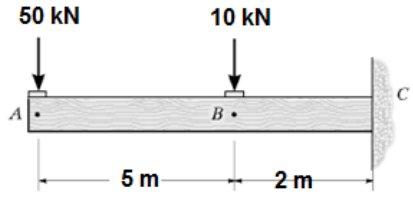
SOLUTION- A2

Problem 1 (5 marks)

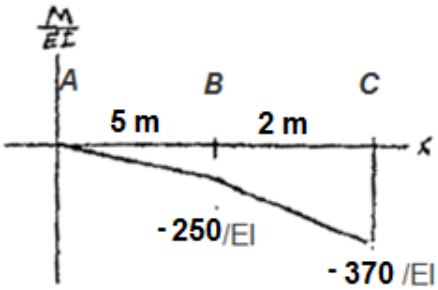
The cantilever beam shown below is subjected to the loads shown in the figure. Use the **moment-area method** to determine the **displacement @B** and the **slope @A**.

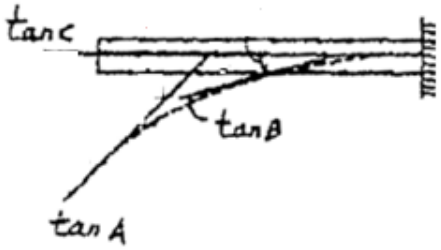


Note: E = 200 GPa , I = 50(10^6) mm^4

Note: Give your answers in "mm"

Note: C = fixed support





the displacement at point B.

$\Delta_B = t_{B/C}$ = (-250/EI *2)(2/2) + (0.5*-120/EI *2)(2*2/3)

= 660/EI ↓ …. 660 / [(200 x 10^6)*(50 x 10^{-6})] = 0.066 m = 66 mm ↓

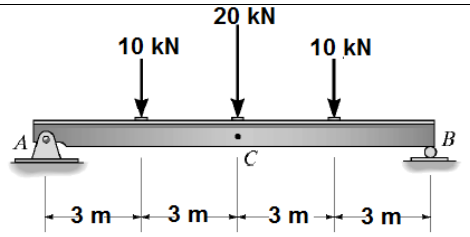
the slope at point A.

$\Theta_A = \Theta_{A/C}$ = (-250/EI *5*0.5) +(-250/EI *2) + (0.5*-120/EI *2)

= 1245/EI …. 1870 / [(200 x 10^6)*(50 x 10^{-6})] = 0.1245 radians ccw

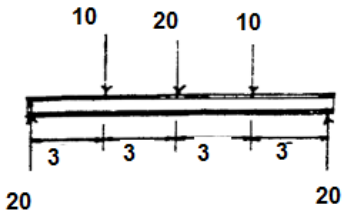
Problem 2 (5 marks)

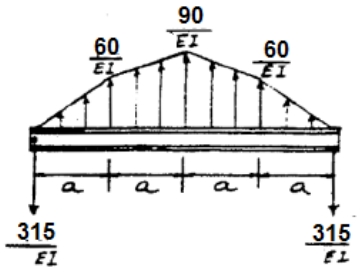
The beam shown below is subjected to the load shown in the figure. Use the **conjugate-beam method** to determine the displacement at point C.



Note: Give your answers in terms of "EI" (constant for the entire beam).

Note: A = pin , B = roller support



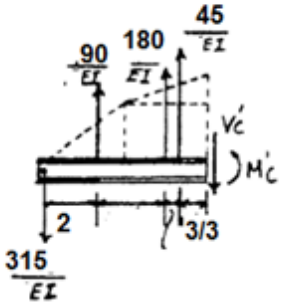


$\theta_B = V_B' = \frac{315}{EI}$ **Ans**

$\left(+\Sigma M_C = 0: \quad -\frac{45}{EI}\left(\frac{3}{3}\right) - \frac{180}{EI}\left(\frac{3}{2}\right) - \frac{90}{EI}(4) + \frac{315}{EI}(6) + M_{C'} = 0\right.$

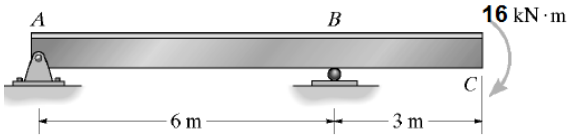
$\Delta_C = M_{C'} = -\frac{1215}{EI}$ **Ans**

(displacment is downwards)



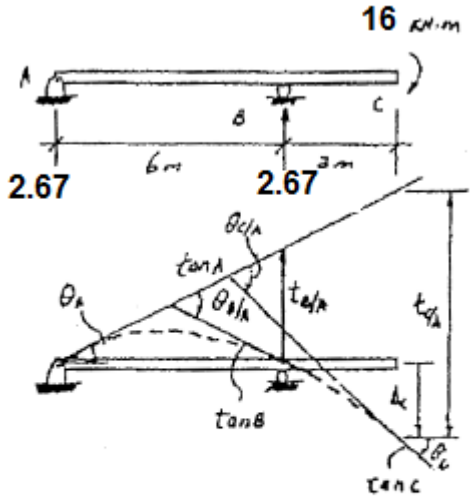
Problem 3 (5 marks)

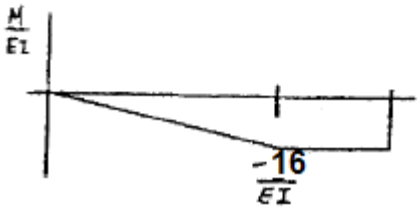
The beam shown below is subjected to the loads shown in the figure. Use the **moment-area method** to determine the displacement at point C.



Note: Give your answers in terms of "EI" (constant for the entire beam).

Note: A = pin , B = roller support





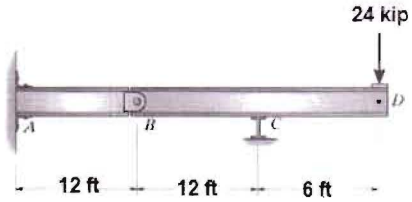
$$t_{B/A} = \frac{1}{2}\left(\frac{-16}{EI}\right)(6)(2) = \frac{-96}{EI}$$

$$t_{C/A} = \frac{1}{2}\left(\frac{-16}{EI}\right)(6)(3+2) + \left(\frac{-16}{EI}\right)(3)(1.5) = \frac{-312}{EI}$$

$$\Delta_C = |t_{C/A}| - \frac{9}{6}|t_{B/A}| = \frac{312}{EI} - \frac{9(96)}{6(EI)} = \frac{168}{EI} \downarrow \quad \text{Ans}$$

Problem 4 (5 marks)

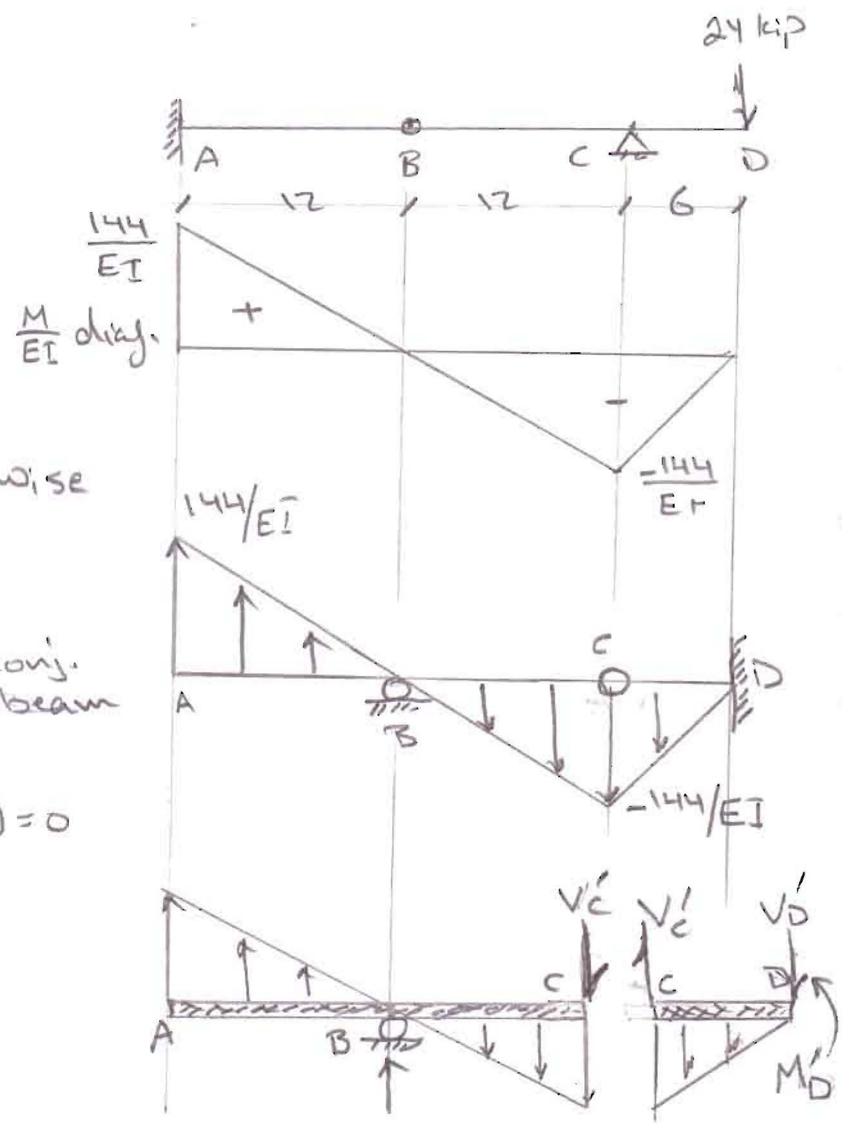
The beam shown below is subjected to the load shown in the figure. Use the **conjugate-beam method** to determine the displacement at point D.



Note: $E = 29(10^3)$ ksi , $I = 30$ in^4

Note:

- **A = fixed support**
- **B = hinge**
- **C = roller**



For part ABC :

$\curvearrowleft + \sum M_B = 0$

$-V'_c(12) - \left[\frac{1}{2}\left(\frac{144}{EI}\right)(12)(8)\right] \times 2 = 0$

$\Rightarrow V'_c = -\frac{1152}{EI}$

$\therefore \theta_c = V'_c \Rightarrow \theta_c = \frac{1152}{EI}$ clockwise

For part CD :

$\curvearrowleft + \sum M_D = 0$

$M'_D + \left(\frac{1152}{EI}\right)(6) + \frac{1}{2}\left(\frac{144}{EI}\right)(6)(4) = 0$

$\Rightarrow M'_D = -\frac{8640}{EI}$

$\therefore \Delta_D = M'_D$

$\Rightarrow \Delta_D = \frac{8640}{EI} \downarrow$