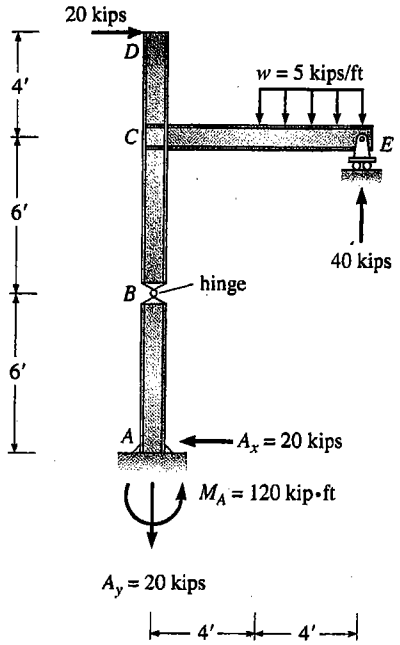
TLK/LLL/JRM | CVEN 345 EXAM 2 | April 18, 2005

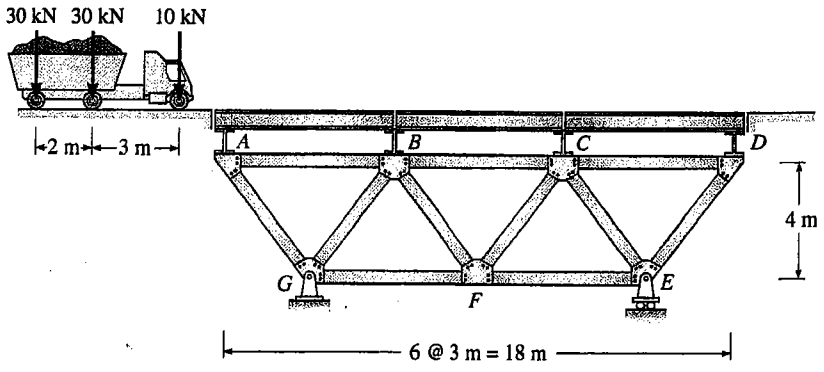
NAME:_____ **Student I.D.**_____

CLOSED BOOK AND NOTES. Your work should be legible, neat and presented in a logical, stepwise manner. You need only to present your solution (i.e. – Given, Required, not necessary). However, **YOU MUST SHOW ALL YOUR WORK TO RECEIVE FULL CREDIT FOR A PROBLEM.**

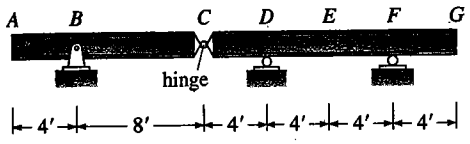
Problem: 1 (20 pts)
Draw the complete shear and bending moment diagrams for the frame shown below. The diagrams should be drawn on axes that have the same shape as the frame. You may "explode" the structure for your diagrams to avoid overlap at the corners. Be sure to include numerical values for all maxima, minima values and appropriate slopes.



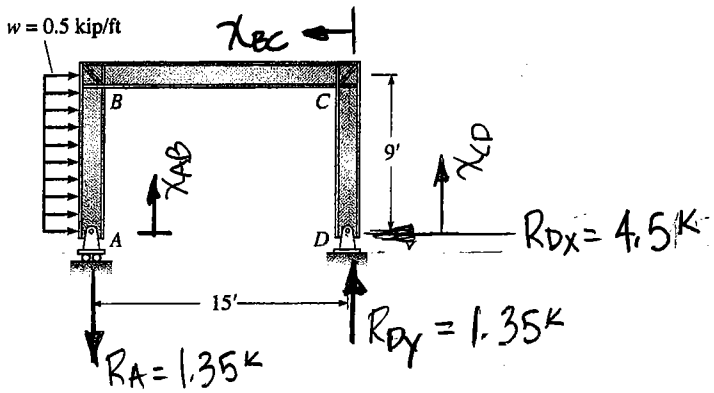
Problem: 2 (20 pts)
A bridge is composed of two parallel trusses in the configuration shown below. Draw the influence line for: a) the vertical reaction at E, b) member CF. You may assume that a deck/stringer/floor beam system exists so that the load is smoothly transmitted from one panel point to the next along the top chord AD. c) Compute the maximum tension force for member CF for a uniformly distributed live load of 0.64 KN/m and the wheel loads shown. The distributed load can act anywhere at any length with the wheel loads and the truck can move in either direction. You may neglect the affects of the dead load.



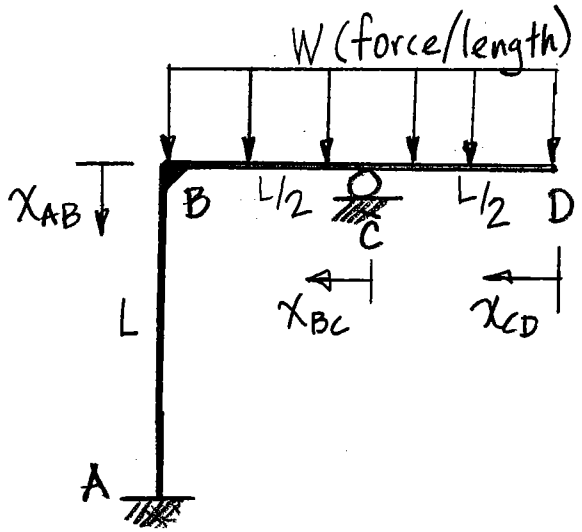
Problem: 3 (20 pts)
Draw the influence lines for the: a) reaction at B, b) reaction at F, c) moment at E, d) shear at E, e) shear at a section just to the left of support D.



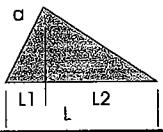
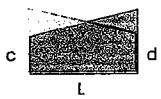
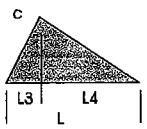
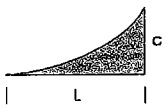
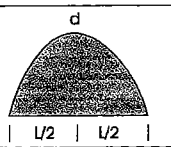
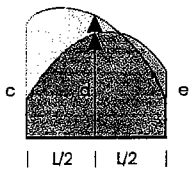
Problem: 4 (20 pts)
Compute the horizontal deflection (in inches) at C **using the coordinate systems shown for each span if you use the integral method**. You must use virtual work for your solution. Assume E = 29,000 kips/in^2 for all members. The moment of inertia for all members is 600 in^4.



Problem: 5 (20 pts)
Compute the reactions in the frame shown below using the method of consistent displacements and virtual work. **You must use the coordinate system provided for each span if you use the integral method.** Note, EI = constant for all members.



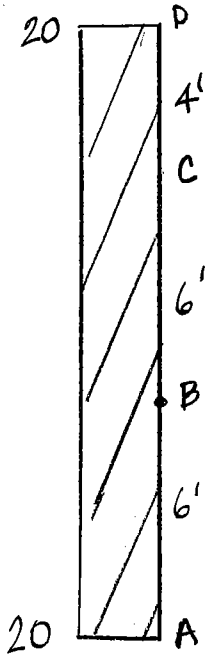
VOLUME INTEGRALS

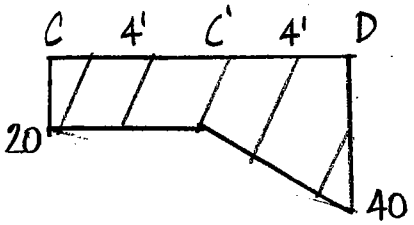
					
	Lac	$\frac{Lac}{2}$	$\frac{Lac}{2}$	$\frac{Lc(a+b)}{2}$	$\frac{Lac}{2}$
	$\frac{Lac}{2}$	$\frac{Lac}{3}$	$\frac{Lac}{6}$	$\frac{Lc(2a+b)}{6}$	$\frac{(L+L_2)ac}{6}$
	$\frac{Lac}{2}$	$\frac{Lac}{6}$	$\frac{Lac}{3}$	$\frac{Lc(a+2b)}{6}$	$\frac{(L+L_1)ac}{6}$
	$\frac{La(c+d)}{2}$	$\frac{La(2c+d)}{6}$	$\frac{La(c+2d)}{6}$	$\frac{La(2c+d)+Lb(c+2d)}{6}$	$\frac{ac(L+L_2)+ad(L+L_1)}{6}$
	$\frac{Lac}{2}$	$\frac{(L+L_4)ac}{6}$	$\frac{(L+L_3)ac}{6}$	$\frac{ac(L+L_4)+bc(L+L_3)}{6}$	For $L_3<=L_1$ ONLY: $\frac{acL(2-((L_1-L_3)^2/L_1L_4))}{6}$
	$\frac{Lac}{3}$	$\frac{Lac}{12}$	$\frac{Lac}{4}$	$\frac{Lc(a+3b)}{12}$	Worthless
	$\frac{2Lad}{3}$	$\frac{Lad}{3}$	$\frac{Lad}{3}$	$\frac{Ld(a+b)}{3}$	$\frac{ad(L+(L_1L_2)/L)}{3}$
	$\frac{La(c+4d+e)}{6}$	$\frac{La(c+2d)}{6}$	$\frac{La(2d+e)}{6}$	$\frac{La(c+2d)+Lb(2d+e)}{6}$	Unknown

L is the total length of the member.
d is the central ordinate of the parabola.
The parabola values c, d, e, can be positive or negative.
The trapezoid a/c value can be greater of smaller than its b/d value.

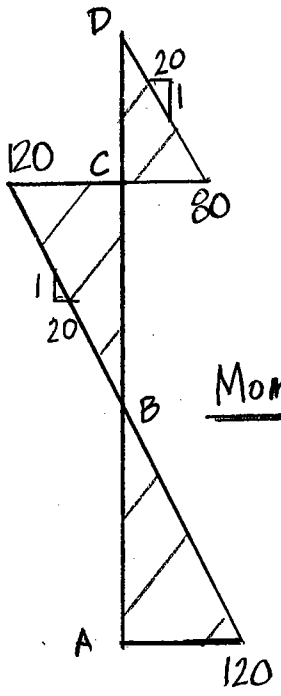
Exam 2 - Solutions:

Problem: 1

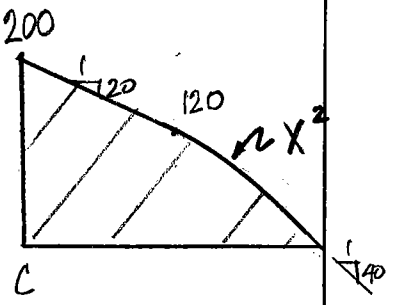




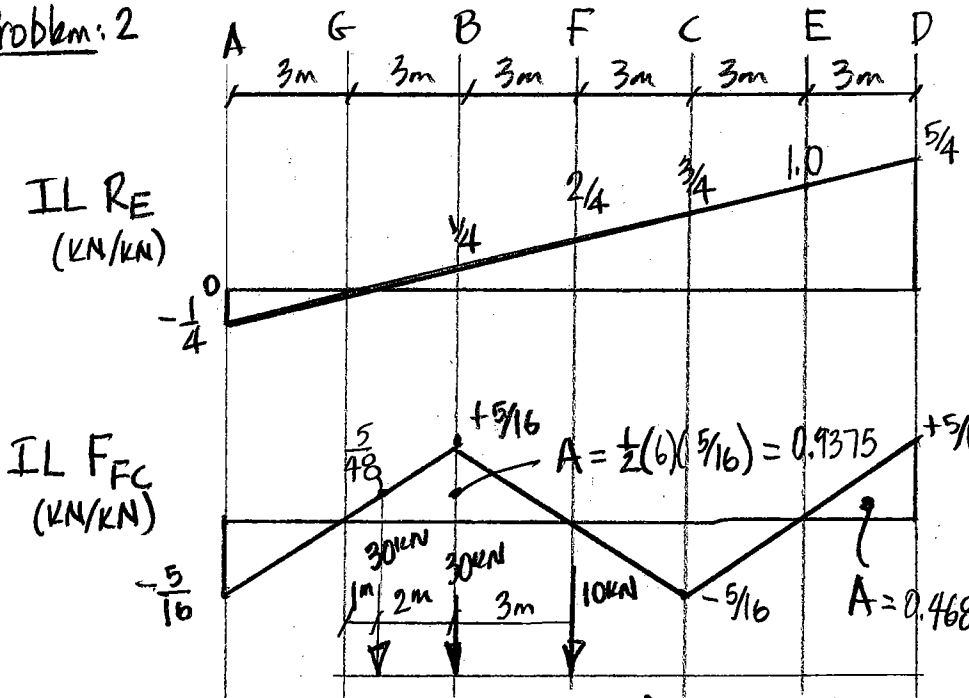
Shear (Kips)

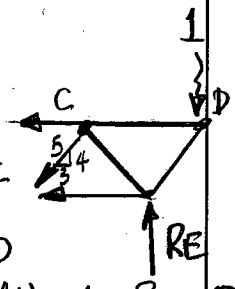


Moment (Kip-ft)



Problem: 2





$+\circlearrowleft \Sigma F_y = 0$

$-F_{FC}(4/5) - 1 + R_E = 0$

$F_{FC} = \frac{5}{4}(R_E - 1)$ @ C : D

$F_{FC} = \frac{5}{4}(R_E)$ @ A : B

Place W_{Live} from G to F and from E to D.

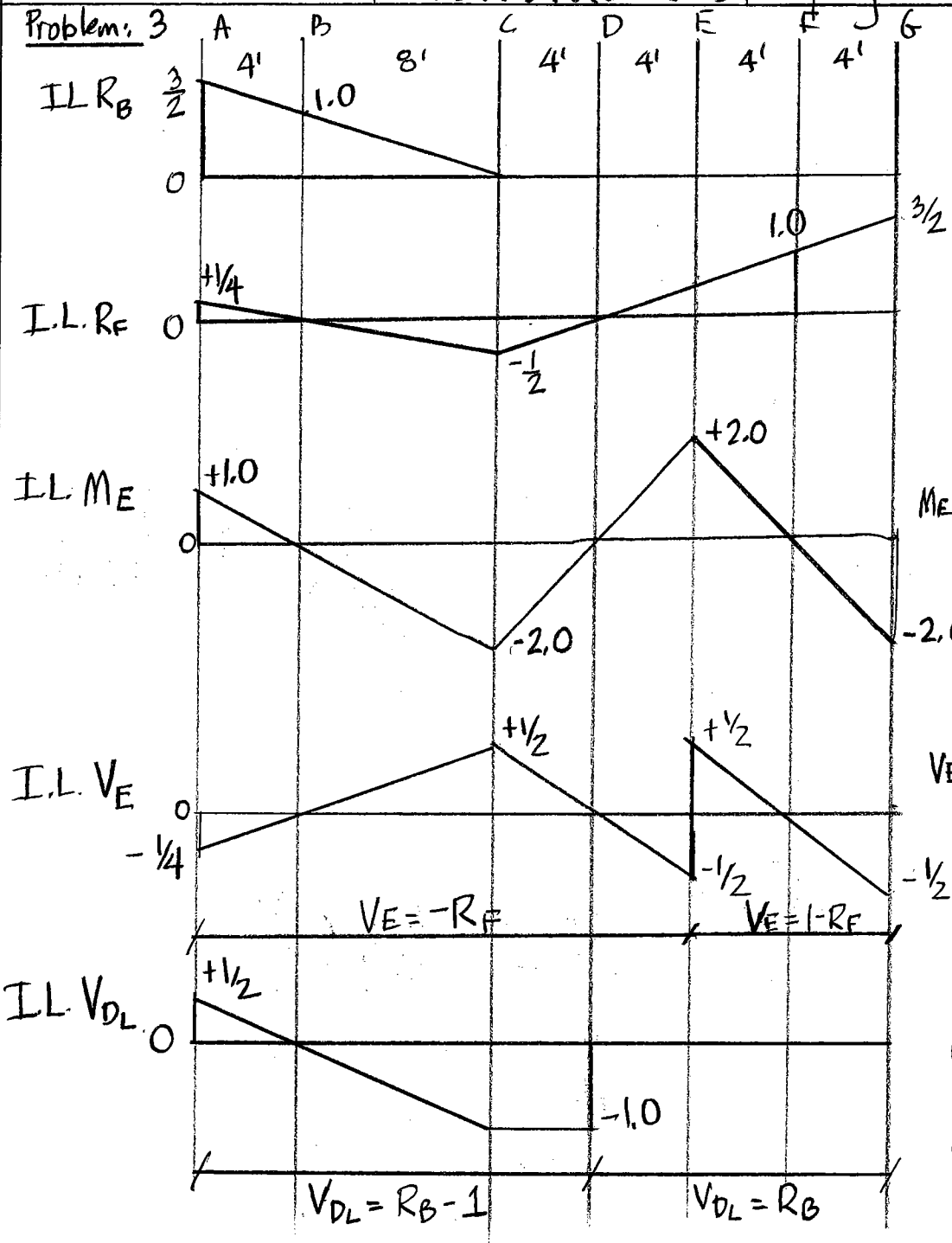
$(F_{FC})_{max_T} = 30^{KN}\left(\frac{5}{48} + \frac{5}{16}\right) + 0.64^{KN/ft}(0.9375 + 0.4688)^{ft}$

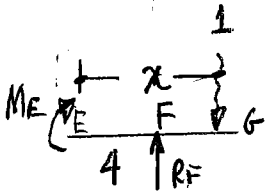
$= 12.50^{KN} + 0.900^{KN} = 13.40^{KN}$ (for both trusses)

$(F_{FC})_{max_T} = 6.70^{KN}\ T$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

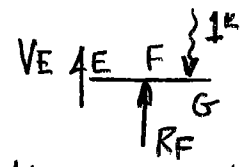
Problem: 3





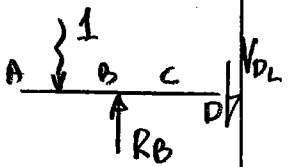
$M_E = 4R_F - 1x$ (E to G)

$M_E = 4R_F$ (A to E)



$V_E = 1 - R_F$ (E to G)

$V_E = -R_F$ (A to E)



$V_{DL} = R_B - 1$ (A to D)

$V_{DL} = R_B$ (D to G)

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22-144 200 SHEETS
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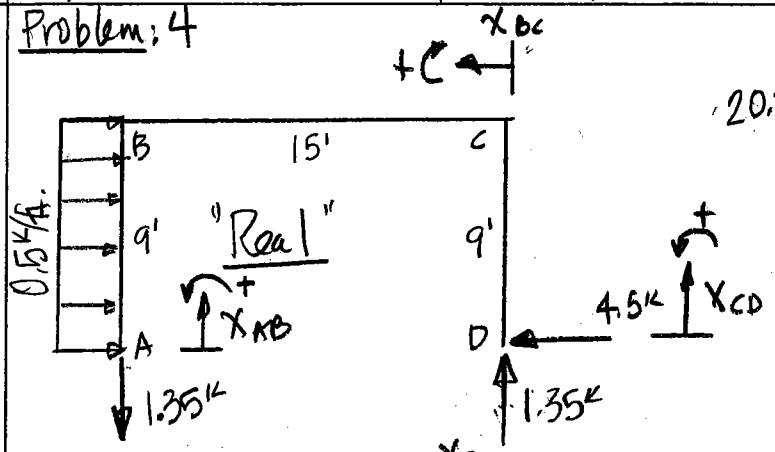
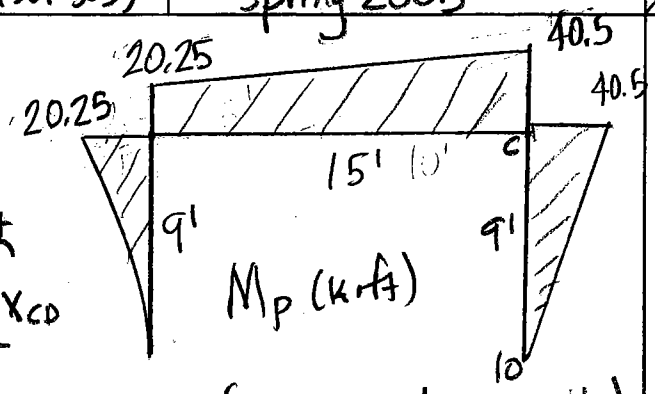
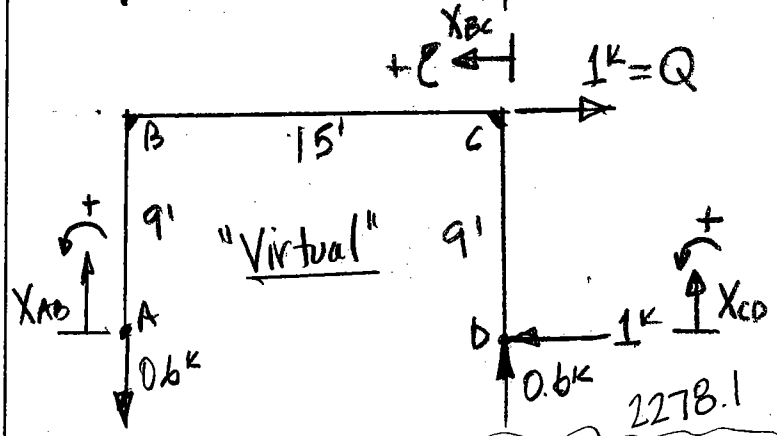
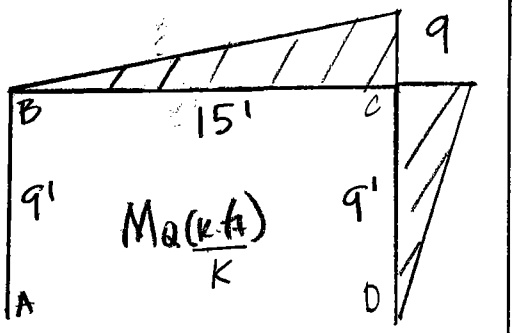
Problem: 4





(Drawn on tension side)





$$\Delta_{CX} = \frac{1}{EI}\left[\underbrace{0}_{AB} + \underbrace{\frac{(15)(9)(2*40.5+20.25)}{6}}_{2278.1} + \underbrace{\frac{(9)(40.5)(9)}{3}}_{10935}\right]_{CD} = \frac{1}{EI}\left[\frac{3371\ k\cdot ft^3}{EI}\right]$$

$$\Delta_{CX} = \frac{3371 \times 1728\ k\cdot in^3}{(29{,}000\ k/in^2)(600\ in^4)} = \underline{0.335\ in \rightarrow}$$

Equation Method: $M_{AB} = -\frac{0.5}{2}x^2$; $M_{BC} = 1.35x - 40.5$; $M_{CD} = 4.5x$

$M_{ab} = 0$; $M_{DC} = 0.6x - 9$; $m_{CD} = x$

$$\Delta_{CX} = \frac{1}{EI}\left[\int_0^9 (0)\,dx + \int_0^{15} (1.35x - 40.5)(0.6x - 9)\,dx + \int_0^9 (4.5x)(x)\,dx\right]$$

$$= \frac{1}{EI}\left[\int_0^{15} (0.810x^2 - 36.45x + 364.5)\,dx + \int_0^9 4.5x^2\right]$$

$$= \frac{1}{EI}\left[\underbrace{0.270x^3 - 18.23x^2 + 364.5x\Big|_0^{15}}_{2277} + \underbrace{1.5x^3\Big|_0^9}_{10935}\right] = \frac{3371\ k\cdot ft^3}{EI}$$

$\Delta_{CX} = 0.335\ in \rightarrow$

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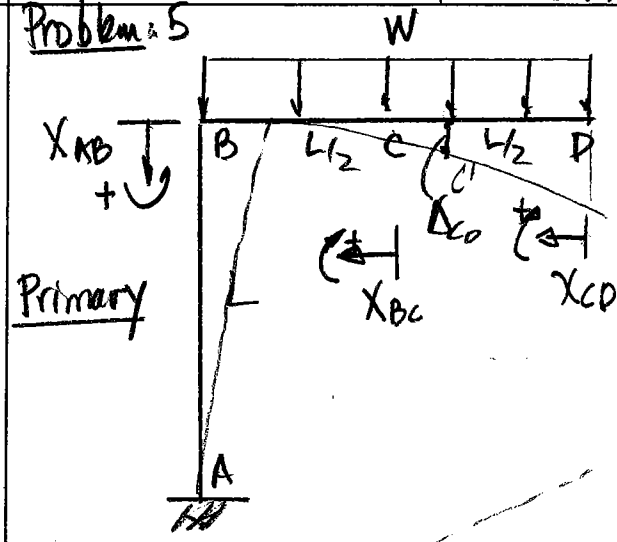
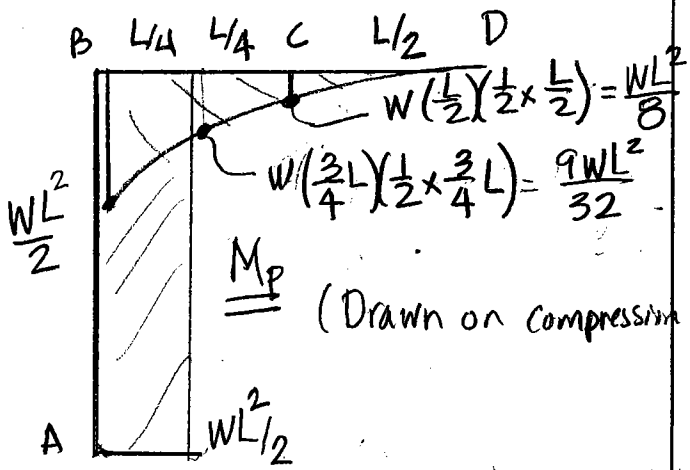
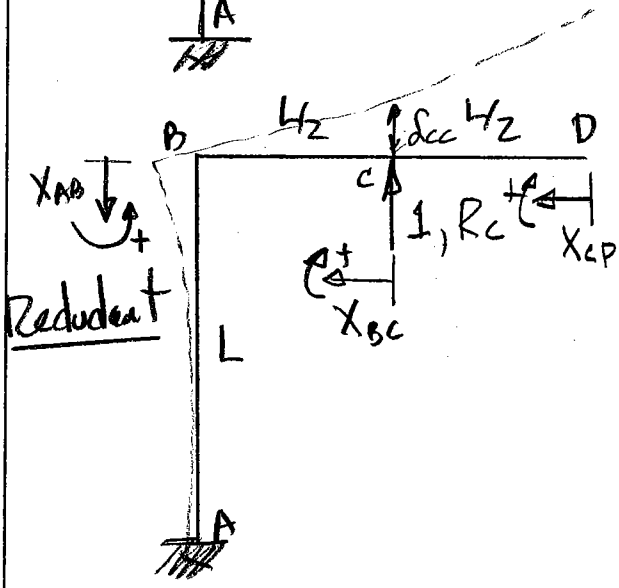
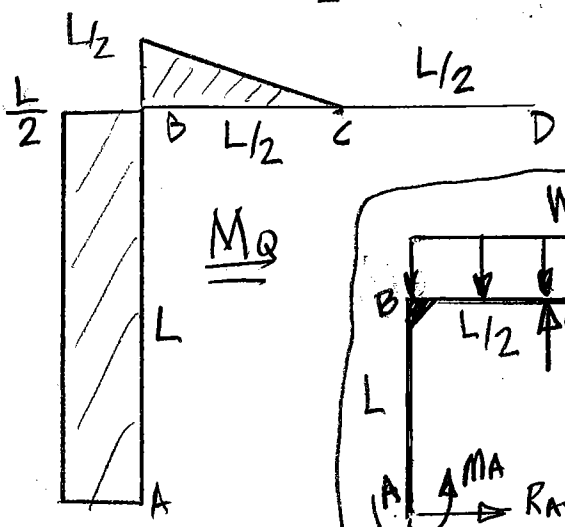
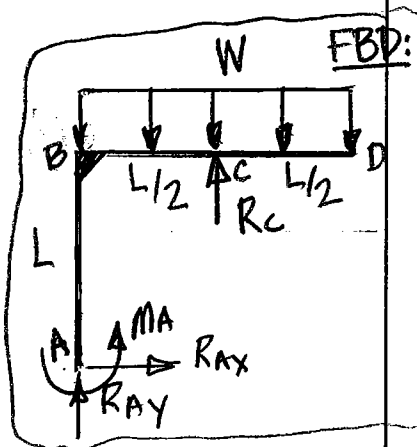
Problem 5











Compatibility: $\Delta_{CO} + R_C \delta_{CC} = 0$

$$\Delta_{CO} = \frac{1}{EI}\left[\left(\frac{-WL^2}{2}\right)\left(\frac{L}{2}\right)(L) + \left(\frac{L}{2}\right)\left(\frac{L}{2}\right)\left(\frac{-WL^2}{2}, + 2*\frac{-9WL^2}{32}\right)\left(\frac{1}{6}\right)\right]$$

$$\Delta_{CO} = -0.294\frac{WL^4}{EI} = \frac{0.294WL^4}{EI} \downarrow$$

$$\delta_{CC} = \frac{1}{EI}\left[(L)\left(\frac{L}{2}\right)\left(\frac{L}{2}\right) + \left(\frac{L}{2}\right)\left(\frac{L}{2}\right)\left(\frac{L}{2}\right)\left(\frac{1}{3}\right)\right] = \frac{0.292L^3}{EI} \uparrow$$

$$\therefore +\uparrow \quad -0.294\frac{WL^4}{EI} + \left(0.292\frac{L^3}{EI}\right)R_C = 0$$

$$\underline{R_C = WL \uparrow}$$

Equilibrium: $\pm\Sigma F_x = 0$; $\underline{R_{AX} = 0}$; $(+\Sigma M = 0$; $\underline{M_A = 0}$

$+\uparrow \Sigma F_y = 0$; $\underline{R_{AY} = 0}$

Problem: 5

Equation Method:

$M_{AB} = \frac{WL^2}{2}$; $M_{BC} = \frac{-W(X+L/2)^2}{2}$ $M_{CD} = \frac{-WX^2}{2}$

$m_{AB} = -\frac{L}{2}$ $m_{BC} = +X$ $m_{CD} = 0$

$$\Delta_{CO} = \frac{1}{EI}\left[\int_0^L \left(\frac{WL^2}{2}\right)\left(-\frac{L}{2}\right)dx + \int_0^{L/2}\left(\frac{-W(X+L/2)^2}{2}\right)(X)\,dx + 0\right]$$

$$= \frac{1}{EI}\left[\int_0^L \frac{-WL^3}{4}\,dx + \int_0^{L/2} -\frac{W}{2}\left(X^3 + X^2L + \frac{L^2}{4}X\right)dx + 0\right]$$

$$= \frac{-W}{EI}\left[+\frac{L^3}{4}X\Big|_0^L + \frac{X^4}{8} + \frac{X^3L}{6} + \frac{L^2X^2}{16}\Big|_0^{L/2}\right]$$

$$= \frac{-WL^4}{EI}\left[\frac{1}{4} + 0.00781 + 0.02083 + 0.01563\right] = -0.294\frac{WL^4}{EI}$$

$$\Delta_{CO} = 0.294\frac{WL^4}{EI} \downarrow$$

$$\delta_{CC} = \frac{1}{EI}\left[\int_0^L \left(-\frac{L}{2}\right)\left(-\frac{L}{2}\right)dx + \int_0^{L/2}(X)(X)\,dx + 0\right]$$

$$= \frac{1}{EI}\left[+\frac{L^2X}{4}\Big|_0^L + \frac{X^3}{3}\Big|_0^{L/2}\right] = \frac{L^3}{EI}\left(\frac{1}{4} + \frac{1}{24}\right) = 0.292\frac{L^3}{EI}$$

$\delta_{CC} = 0.292\frac{L^3}{EI}\uparrow$; by compatibility: $-0.294\frac{WL^4}{EI} + \left(0.292\frac{L^3}{EI}\right)R_C = 0$

$R_C = WL \uparrow$

by equilibrium: $R_{AX} = 0$; $R_{AY} = 0$; $M_A = 0$.

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