University of Maryland
ENCE353: Introduction to Structural Analysis

Fall 2013
Exam #2

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Name: Solution

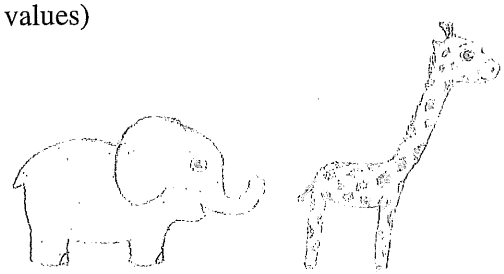
CSI 3117: 9:00-9:50AM, November 15, 2013
Closed book, closed notes, one sheet of notes and integration tables allowed
Show all work

Problem	Points	Score
1	10	10
2	10	10
3	10	10
4	10	10
Total	40	40

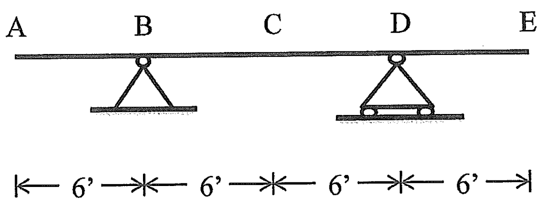
Problem 1 (10 Points)

a) Draw the influence lines for $\mathbf{B_y}$ and $\mathbf{M_c}$ (Show all values)

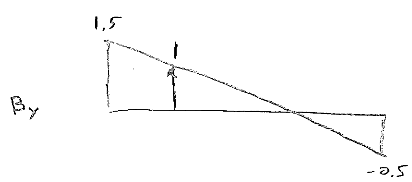
b) Stephanie and Kelsey are delivering a couple animals to Tonia's new zoo. If a **distributed elephant load of 2 k/ft** is located along section AB, and a **giraffe point load of 1.8 k** is at C, using the influence lines, find the vertical reaction at B and the moment at C

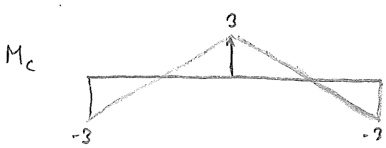


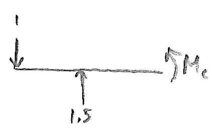
Hint: Use the Müller-Breslau principle to save time



a)







$\circlearrowleft + \Sigma M_c = 0$: $M_c - 1.5(6) + 1(12) = 0$

$\Rightarrow M_c = -3$

b)

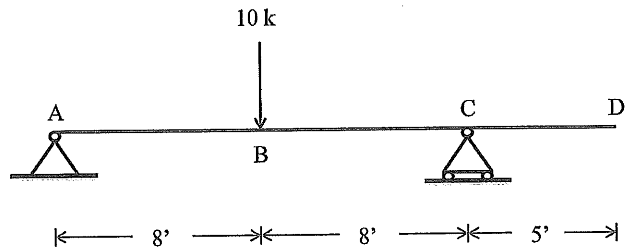
$B_y = 2\left[\frac{1}{2}(1.5+1)(6)\right] + 1.8(0.5) = 15.9\ k$

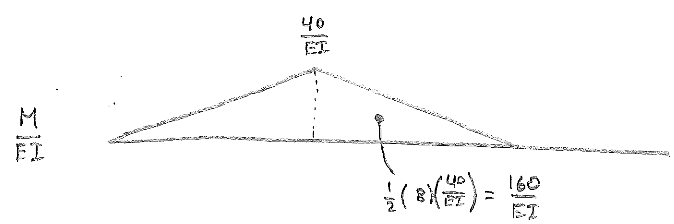
$M_c = 2\left[\frac{1}{2}(-3)(6)\right] + 1.8(3) = -12.6k$

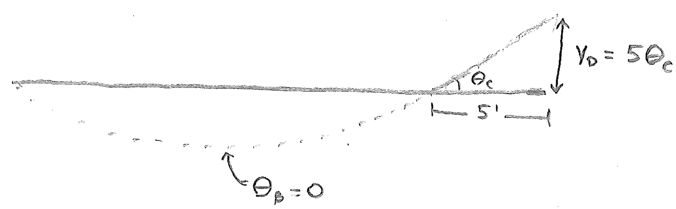
$\boldsymbol{B_y} =$ 15.9 k
$\boldsymbol{M_C} =$ -12.6 k·ft

Problem 2 (10 Points)

Use the **moment-area** method to determine the deflection at D
$E = 29{,}000$ ksi, $I = 100$ in.^{4} for the entire span of the beam
Provide the solution in inches







$\theta_{B/C} = \cancel{\theta_B}^{0} - \theta_C \quad \Rightarrow \quad \theta_C = -\theta_{B/C} = -\frac{160}{EI}$

$Y_D = 5\left(\frac{160}{EI}\right) = \frac{800}{EI} = \frac{800}{(29000)(100)} \times 12^3 = 0.477 \text{ in.}$

$\boxed{y_D = 0.477 \text{ in. } \uparrow}$

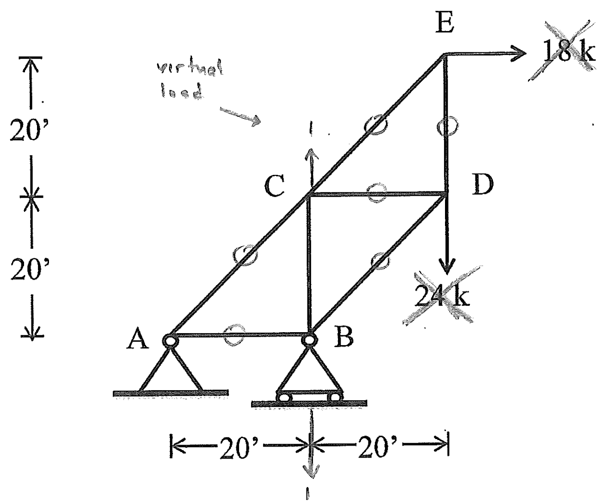
Problem 3 (10 Points)

a) Use **virtual work** to determine the vertical displacement of C
b) If the reaction at B settles 0.5 in, what is the new value for Δ_{Cy}?

Area of members: $A_{AB} = A_{AC} = A_{BC} = 3\ in.^2$ $\quad A_{BD} = A_{CD} = A_{CE} = A_{DE} = 5\ in.^2$
$E = 29{,}000\ ksi$ for all members
For the given loading, the axial forces are

$F_{AB} = 42\ (C)$ $\quad F_{AC} = 84.85\ (T)$ $\quad F_{BC} = 42\ (C)$ $\quad F_{BD} = 59.40\ (C)$
$F_{CD} = 42\ (T)$ $\quad F_{CE} = 25.46\ (C)$ $\quad F_{DE} = 18\ (C)$

Hint: Solve for the virtual axial forces first. (There will be zero force members)



Virtual

$F_{BC} = 1\ (T)$

All others = 0

$B_y = -1$

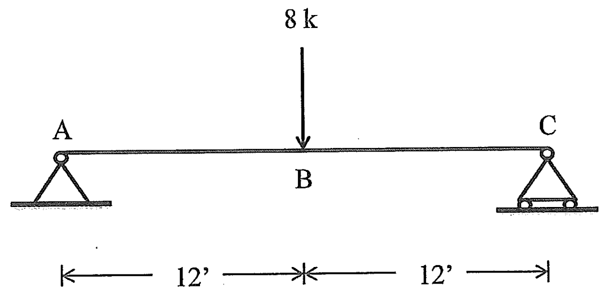
a) $(1)\Delta_c = \Sigma \frac{nNL}{EA}$ $\Rightarrow$ $\Delta_c = \frac{(1)(-42)(20)}{(29000)(3)} \times 12 = -0.116$ in.

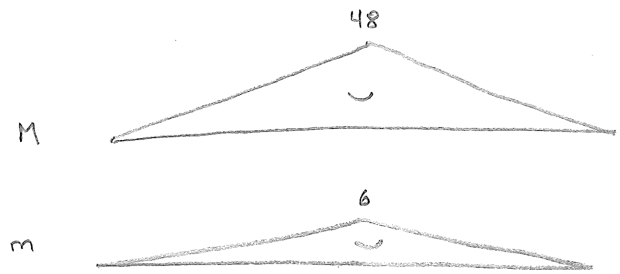
b) $(1)\Delta_c + \Sigma R\Delta_R = \Sigma \frac{nNL}{EA}$ $\Rightarrow$ $\Delta_c + (-1)(-0.5) = -0.116$ $\Rightarrow$ $\Delta_c = -0.616$ in.

a) $\Delta_{Cy} =$ 0.116 in. ↓
b) $\Delta_{Cy} =$ 0.616 in. ↓

Problem 4 (10 Points)

Using **virtual work**, determine the value of $\boldsymbol{I}$ that will provide a displacement of 0.5 in. at point B. Assume $E = 29{,}000\ ksi$ for the length of the beam.





$$(-1)\Delta_B = \int_0^L \frac{mM}{EI}\,dx \quad \Rightarrow (-1)(-0.5) = \frac{1}{(29000)\,I}\left[\frac{1}{3}(6)(48)(24)\right]\times 12^3$$

$$\Rightarrow \quad I = 274.57 \text{ in.}^4$$

$\boxed{I = 274.57 \text{ in.}^4}$