CE 120 – Structural Engineering

Mid-Term Examination No. 1

Instructions:

- Read these instructions. Do not open the exam until instructed to do so.
- Work all problems. Pace yourself so that you have time to work on each problem. Show all relevant work.
- Start solutions alongside or immediately following problem statements. If additional space is required, insert additional sheets. Do not show the work for more than one problem on any given sheet of paper.
- Organize and write solutions neatly. Points will be taken off for messy solutions.
- Indicate units and sign conventions in final solutions. Points will be taken off if units are missing or signs are unclear.
- If you have any questions, or need any paper or other materials, walk to the front of the classroom and ask the instructor. Do not raise your hand to get the instructor's attention, and do not call out questions from your seat.

Some potentially useful equations:

$\Sigma F_x = 0;\ \Sigma F_y = 0;\ \Sigma \mathrm{M} = 0$

$n = r - 3m; \quad n = r - 2\mathrm{j}$

	Possible Points	Score	
Problem 1	20		_____
Problem 2	35		_____
Problem 3	35		_____
Problem 4	10		_____
TOTAL	100		_____

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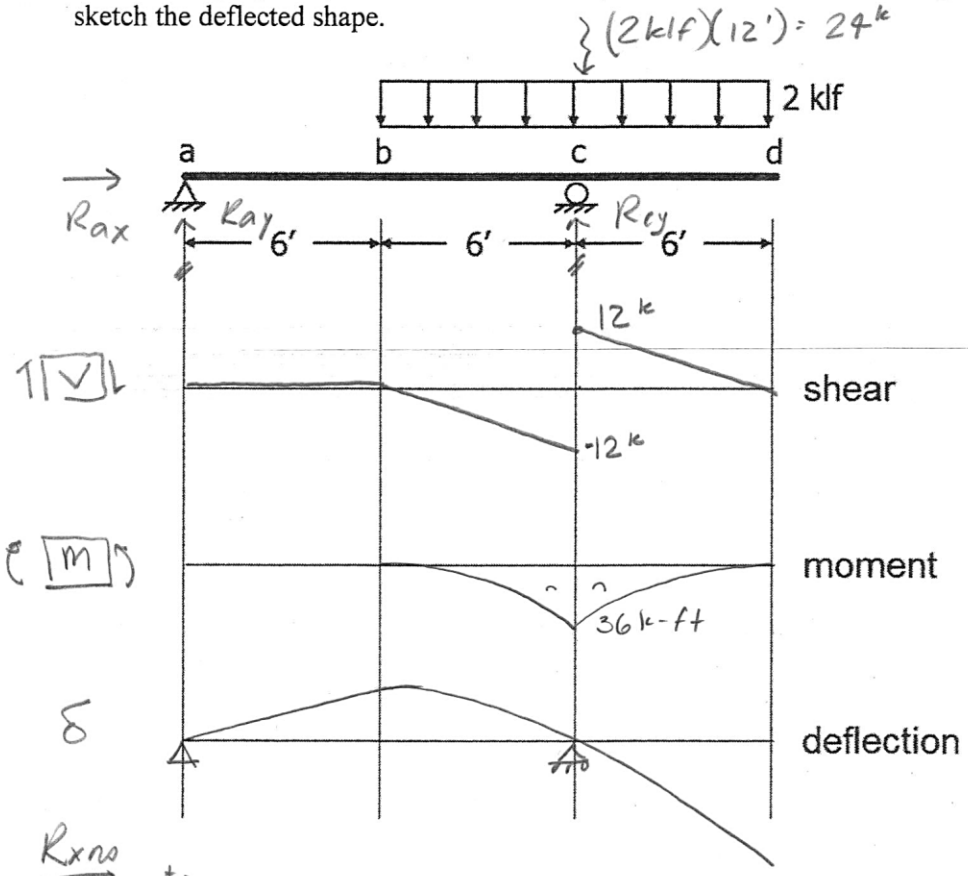
Problem 1 (20 points) – For the beam shown, draw shear and moment diagrams, indicating the peak values, and sketch the deflected shape.



R_{xns}

$\overset{+}{\rightarrow} \Sigma F_x = 0 \rightarrow \underline{R_{ax} = 0}$

$(+\circlearrowleft) \Sigma M_a = 0 \rightarrow (24^k)(12') - R_{cy}(12') = 0 \rightarrow \underline{R_{cy} = 24^k}$

$(+\circlearrowleft) \Sigma M_c = 0 \rightarrow (24')(0') + R_{ay}(12') = 0 \rightarrow \underline{R_{ay} = 0}$

Shear & Moment

$V_{c^-} = (2\ klf)(6') = -12^k$

$V_{c^+} = -12^k + 24^k = 12^k$

$M_c = (-12^k)(6')\left(\frac{1}{2}\right) = 36\ k\text{-}ft$

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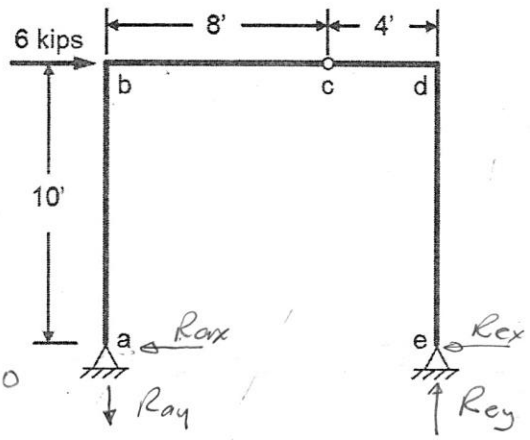
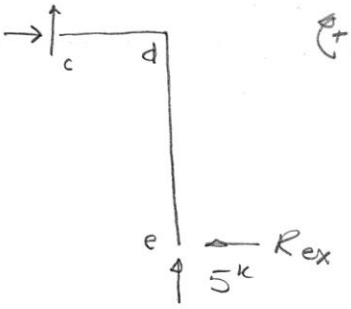
Problem 2 (35 points) – A 6 kip load is applied to a weightless frame as shown. Plot the axial force (P), shear (V), and moment (M) diagrams, showing key values.



Rxns

$\circlearrowleft + \Sigma M_a = 0 \quad (6^k)(10') - R_{ey}(12') = 0 \rightarrow \underline{R_{ey} = 5^k}$

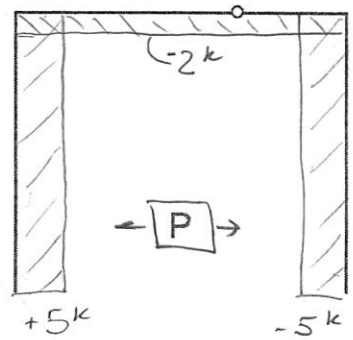
$\circlearrowleft + \Sigma M_e = 0 \quad (6^k)(10') - R_{ay}(12') = 0 \rightarrow \underline{R_{ay} = 5^k}$

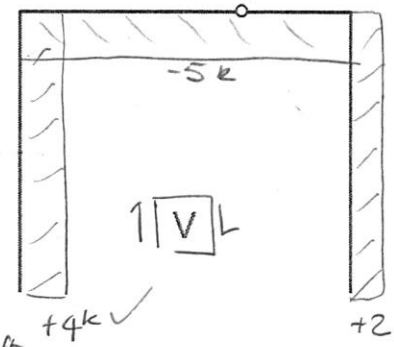


$\circlearrowleft + \Sigma M_c = 0 \quad -(5^k)(4') + R_{ex}(10') = 0$

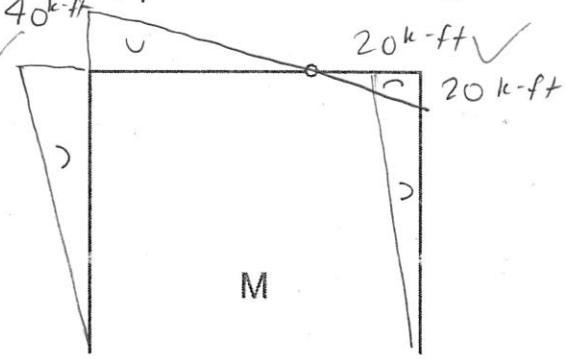
$\hookrightarrow \underline{R_{ex} = 2^k}$

$\Sigma F_x = 0 \rightarrow \underline{R_{ax} = 4^k}$





$(4^k)(10') = 40\,k\text{-ft}$



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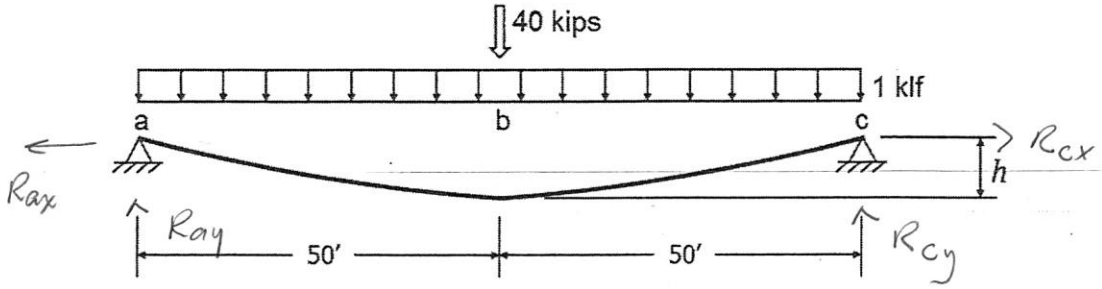
Problem 3 (35 points)

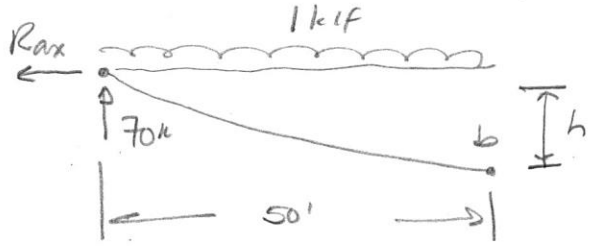
A weightless cable spans 100 ft between points **a** and **c**, which are at the same elevation. The cable supports a uniformly distributed load of 1 klf plus a midspan concentrated load of 40 kips. What value of the cable sag *h* will result in cable tensile force of 250 kips?



Reactions

$\circlearrowleft + \Sigma M_a = 0 \rightarrow \quad (40)(50') + (1\,klf)(100')(50') - R_{cy}(100') = 0 \rightarrow \underline{R_{cy} = 70^k}$

$\circlearrowleft + \Sigma M_c = 0 \rightarrow \quad \underline{R_{ay} = 70^k}$



$\circlearrowleft + \Sigma M_b = 0 \rightarrow (70^k)(50') - (R_{ax})(h) - \frac{(1\,klf)(50)^2}{2} = 0$

$\therefore R_{ax} = \frac{2250}{h}$

$T_{max} = 250^k = \sqrt{R_{ax}^2 + R_{ay}^2} = \sqrt{R_{ax}^2 + 70^2} \rightarrow R_{ax} = 240^k$

$\therefore h = \frac{2250\ ft}{240'} = \underline{9.4\ ft}$

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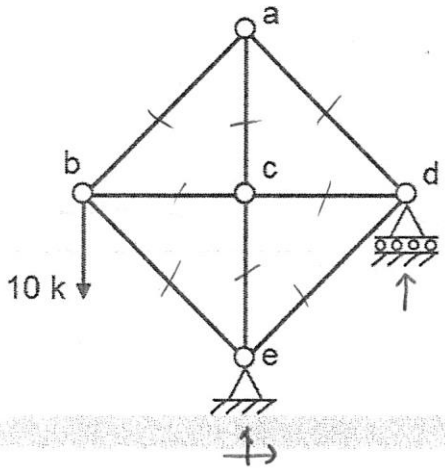
Problem 4 (10 points)

Is the truss shown (a) unstable, (b) stable and determinate, (c) stable and indeterminate, or (d) none of the previous?



r = # Rxns + # Members
= 3 + 8 = 11

$j = 5$

$r - 2j = n = 1$

∴ indeterminate to first degree & stable