF} \sin 28.07 + F_{EF} = 0$$

$$\text{or } F_{EF} = 8 \text{ kN (T)}$$

Prepared By: Hem Raj Pant
Lecturer
K.E.C, (Calicut)

Joint E



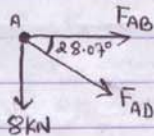
$$(\uparrow) \sum F_y = 0$$

$$F_{BE} \sin 28.07 + F_{CE} - F_{EF} = 0$$

$$F_{BE} = 0$$

$$(\rightarrow) \sum F_x = 0 \Rightarrow F_{DE} = 0$$

Joint A



$$(\uparrow) \sum F_y = 0$$

$$-8 - F_{AD} \sin 28.07 = 0$$

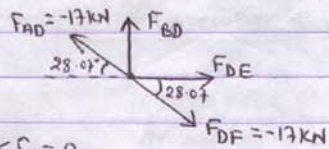
$$F_{AD} = -17 \text{ kN} = 17 \text{ kN (C)}$$

$$(\rightarrow) \sum F_x = 0$$

$$F_{AD} \cos 28.07 + F_{AB} = 0$$

$$\text{or } F_{AB} = 15 \text{ kN (T)}$$

Joint D

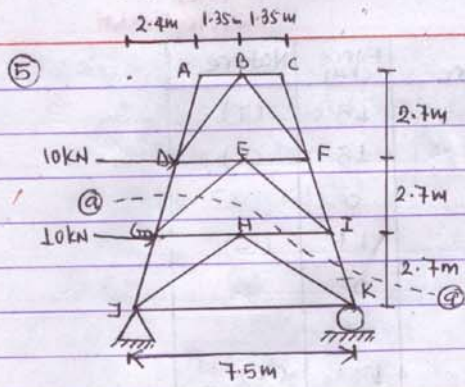


$$(\uparrow) \sum F_y = 0$$

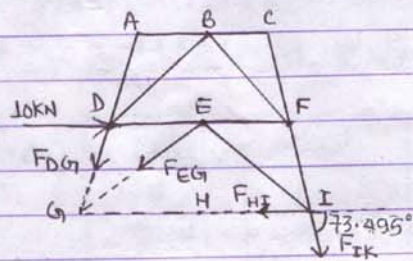
$$F_{AD} \sin 28.07 + F_{BD} - F_{DF} \sin 28.07 = 0$$

$$F_{BD} = 0$$

member	Force (kN)	Nature
AB	15	(T)
BC	15	(T)
BD	0	
AD	17	(C)
BE	0	
DE	0	
DF	17	(C)
EF	8	(T)
CE	8	(T)



Passing section @-@ as shown in fig and considering upper portion of it.



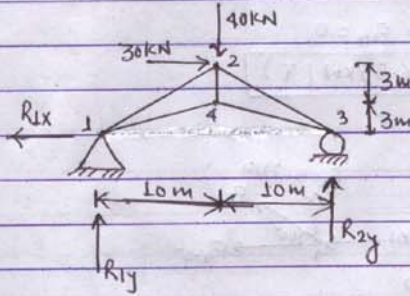
$$(+\curvearrowright) \sum M_G = 0$$

$$-10 \times 2.70 + F_{IK} \sin 73.495 \times (7.5 - 2 \times 0.8) = 0$$

$$F_{IK} = -4.773 \text{ kN} = 4.773 \text{ kN (C)}$$

Prepared By: Hem Raj Pant
Lecturer
KEC, Kalimati

⑥



Calculation of Reaction

$$(\rightarrow) \sum F_x = 0$$

$$-R_{1x} + 30 = 0$$

$$R_{1x} = 30 \text{ kN}$$

$$(\curvearrowright) \sum M_2 = 0$$

$$20R_{2y} - 30 \times 6 - 40 \times 10 = 0$$

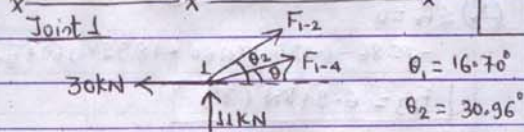
$$R_{2y} = 29 \text{ kN} (\uparrow)$$

$$(\uparrow) \sum F_y = 0$$

$$R_{1y} + R_{2y} - 40 = 0$$

$$R_{1y} = 11 \text{ kN} (\uparrow)$$

Calculation of member forces :-



$$(\rightarrow) \sum F_x = 0$$

$$-30 + F_{1-4} \cos 16.7 + F_{1-2} \cos 30.96 = 0 \quad \text{--- (i)}$$

$$(\uparrow) \sum F_y = 0$$

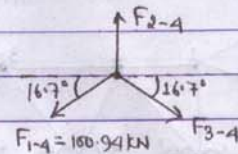
$$11 + F_{1-4} \sin 16.7 + F_{1-2} \sin 30.96 = 0 \quad \text{--- (ii)}$$

Solving eq (i) and (ii), we get

$$F_{1-4} = 100.94 \text{ kN (T)}$$

$$F_{1-2} = -77.77 \text{ kN} = 77.77 \text{ kN (C)}$$

Joint 4



$$(\rightarrow) \sum F_x = 0$$

$$-F_{1-4} \cos 16.7 + F_{3-4} \cos 16.7 = 0$$

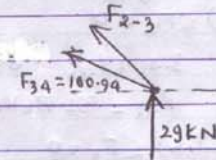
$$F_{3-4} = 100.94 \text{ kN (T)}$$

$$(\uparrow) \sum F_y = 0$$

$$F_{2-4} - 100.94 \sin 16.7 - 100.94 \sin 16.7 = 0$$

$$F_{2-4} = 58.01 \text{ kN (T)}$$

Joint 3

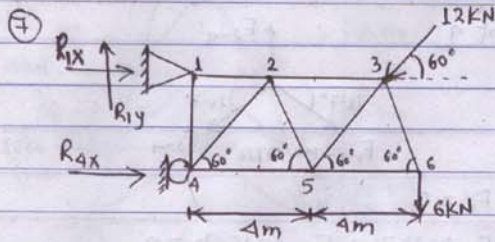


$$(\rightarrow) \sum F_x = 0$$

$$-100.94 \cos 16.7 - F_{2-3} \cos 30.96 = 0$$

$$F_{2-3} = -112.74 \text{ kN} = 112.74 \text{ kN (C)}$$

member	Force (kN)	Nature
1-2	77.77	(C)
1-4	100.94	(T)
2-4	58.01	(T)
2-3	112.74	(C)
3-4	100.94	(T)



Calculation of Reactions

$(\uparrow) \sum F_y = 0$

$R_{1y} - 12 \sin 60 - 6 = 0$

$R_{1y} = 16.39 \text{ kN}$

$(\rightarrow) \sum M_A = 0$

$3.464 R_{4x} - 6 \times 8 - 12 \sin 60 \times 6 = 0$

$R_{4x} = 31.86 \text{ kN}$

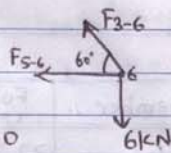
$(\rightarrow) \sum F_x = 0$

$R_{4x} + R_{1x} - 12 \cos 60 = 0$

$R_{1x} = -25.86 \text{ kN} = 25.86 \text{ kN} (\leftarrow)$

Calculation of member forces :-

Joint 6



$(\uparrow) \sum F_y = 0$

$F_{2-6} \sin 60 - 6 = 0$

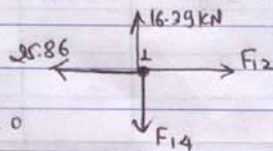
$F_{2-6} = 6.93 \text{ kN (T)}$

$(\rightarrow) \sum F_x = 0$

$-F_{5-6} - F_{2-6} \cos 60 = 0$

$F_{5-6} = -3.46 \text{ kN} = 3.46 \text{ kN (C)}$

Joint 1



$(\rightarrow) \sum F_x = 0$

$F_{1-2} - 25.86 = 0$

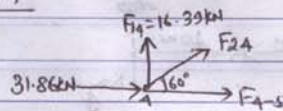
$F_{1-2} = 25.86 \text{ kN (T)}$

$(\uparrow) \sum F_y = 0$

$16.39 - F_{1-4} = 0$

$F_{1-4} = 16.39 \text{ kN (T)}$

Joint 4



$(\uparrow) \sum F_y = 0$

$16.39 + F_{2-4} \sin 60 = 0$

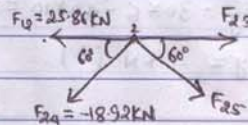
$F_{2-4} = -18.92 \text{ kN} = 18.92 \text{ kN (C)}$

$(\rightarrow) \sum F_x = 0$

$31.86 + F_{4-5} + F_{2-4} \cos 60 = 0$

$F_{4-5} = -22.40 \text{ kN} = 22.40 \text{ kN (C)}$

Joint 2



$(\uparrow) \sum F_y = 0$

$-F_{2-4} \sin 60 - F_{2-5} \sin 60 = 0$

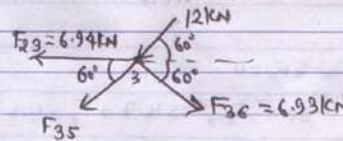
$F_{2-5} = 18.92 \text{ kN (T)}$

$(\rightarrow) \sum F_x = 0$

$-25.86 - (-18.92) \cos 60 + 18.92 \cos 60 + F_{2-3} = 0$

$F_{2-3} = 6.94 \text{ kN (T)}$

Joint 3



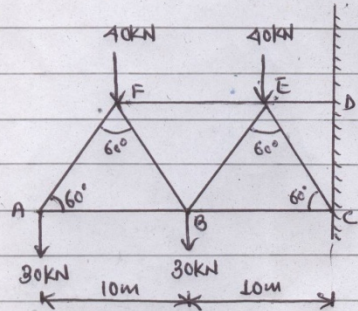
$(\uparrow) \sum F_y = 0$

$-F_{3-5} \sin 60 - F_{3-6} \sin 60 - 12 \sin 60 = 0$

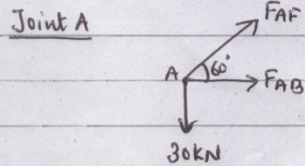
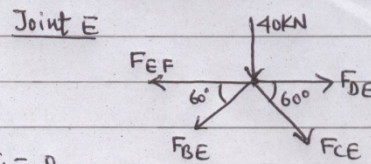
$F_{3-5} = -18.93 \text{ kN} = 18.93 \text{ kN (T)}$

Prepared by: Hem Raj Paul
K.E.C, Kalimati

8

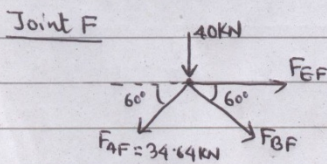


$$\begin{aligned} (\pm) \sum F_x = 0 \\ -F_{AB} - F_{BF} \cos 60 + F_{BE} \cos 60 + F_{BC} = 0 \\ \text{or } 17.32 + 80.82 \cos 60 + 115.46 \cos 60 + F_{BC} = 0 \\ F_{BC} = -115.46 \text{ kN} = 115.46 \text{ kN (C)} \end{aligned}$$



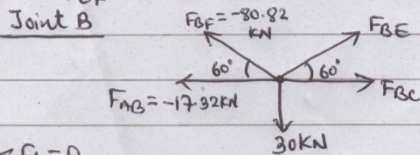
$$\begin{aligned} (+\uparrow) \sum F_y = 0 \\ -30 + F_{AF} \sin 60 = 0 \\ F_{AF} = 34.64 \text{ kN (T)} \end{aligned}$$

$$\begin{aligned} (\pm) \sum F_x = 0 \\ F_{AF} \cos 60 + F_{AB} = 0 \\ F_{AB} = -17.32 \text{ kN} = 17.32 \text{ kN (C)} \end{aligned}$$



$$\begin{aligned} (+\uparrow) \sum F_y = 0 \\ -40 - 34.64 \sin 60 - F_{BF} \sin 60 = 0 \\ F_{BF} = -80.82 \text{ kN} = 80.82 \text{ kN (C)} \end{aligned}$$

$$(\pm) \sum F_x = 0 \quad F_{EF} = 57.73 \text{ kN (T)}$$



$$\begin{aligned} (+\uparrow) \sum F_y = 0 \\ -30 + (-80.82) \sin 60 + F_{BE} \sin 60 = 0 \\ F_{BE} = 115.46 \text{ kN (T)} \end{aligned}$$

$$\begin{aligned} (+\uparrow) \sum F_y = 0 \\ -40 - F_{BC} \sin 60 - F_{CE} \sin 60 = 0 \\ -40 - (115.46) \sin 60 - F_{CE} \sin 60 = 0 \\ F_{CE} = -161.65 \text{ kN} = 161.65 \text{ kN (C)} \end{aligned}$$

$$\begin{aligned} (\pm) \sum F_x = 0 \\ -F_{EF} - F_{BE} \cos 60 + F_{CE} \cos 60 + F_{DE} = 0 \\ -57.73 - 115.46 \cos 60 + (-161.65) \cos 60 + F_{DE} = 0 \\ F_{DE} = 196.28 \text{ kN (T)} \end{aligned}$$

Member	Force (kN)	Nature
AB	17.32	C
AF	34.64	T
BF	80.82	C
BC	115.46	C
BE	115.46	T
EF	57.73	T
ED	196.28	T
CE	161.65	C