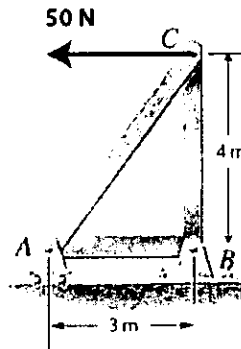**Problem 1** (20 points)

Figure 1: 2-D Frame with Loading applied at the Pivot C.

(a) (5 points) Draw a FBD of the frame under loading and with support reactions.

$$\vec{R}_A + \vec{R}_B + 50N = 0$$

$$\Sigma F_y = A_y + B_y = 0$$

$$\Sigma F_x = B_x - 50 = 0 \qquad B_x = 50N$$

$$\Sigma m_c = 3A_y - (4 \cdot 50) = 0$$

$$\frac{200}{3} = A_y = 66.67 \ N$$

$$B_y = -66.67 N$$

(b) (5 points) Determine the reactions at the pivot supports.

See part A for work

$$B_x = 50N$$
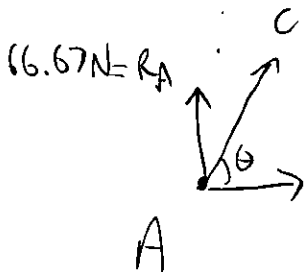$$B_y = -66.67N$$
$$A_y = 66.67N$$

(c) (10 points) Using the method of joints, determine the axial force in member AB. Indicate whether the member is in tension or compression.

$$\theta = \tan^{-1}\frac{4}{3} = 53.13°$$

$66.67N = R_A$

C

θ

A

B

$$\Sigma f_y = 66.67N + AC\sin 53.13 = 0$$
$$AC = -88.34N \ (C)$$
$$\Sigma f_x = AC\cos 53.13 + AB = 0$$
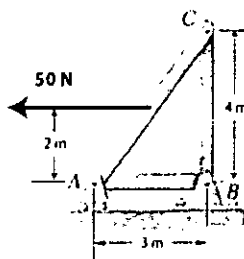
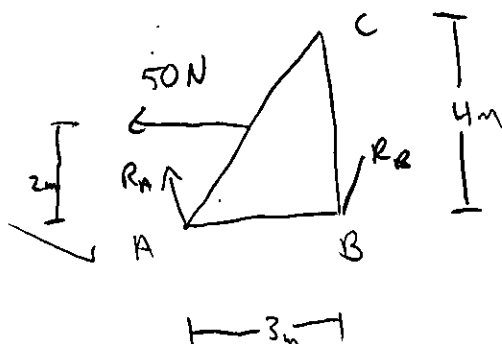$$\boxed{AB = 50N \ \text{Tension}}$$

Problem 2 (20 points)

Figure 2: 2-D Frame with Loading applied at the Member *AC*.

(a) (5 points) Draw a FBD of the frame under loading and with support reactions.

(b) (5 points) Determine the reactions at the pivot supports.

$$\Sigma F = 50N + \vec{R}_A + \vec{R}_B = 0$$

$$\Sigma F_x = B_x - 50N = 0 \qquad \boxed{B_x = 50N}$$

$$\Sigma F_y = A_y + B_y = 0$$

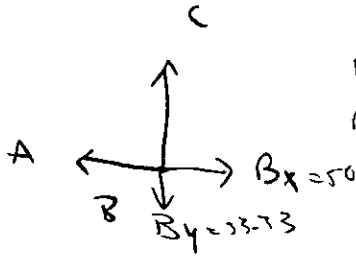$$\Sigma m_c = (-50 \cdot 2) - (A_y \cdot 3) + (50 \cdot 4) = 0$$

$$-100 \qquad\qquad 200$$

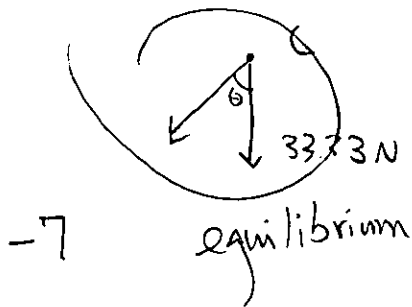$$\frac{3 A_y}{3} = \frac{100}{3} \qquad \boxed{\begin{array}{l} A_y = 33.33 N \\ B_y = -33.33 N \end{array}}$$

(c) (10 points) Determine the force applied to member AC at point C. Indicate whether the member is in tension or compression.

C

A

$B_x = 50$

B

$B_y = 33.33$

$BC = 33.33$ N (T)

$BA = -50$ N (T)

$\theta = \tan^{-1} \frac{3}{4} = 36.87°$

33.33 N

equilibrium

-7

$\Sigma f_y = -33.33 + AC \sin\theta = 0$

$\boxed{AC = 55.55 \text{ N} \quad (c)}$
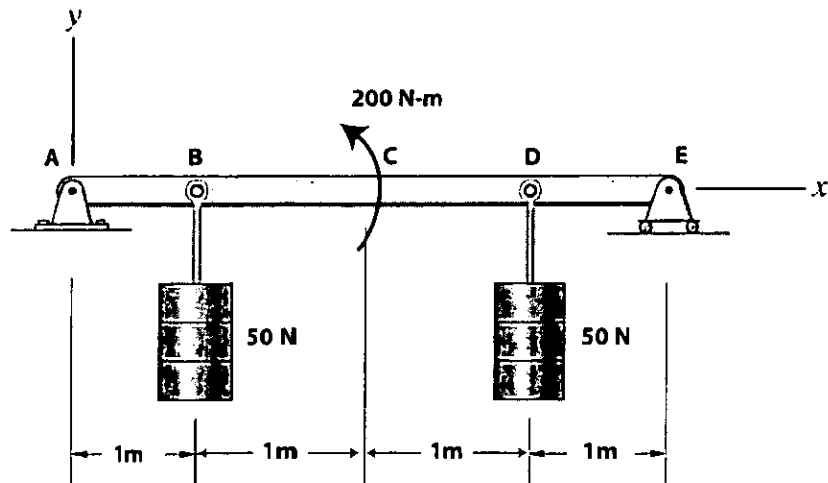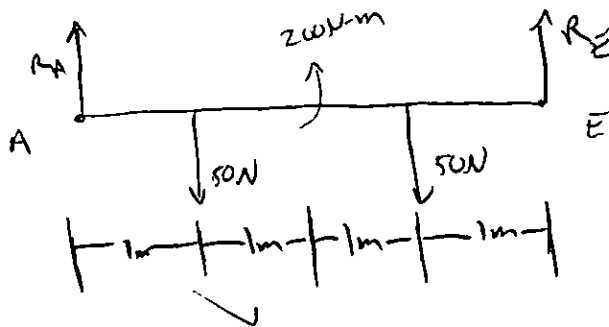
Problem 3 (35 points)

Figure 3: Beam under Force and Moment Loadings.

(a) (5 points) Draw FBD of the beam under loading.

(b) (10 points) Determine the reactions at the supports.

$$\Sigma f_x = 0 = A_x + A_E$$

$$\Sigma f_y = -50 - 50 + A_y + E_y = 0$$

$$\Sigma m_A = (-50 \cdot 1) - (50 \cdot 3) + 200 \, N\text{-}m + E_y \cdot 4 = 0$$

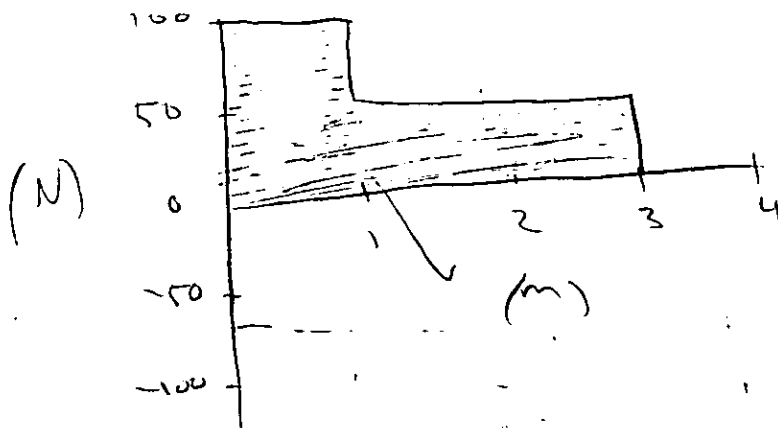$$\Sigma m_E = (50 \cdot 1) + (50 \cdot 3) + 200 + 4 A_y = 0 \quad E_y = 0$$

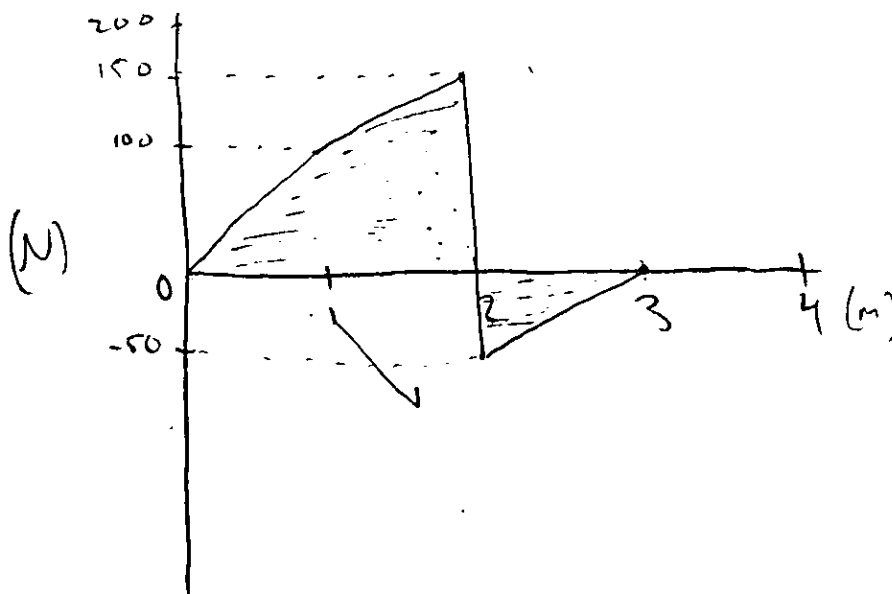$$\boxed{\begin{array}{l} A_y = 100 \, N \\ E_y = 0 \, N \\ E_x = 0 N \\ A_x = 0 \, N \end{array}}$$

(c) (10 points) Draw the shear force diagram.

(d) (10 points) Draw the bending moment diagram.

$$M = \begin{cases} 100x & 0 \le x \le 1 \\ 50x & 1 \le x \le 2 \\ drop\ 200 & 2 \\ 50x & 2 \le x \le 3 \\ 0 & 3 \le x \le 4 \end{cases}$$