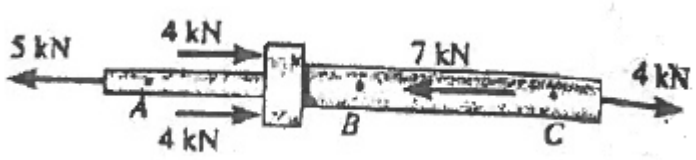
17/12/2020

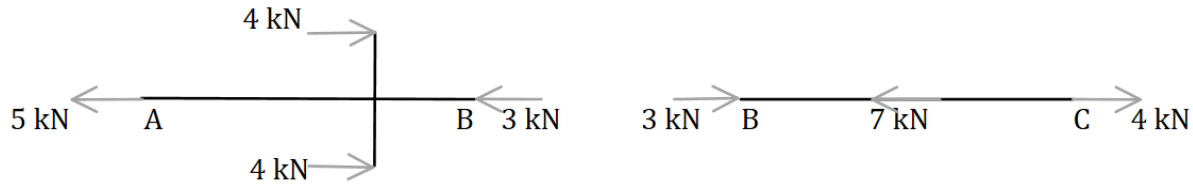
ES 221 MECHANICS I (STATICS) RECITATION IX

Q1)

The forces act on the shaft shown. Determine the internal normal force at point B.

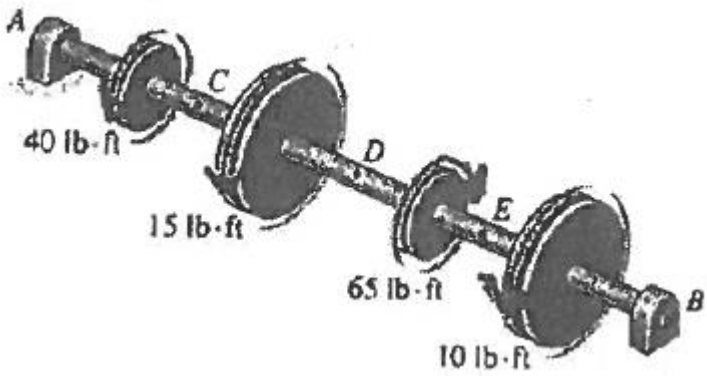


Solution to Q1

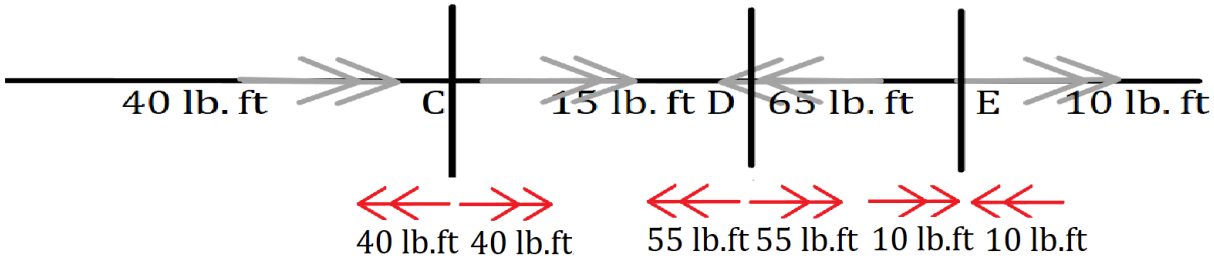


Q2)

The shaft is supported by the two smooth bearings at A and B. The four pulleys attached to the shaft are used to transmit power to adjacent machinery. If the torques applied to the pulleys are as shown, determine the internal torques at points C, D and E.

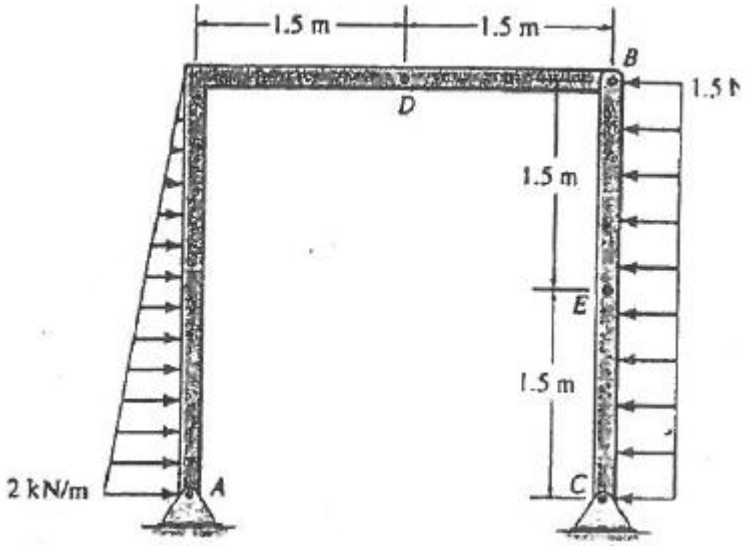


Solution to Q2



Q3)

Determine the internal force, shear force and moment at point D of the two-member frame.



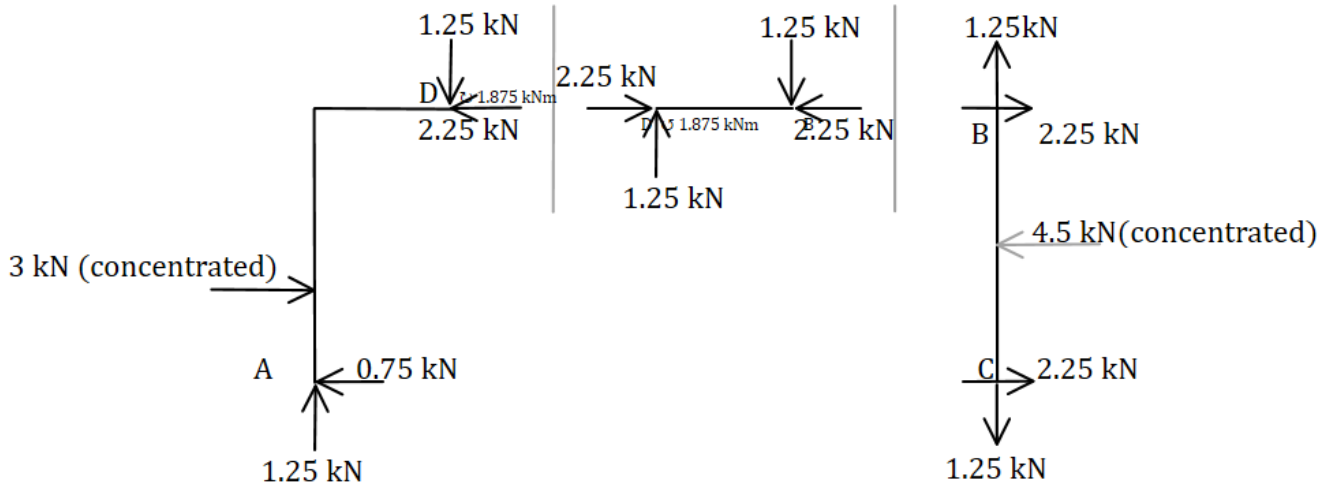
Solution to Q3

$$\circlearrowleft \sum M_A = 0$$

$$-3\ kN \times 1\ m + 4.5\ kN \times 1.5\ m + C_y \times 3\ m = 0$$

$$C_y = -1.25\ kN$$

$$C_y = 1.25\ kN \downarrow$$



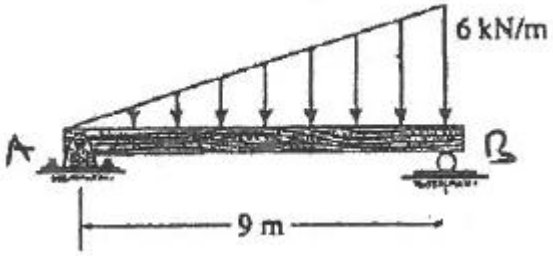
$N_D = 2.25\ kN \leftarrow$

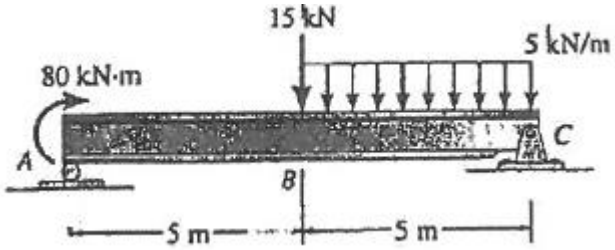
$V_D = 1.25\ kN \downarrow$

$M_D = 1.875\ kNm\ \circlearrowright$

Q4)

Draw the shear and moment diagrams for the beams shown.





Solution to the Beam on the Left:

$$\circlearrowleft \sum M_A = 0$$

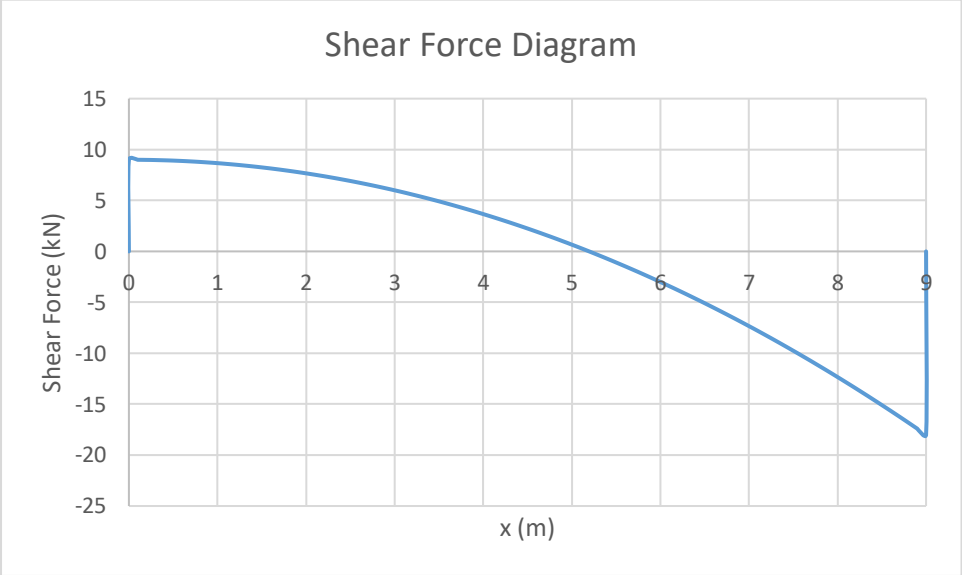
$$B_y \times 9\ m - 27\ kN \times 6\ m = 0$$

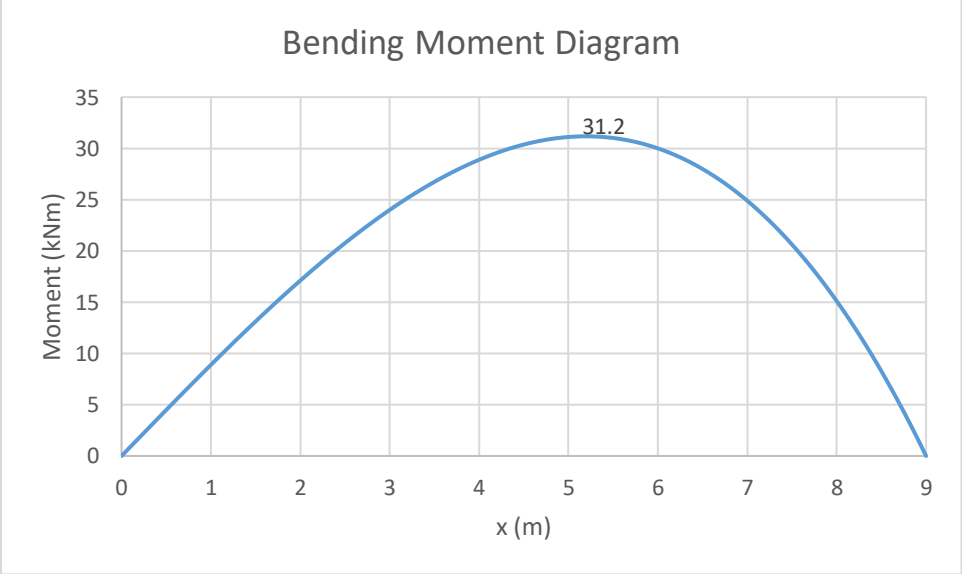
$$B_y = 18\ kN \uparrow,\ A_y = 9\ kN \uparrow$$

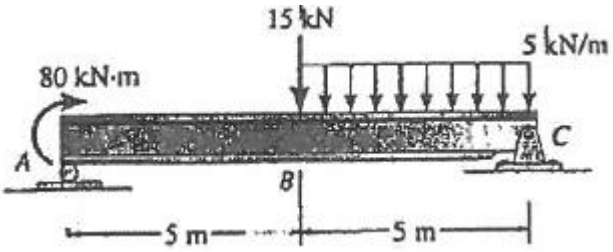
$0 \le x \le 9\ m$

$V(x) = 9 - \frac{x^2}{3}\ ,\qquad @x \cong 5.2\ m, V = 0$

$M(x) = -\frac{x^3}{9} + 9x + C_1,\quad C_1 = 0$







Solution to the Beam:

$$\circlearrowleft \sum M_A = 0$$

$$-15\ kN \times 5\ m - 25\ kN \times 7.5\ m + C_y \times 10\ m - 80\ kNm = 0$$

$$C_y = 34.25\ kN \uparrow$$

$$A_y = 5.75\ kN \uparrow$$

$$0 \leq x < 5\ m$$

$$V(x) = 5.75\ kN$$

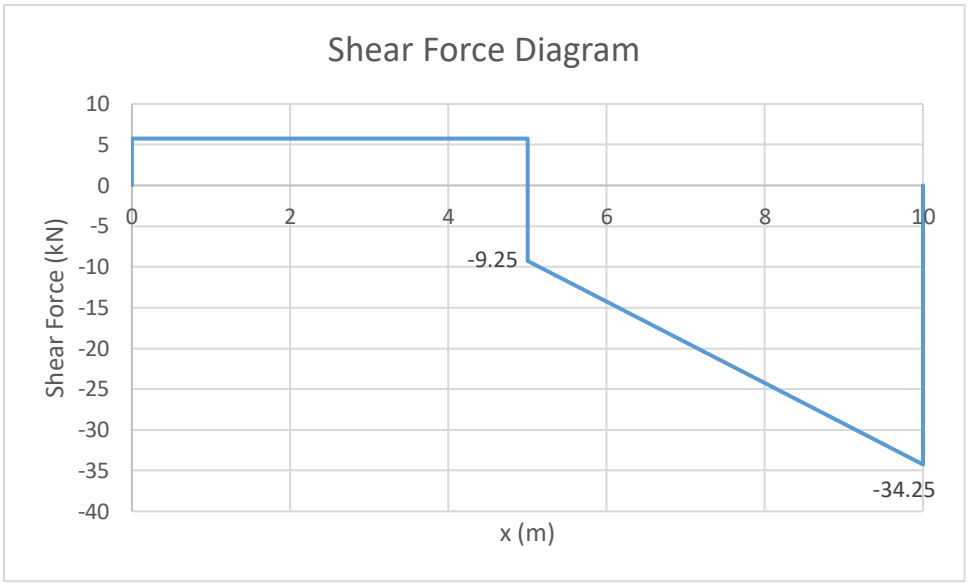
$$M(x) = 5.75x + C_1, \quad C_1 = 80$$

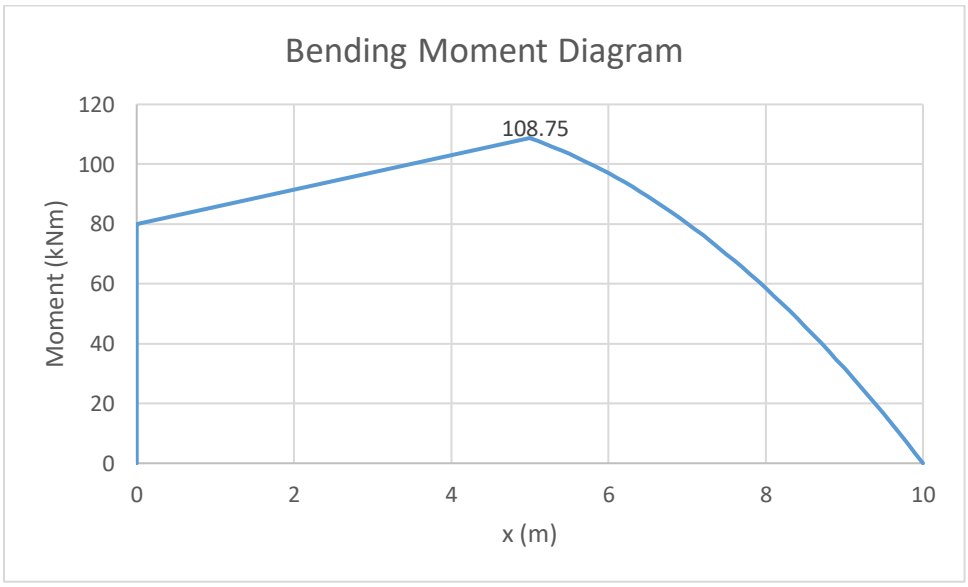
$$5\ m < x \leq 10\ m$$

$$V(x) = -9.25 - 5(x - 5)$$

$$V(x) = -5x + 15.75$$

$$M(x) = \frac{-5x^2}{2} + 15.75x + C_2\ , \quad C_2 = 92.5$$


Shear Force Diagram
Shear Force (kN)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
0
2
4
6
8
10
-9.25
-34.25
x (m)


Bending Moment Diagram
Moment (kNm)
120
100
80
60
40
20
0
108.75
0
2
4
6
8
10
x (m)