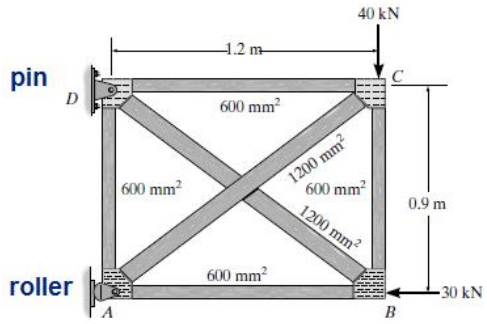
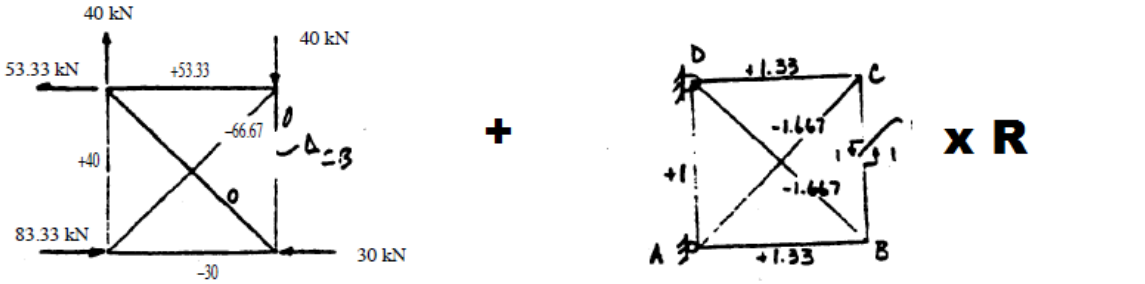
A4 - SOLUTION

Problem 1 **(5 marks)**



primary structure **redundant structure**



R = N_{BC}

Setup a table with L_i, A_i, No_i, n_i (not shown) …

$$\Delta_{CB} = \sum \frac{nNL}{AE} = \frac{1}{600E}\left[\frac{(1.33)(53.33)(1.2)}{1} + \frac{(1.33)(-30)(1.2)}{1} + \frac{(1)(40)(0.9)}{1}\right] + \left[\frac{(-1.667)(-66.67)(1.5)}{2}\right]$$

$$= \frac{156.5}{600E}$$

$$f_{CBCB} = \sum \frac{n^2L}{AE} = \frac{1}{600E}\left[\frac{2(1.33)^2(1.2)}{1} + \frac{2(1)^2(0.9)}{1} + \frac{2(-1.667)^2(1.5)}{2}\right]$$

$$= \frac{10.23}{600E}$$

$$\Delta_{CB} + F_{CB}f_{CBCB} = 0$$

$$\frac{156.5}{600E} + F_{CB}\left(\frac{10.23}{600E}\right) = 0$$

$$F_{CB} = -15.289 \text{ kN} = 15.3 \text{ kN (C)} \qquad \textbf{Ans}$$

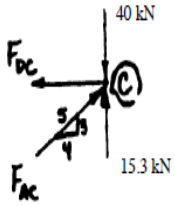
To solve for member forces either use $\boldsymbol{F = No_i + R * n_i}$ or do truss analysis as shown belwo (you should obtain the same results) …

Joint *C*:

$+\uparrow \Sigma F_y = 0; \quad \frac{3}{5}F_{AC} - 40 + 15.3 = 0;$

$F_{AC} = 41.2 \text{ kN (C)}$ **Ans**

$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad \frac{4}{5}(41.2) - F_{DC} = 0; \quad F_{DC} = 32.9 \text{ kN}$ **Ans**



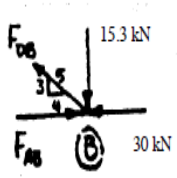
Joint *B*:

$+\uparrow \Sigma F_y = 0; \quad -15.289 + \left(\frac{3}{5}\right)(F_{DB}) = 0;$

$F_{DB} = 25.482 = 25.5 \text{ kN (T)}$ **Ans**

$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad F_{AB} - 30 - 25.5\left(\frac{4}{5}\right) = 0;$

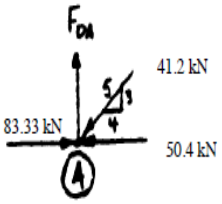
$F_{AB} = 50.4 \text{ kN (C)}$ **Ans**



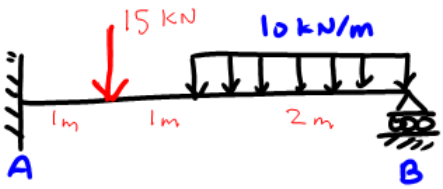
Joint *A*:

$+\uparrow \Sigma F_y = 0; \quad -41.2\left(\frac{3}{5}\right) + F_{DA} = 0;$

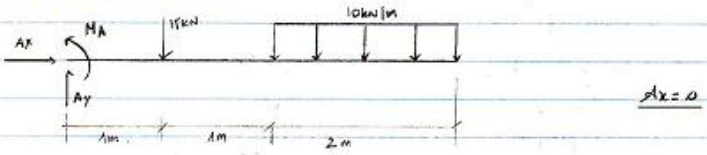
$F_{DA} = 24.7 \text{ kN (T)}$ **Ans**



Problem 2 **(5 marks)**



PRIMARY SYSTEM

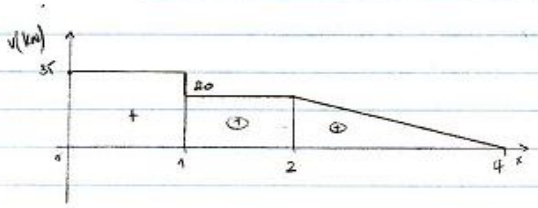


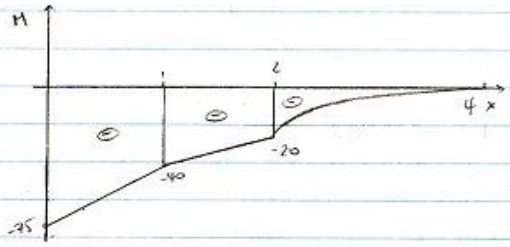
$\Delta x = 0$

$\Sigma F_y = 0 \rightarrow A_y - 15 - (10)(2) = 0 \rightarrow \underline{A_y = 35\ kN}$

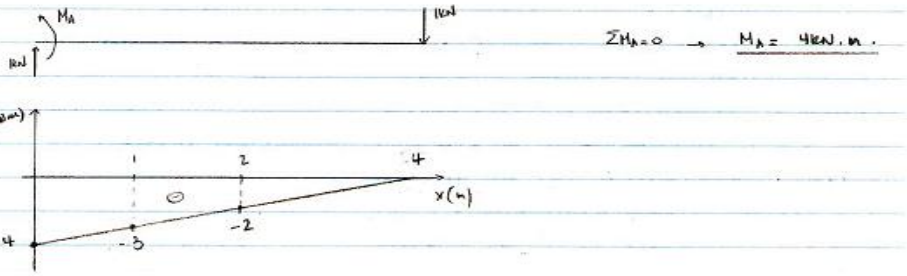
$\circlearrowleft \Sigma M_A = 0 \rightarrow M_A - 15 - (3)(10)(2) = 0$

$\rightarrow \underline{M_A = 75\ kN.m}$



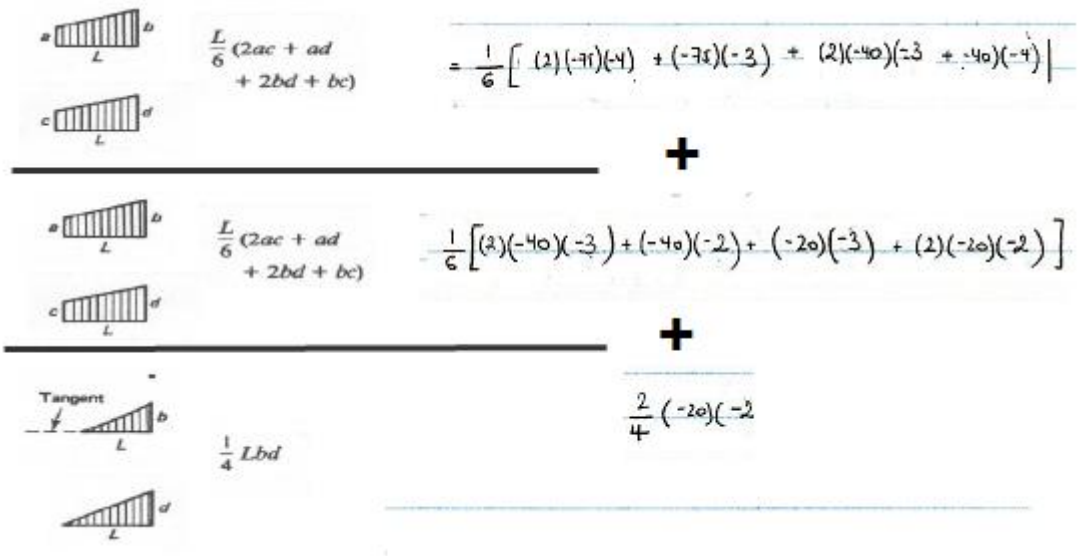


REDUNDANT SYSTEM



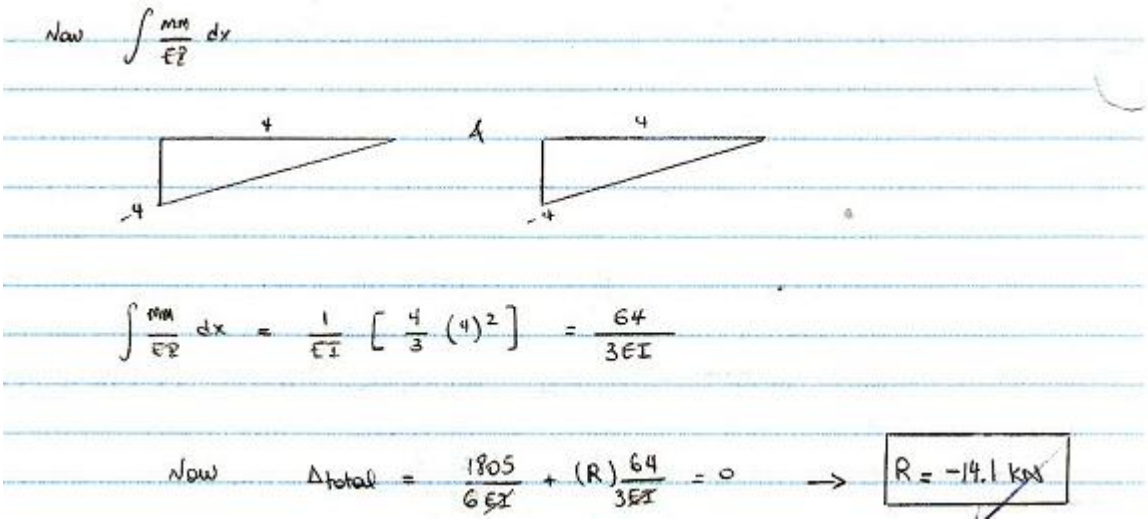
$\Sigma M_A = 0 \rightarrow \underline{M_A = 4kN.m.}$

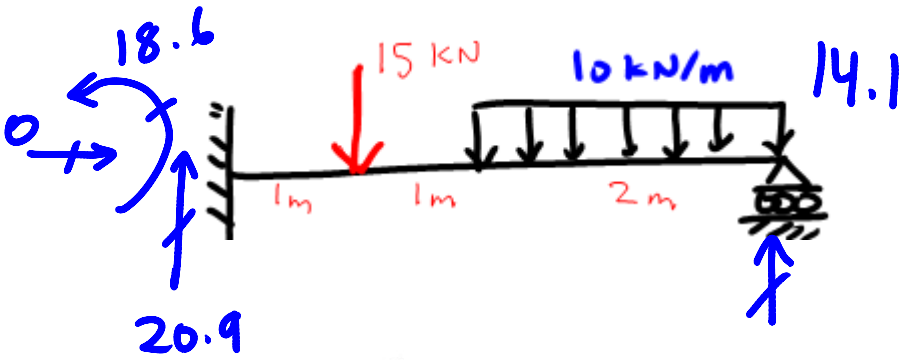
Let's find $\int \frac{mM}{EI} dx$

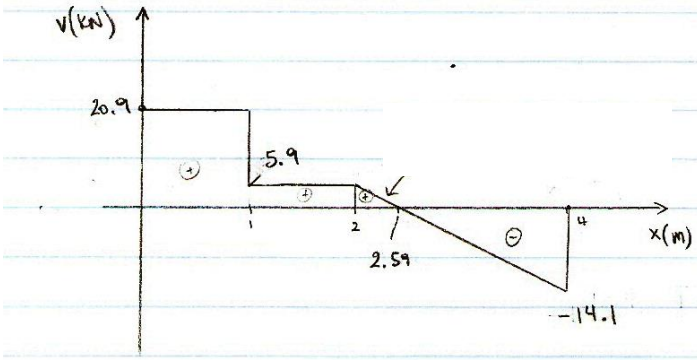


$\int \frac{mM}{EI} dx$ = 1805/(6EI)

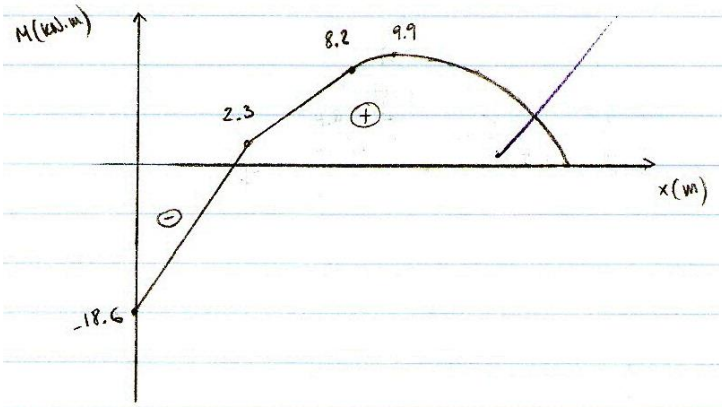
Next we find $\int \frac{mm}{EI} dx$ …



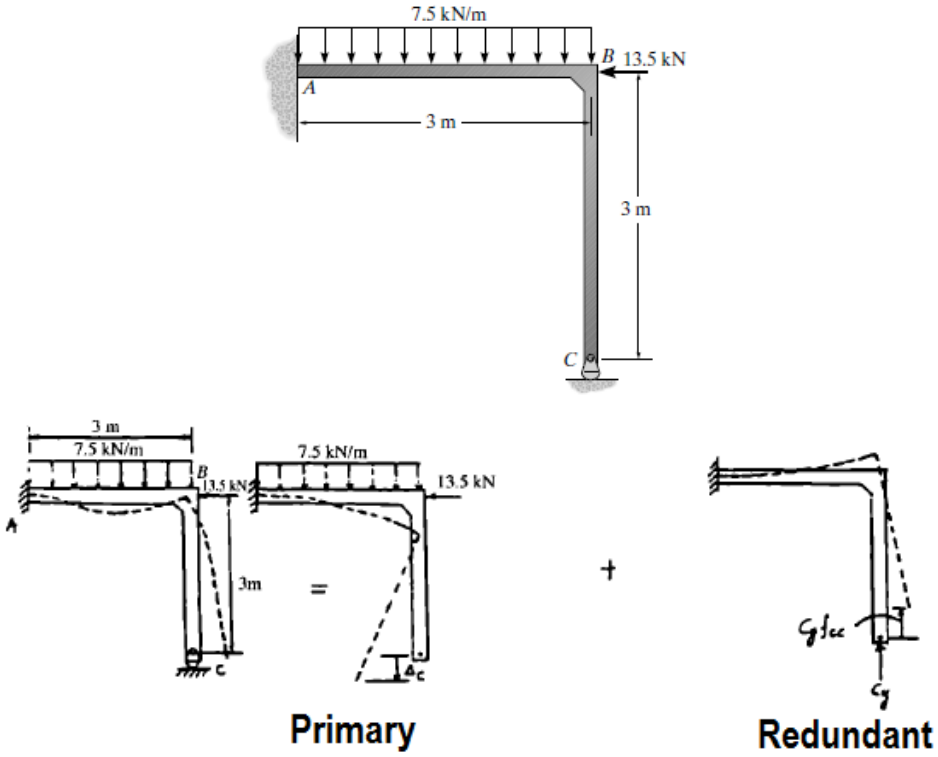




when $V = 0$, $x = 2.59$m



Problem 3 **(10 marks)**



Compatibility Equation :

$$(+\downarrow) \qquad 0 = \Delta_C - C_y f_{CC} \qquad (1)$$

Use virtual work method :

$$\Delta_C = \int_0^L \frac{mM}{EI}\,dx = \text{using Mohr} = \frac{-75.94}{EI}$$

$$f_{CC} = \int_0^L \frac{mm}{EI}\,dx = \text{using Mohr} = \frac{9}{EI}$$

(note I am not showing the steps, please try yourself)

From Eq. (1) $\qquad 0 = \dfrac{75.94}{EI} - \dfrac{9}{EI} C_y$

$C_y = 8.44$ kN **Ans**

$A_x = 13.5$ kN **Ans**

$A_y = 14.06$ kN **Ans**

$M_A = 8.44$ kN · m **Ans**

Now you can draw shear and moment diagrams (not shown) …