Deflection. Rotation for Beams. Frames

15/09/2015

By Virtual Work

(If support movement)

$$\Sigma Q\delta + W_R = \Sigma \frac{F_Q F_P L}{AE} + \Sigma F_Q \alpha t L + \int \frac{M_Q M_P}{EI} ds$$

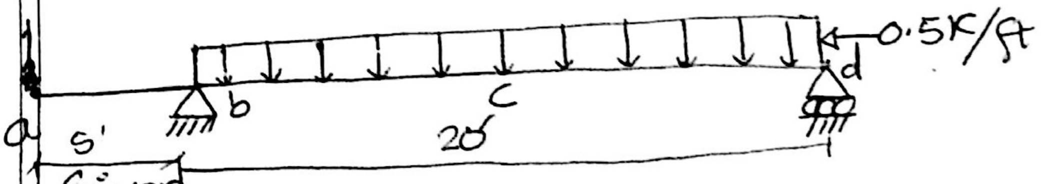
for temp. change

For Beam with No axial force & Temp change, support movement

$$\Sigma Q\delta = \int \frac{M_Q M_P}{EI} ds$$

Example 8.1, 8.2, 8.3, 8.4

Example 8.5,



Given

$E = 30 \times 10^3$ ksi

$I = 200$ inch^4

compute vertical deflection at point 'a'.

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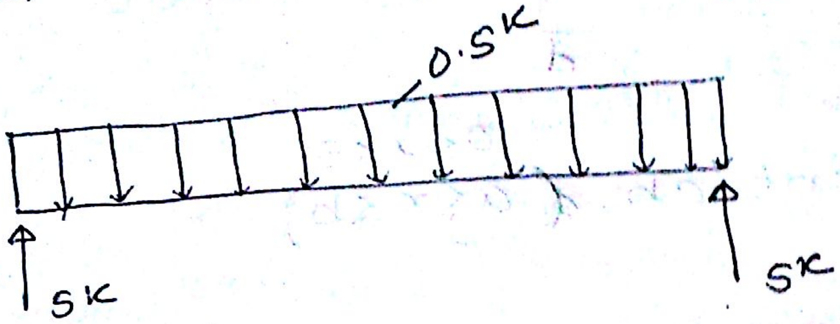
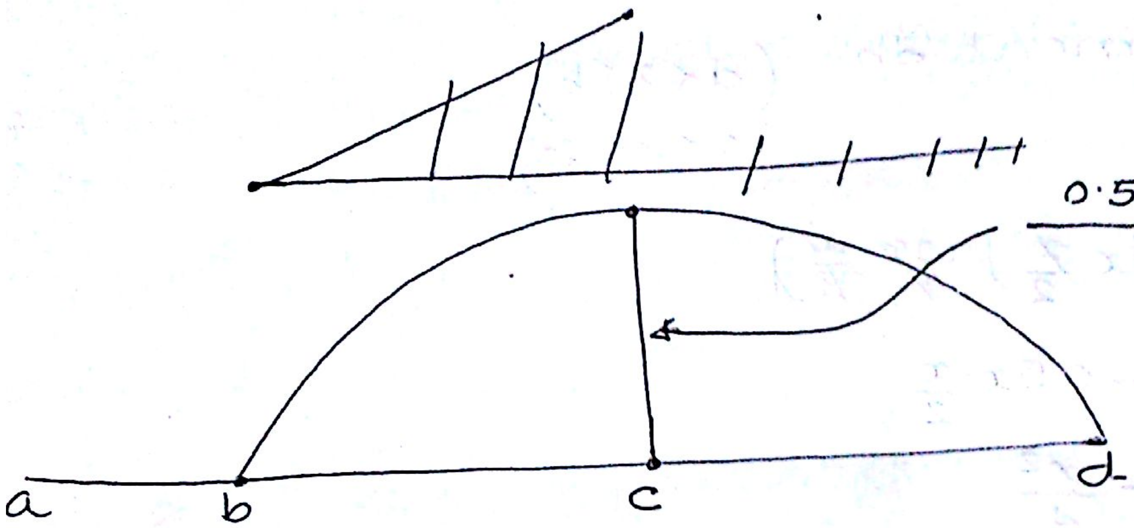
Solution:

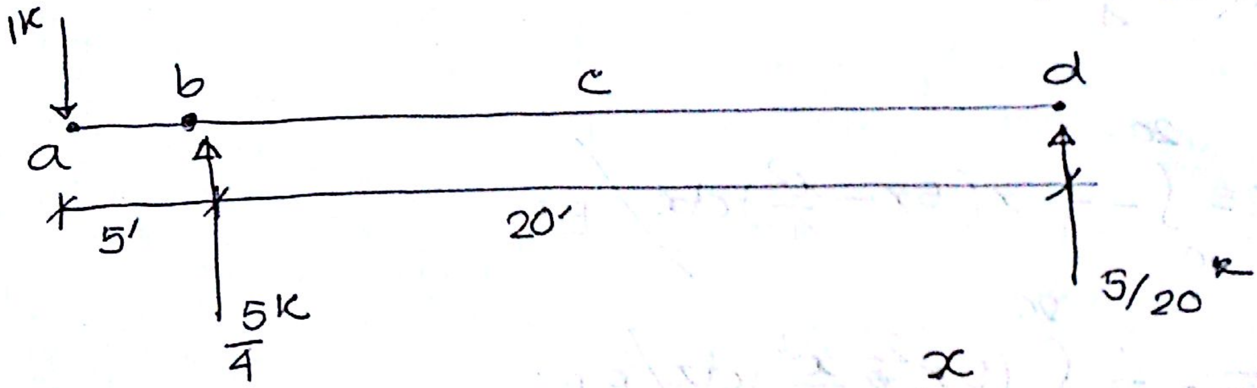
For 'P' force.





$$\frac{0.5\times 20^2}{8} = \frac{wL^2}{8}$$

For 'Q' force.



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$[\because m_p = 0]$

By V.W

$$\Sigma Q\delta = \cancel{\int_a^b \frac{M_Q M_p dx}{EI}} + \int_d^b \frac{M_Q M_p}{EI} dx.$$

For segment 'ab'. $(a \leq x \leq b)$ $0 \leq x \leq 5'$

$m_p = 0$

$M_Q = 1x$

For segment 'db' $(d < x \leq b)$

$(0 < x \leq 20)$

$$m_p = 0.5x \cdot \frac{x}{2} \left[\omega x \cdot \frac{x}{2}\right]$$

$$= 5x - 0.5x \cdot \frac{x}{2}$$

$$= 5x - \frac{x^2}{4}$$

$$M_Q = -\frac{1}{4}x^2$$

$$\Sigma Q\delta = \int_0^{20} -\frac{1}{4}x\left(5x - \frac{x^2}{4}\right)dx \Big/ EI$$

$$= -\frac{1}{4}\int_0^{20}\left(5x^2 - \frac{x^3}{4}\right)dx \Big/ EI$$

$$= \int_0^{20}\left(\frac{x^3}{16} - \frac{5}{4}x^2\right)dx \Big/ EI$$

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$$1.\delta = \frac{1}{EI}\int_0^{20}\left(\frac{x^3}{16} - \frac{5}{4}x^2\right)dx$$

$$= -833.3/EI$$

$$E = 30000\,ksi$$

$$= 30000 \times 144\ ksf \quad (12^2)$$

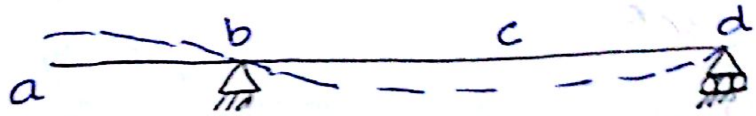
$$= -\frac{833.3}{30000 \times \frac{200}{144}}$$

$$I = 200\,inch^4$$

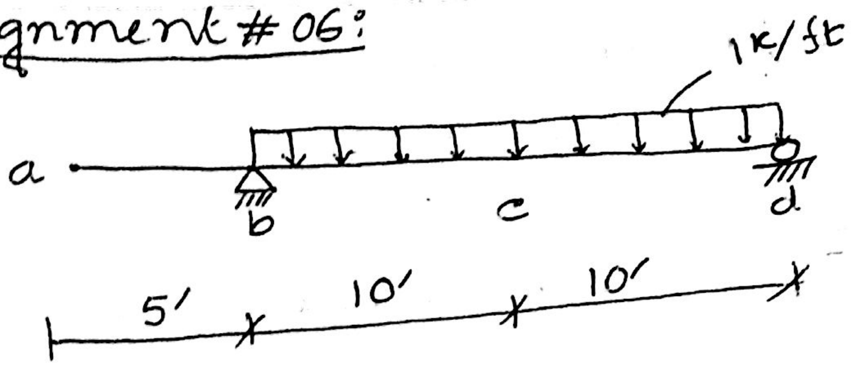
$$= \frac{200}{(144 \times 144)}\,ft^4 \quad (12)^4$$

$$= -0.02\ ft\ (upward)$$

(exam এ upward/downward must
ও লিখতে হবে)



Assignment # 06:



$E = 30{,}000$ ksi

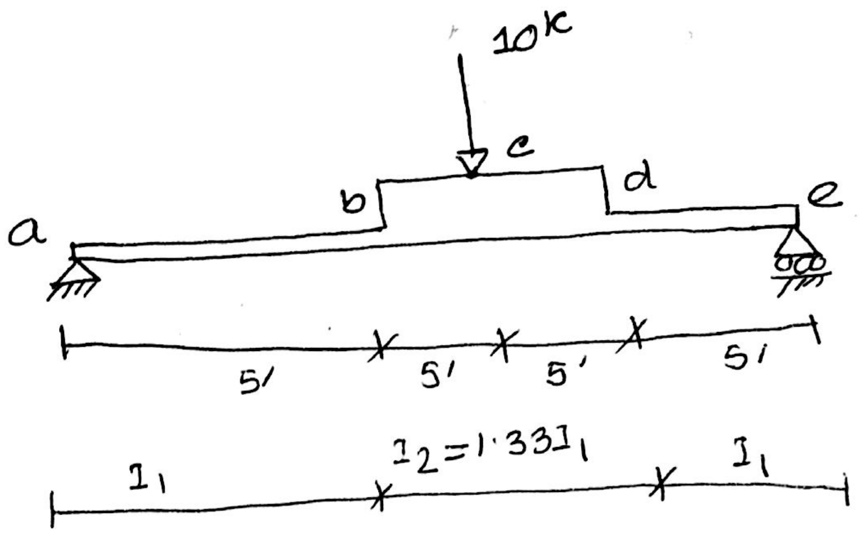
$I = 300$ in^4

Compute:

(a) Vertical deflection at 'c' [b to c & d to c]

(b) Rotation or slope at point "a"

See. Example 8.6



Given, $E = 30{,}000$ ksi

$I_1 = 150$ in^4

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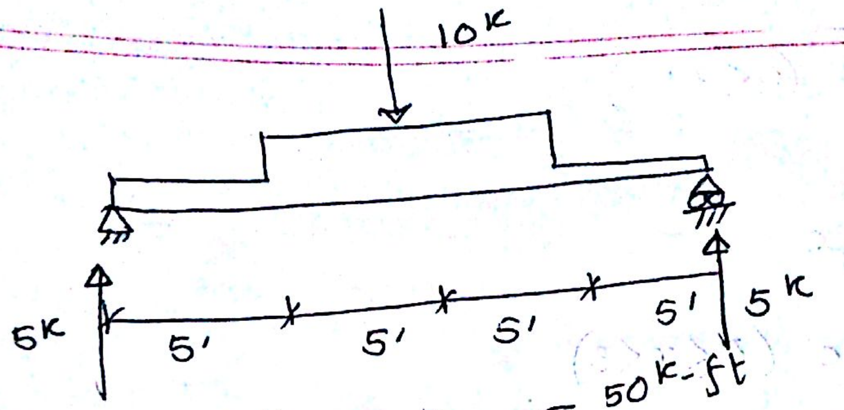
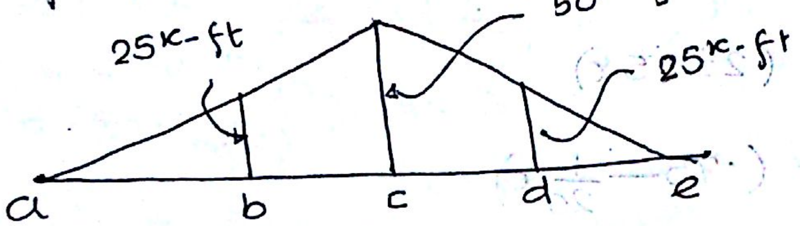
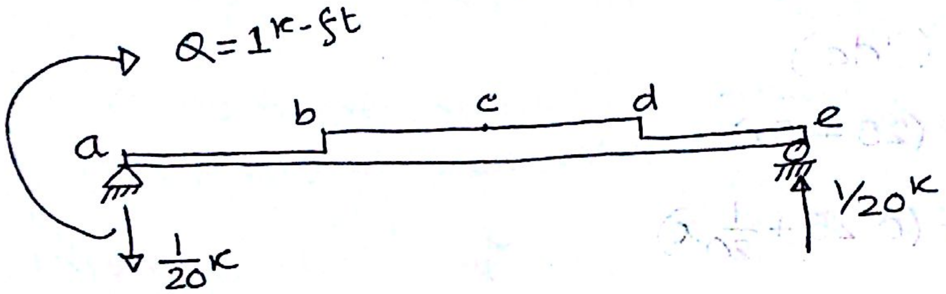
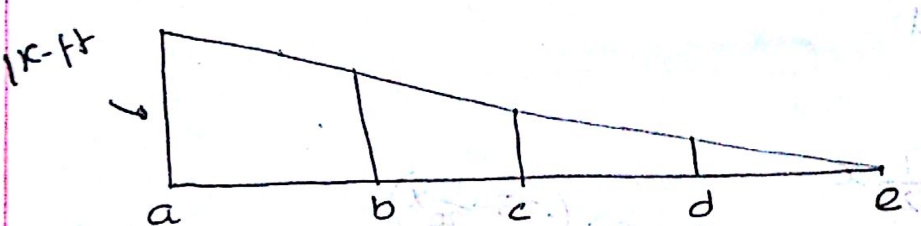
16/03/2015 .





Mpdiagram





MQ diagram

By Virtual Work Method:

change in slope

$$\Sigma Q\,\theta_a = \int_a^b \frac{}{EI_1}\,dx + \int_b^c \frac{}{EI_2}\,dx + \int_d^c \frac{}{EI_2}\,dx$$

$$+ \int_e^d \frac{}{EI_1}\,dx$$

Segment 'ab' $(0 < x \leq 5)$

$M_p = +5x$

$M_Q = 1 - \frac{1}{20}x$

Segment 'bc' $(0 \leq x \leq 5)$

$M_p = +(25 + 5x)$

$M_Q = +(.75 - \frac{1}{20}x)$

Segment ('dc')

$M_p = +(25 + 5x)$

$M_Q = +(0.25 + \frac{1}{20}x)$

Segment 'ed'

$M_p = +5x$

$M_Q = +\frac{1}{20}x$

$$\int_0^5 \frac{(5x)(1 - \frac{x}{20})}{EI_1} dx + \int_0^5 \frac{(25+5x)(.75 - \frac{1}{20}x)}{EI_2} dx + \int_0^5 \frac{(25+5x)(.25 + \frac{1}{20}x)}{EI_2} dx$$

$$+ \int^5 \frac{(5x)(\frac{1}{20})x}{EI_1} dx$$

$$= \frac{52.08}{EI_1} + \frac{114.58}{EI_2} + \frac{79.920}{EI_2} + \frac{10.4167}{EI_1}$$

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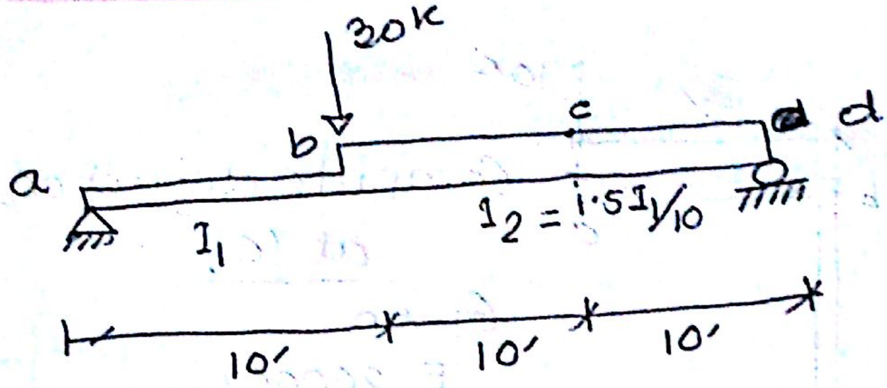
Assignment 07:



$E = 30{,}000$ k/in²

$I_1 = 400$ inch⁴

Compute i) vertical deflection at 'c'
ii) Vertical deflection · 'b'
iii) change in slope at point 'd'.

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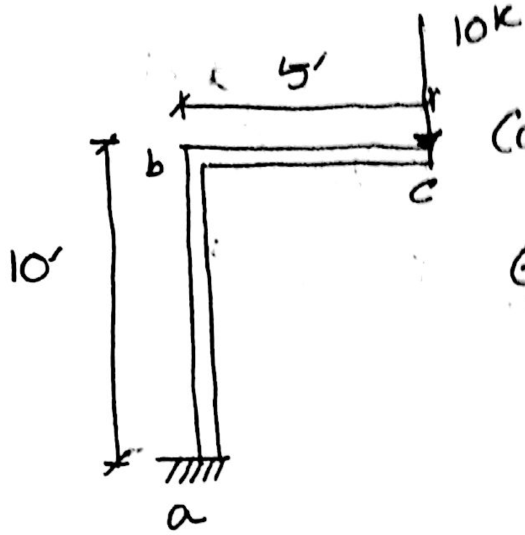
FRAME



Compute deflection at 'C'.

Given,

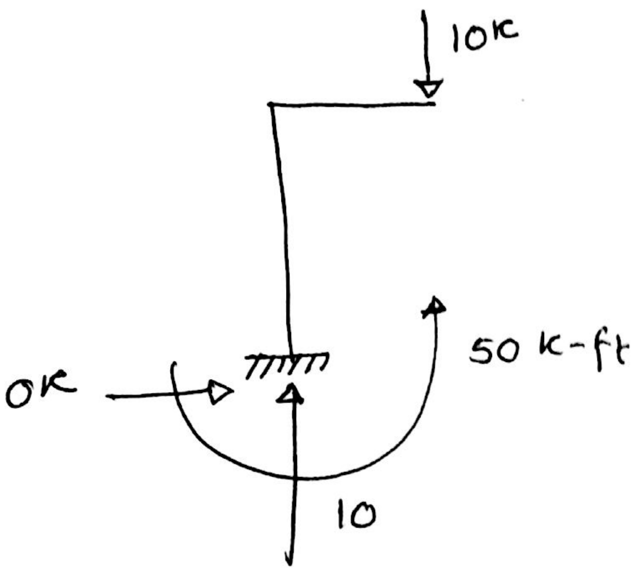
E = 30000

A = 10 inch^2

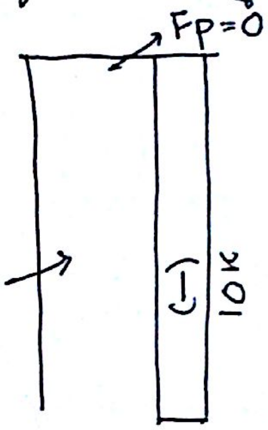
I = 200 inch^4

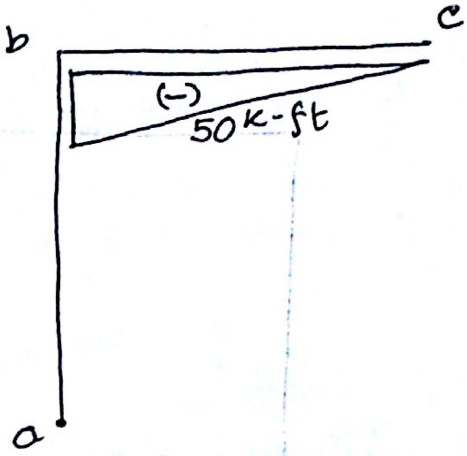
Frame এ Axial force, Moment দুটোই থাকে।

Sol^n for 'P' force:

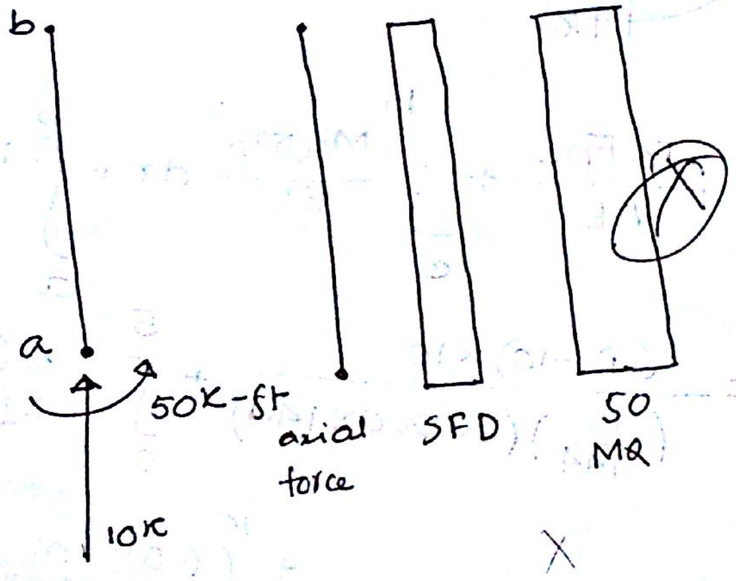


Axial force diagram

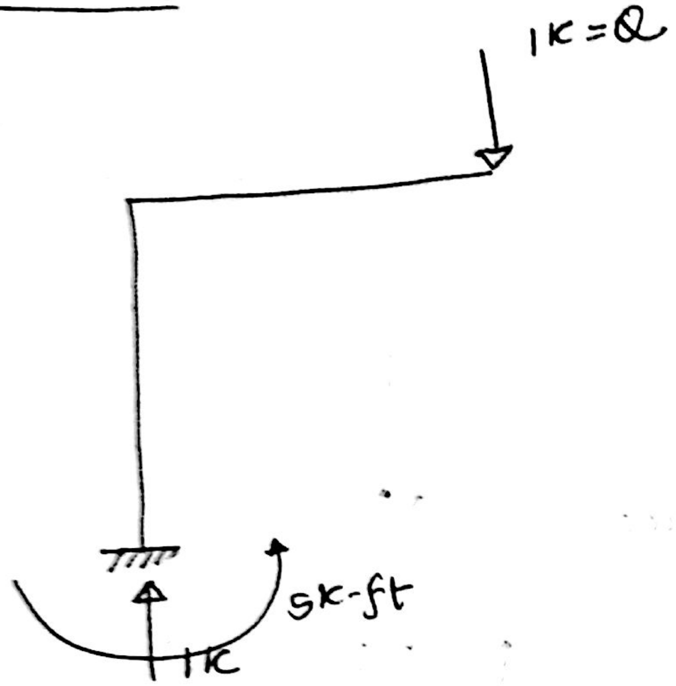




Axial force



For 'Q' Force :



$$\Sigma Q \delta_c = \frac{\Sigma F_Q F_P L}{AE} + \int_c^b \frac{M_Q M_P}{EI} dx + \int_a^b \frac{M_Q M_P}{EI} dx$$

$$= \frac{(-1)(-10) \times 10}{\left(\frac{10}{144}\right)(30{,}000 \times 144)} + \int_0^5 \frac{(-x)(-10x)}{EI} dx$$

$$+ \int_0^{10} \frac{(-5)(-50)}{EI} dx$$

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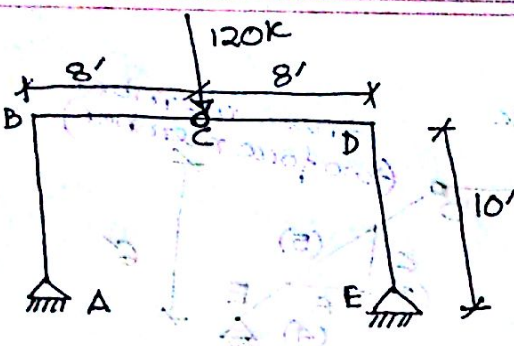
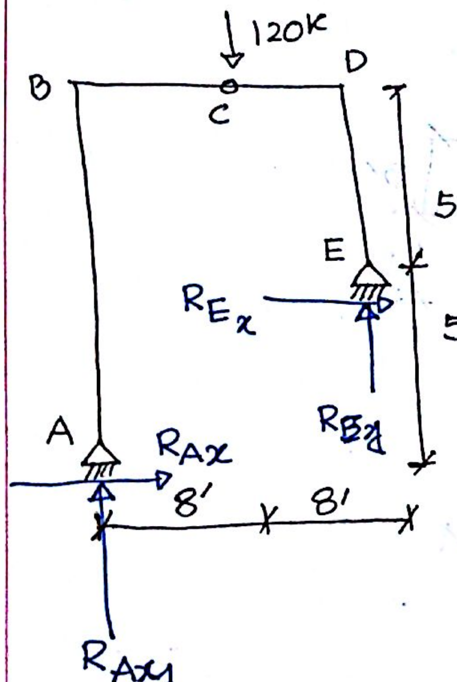
Ex 8.6 22/03/2015



Given, $E = 30{,}000$ ksi
$A = 20$ inch^2
$I = 2500$ inch^4

Compute the change in slope of cross-section on the left side of the hinge 'c'.

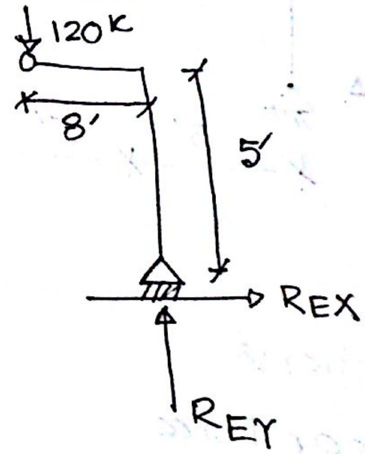


whole structure

$\Sigma M @ A = 0 = 120 \times 8 + R_{Ex} \times 5 - R_{EY} \times 16$

$5R_{Ex} - 16R_{EY} = -960$ —— (1)

Right bar



$\Sigma M @ C = 0$

$= -R_{EY} \times 8 - R_{EX} \times 5$

or, $8R_{EY} + 5R_{EX} = 0$

$R_{EY} = 40^k (\uparrow)$

$R_{EX} = -64^k (\leftarrow)$

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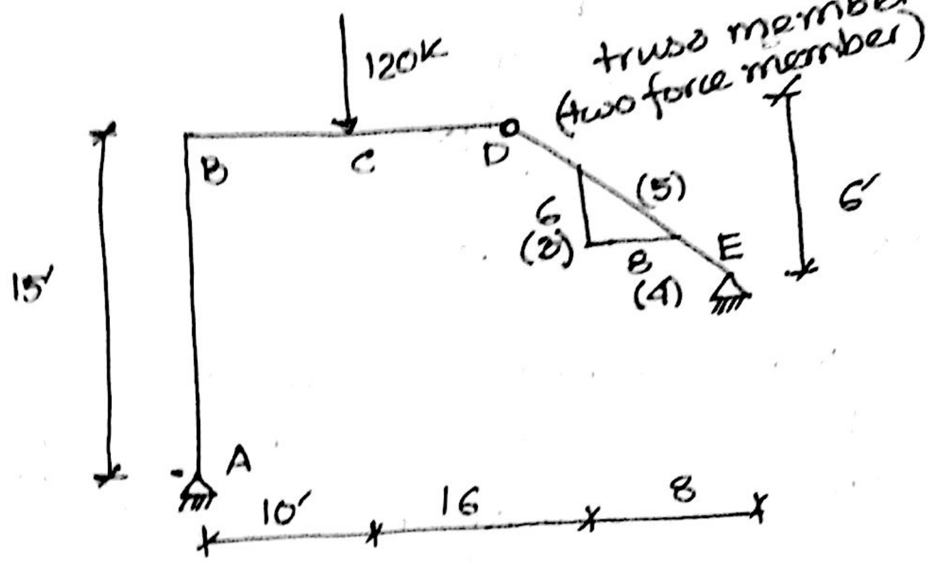
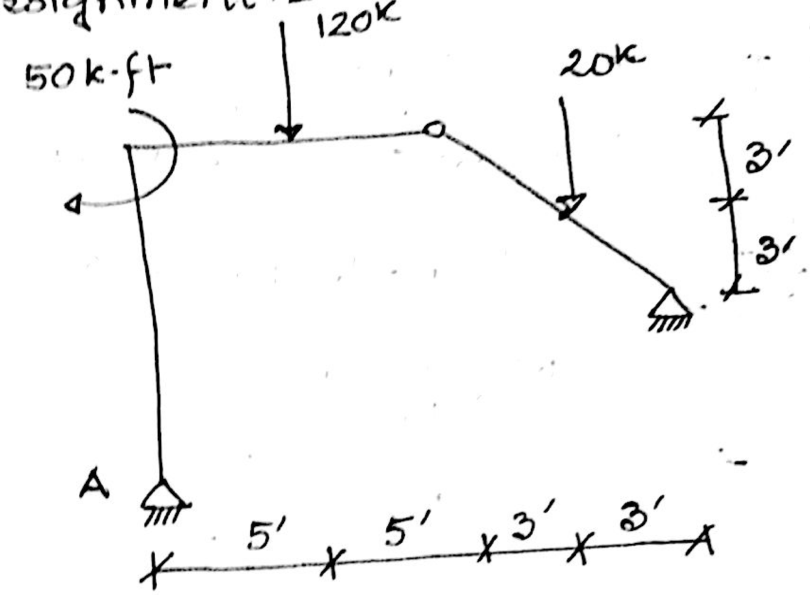
Assignment: 09



Assignment: 10



Find:

1) Reactions
2) Shear Force
3) Bending moment

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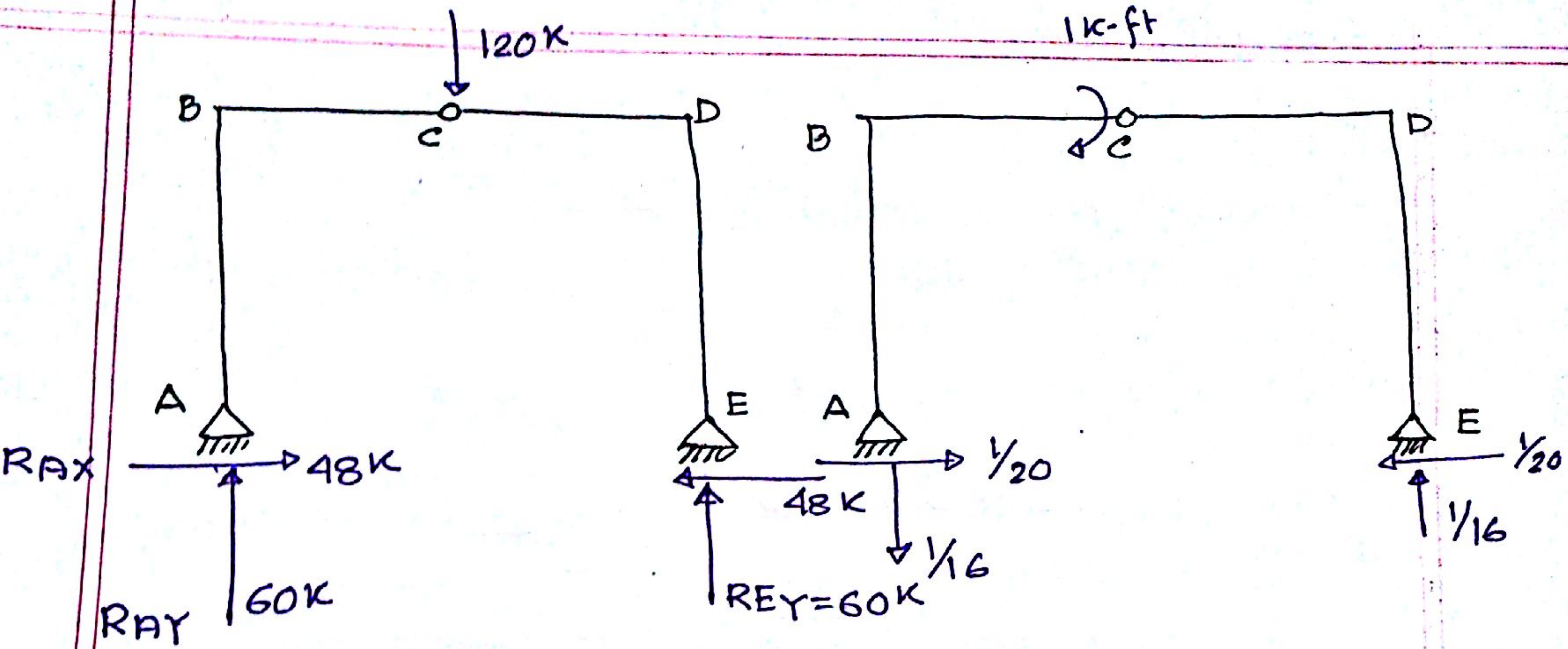

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