

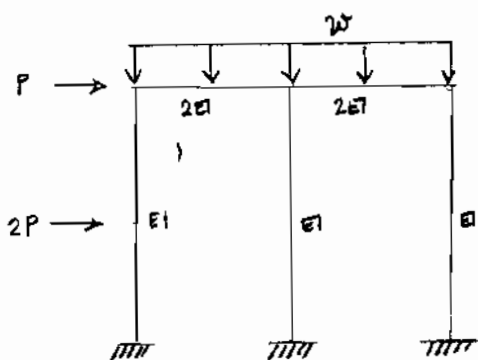
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CE 461 – Structural Analysis
Final Exam

Thanks for all your hard work this semester, and best of luck in your future studies and professional endeavors. It has been a pleasure having each of you in this course. If you would like your final exam grade and your final course grade emailed to you, please indicate so here:

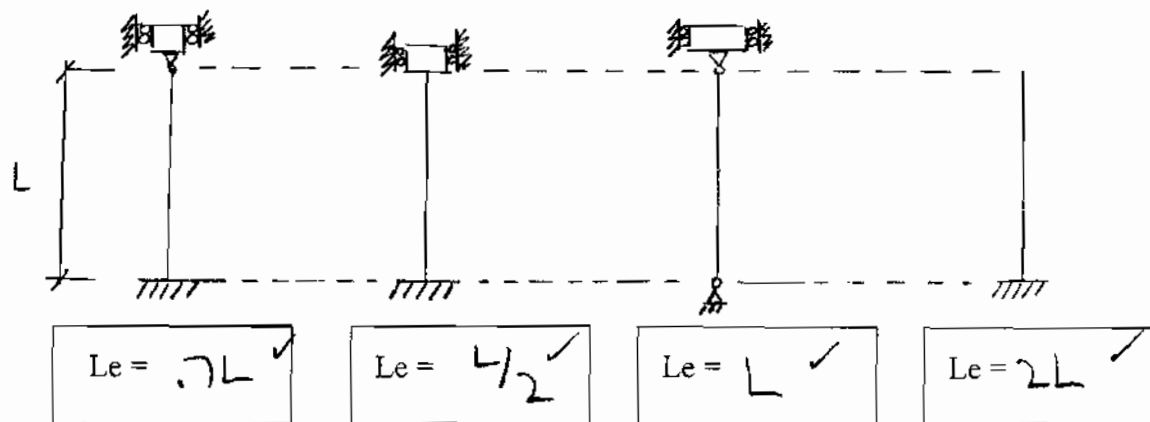
Y / N

1. (3 pts.) Which method of indeterminate analysis that we covered in class would probably be the most *efficient* choice (least computationally intensive) to determine support reactions for the following frame? You only have a pencil, calculator, and paper as tools with which to solve the problem. Your choices are: (1) **Force Method**, (2) **Stiffness Method – Slope Deflection**, and (3) **Stiffness Method – Moment Distribution**. Support your answer. (You will not receive any credit without sufficient reasoning.)



Force method - it would be simpler than the complicated table required for the other two methods - This is actually the most computationally intensive choice

2. (4 pts.) Please supply the effective lengths for each of the following columns.



- ✓ 3. (3 pts.) You have been asked by your boss to design a column of prescribed length L . The material and cross-section dimensions have been chosen for you by the architect. Your preliminary design shows that a pin-pin column of that length, material, and cross-section will buckle under the given loads. What can you do as the engineer-of-record to increase the capacity of the column without changing the overall length, material, or cross-section dimensions? Please be specific.

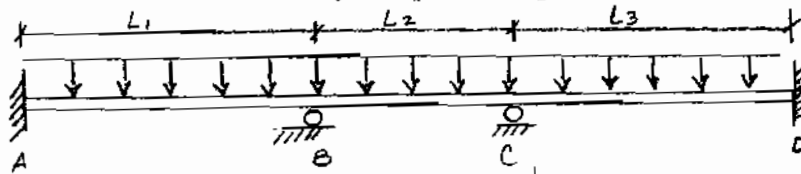
Change the connections to fixed - fixed. It will increase the critical stress of the column.

(Problem 4 got deleted...)

- o 5. (3 pts.) What does a distribution factor in the moment distribution procedure physically describe?

It describes what portion of a moment at one end will be translated to the other end of a beam, X

6. (8 pts.) Fill in the following moment distribution table given the following beam, distribution factors, and fixed end moments. Carry out your precision to 0.10 ft-kip. You may not need to use all the rows in the table to successfully complete this problem.



| | | | | | | |
|-----------|------|-------|-------|--------|--------|-------|
| D.F.s | | 0.444 | 0.556 | 0.556 | 0.444 | |
| FEMs | 78.1 | -78.1 | 50 | -50 | 78.1 | -78.1 |
| Balance | | 12.48 | 15.62 | -15.62 | -12.48 | |
| Carryover | 6.24 | | -7.81 | 7.81 | | -6.24 |
| Balance | | 3.47 | 4.34 | -4.34 | -3.47 | |
| Carryover | 1.73 | | -2.17 | 2.17 | | -1.73 |
| Balance | | .96 | 1.21 | -1.21 | -.96 | |
| Carryover | .48 | | -.6 | .60 | | -.48 |
| Balance | | .27 | .33 | -.33 | -.22 | |
| Carryover | .13 | | -.17 | .17 | | -.13 |
| Balance | | .075 | .095 | -.095 | -.075 | |
| Carryover | .038 | | -.047 | .047 | | -.038 |

FINAL MEMBER END MOMENTS: 86.72, -60.85, 60.80, -60.80, 60.85, -86.72

7. (4 pts.) For the beam in Problem 6, write the complete, numerical slope-deflection equation for M_{AB} if the support at B is subjected to a 4" upheaval due to soil swell. $EI = \text{CONSTANT}$. Assume L_1 is in inches, & write the equation in terms of L_1 .

$$M_{AB} = \frac{2EI}{L} (2\theta_A + \theta_B - 3\psi) + FEM_{AB}$$

$$= \frac{2EI}{L_1} \left(\theta_A - 3\left(\frac{4}{L_1}\right) \right) + 78.1$$

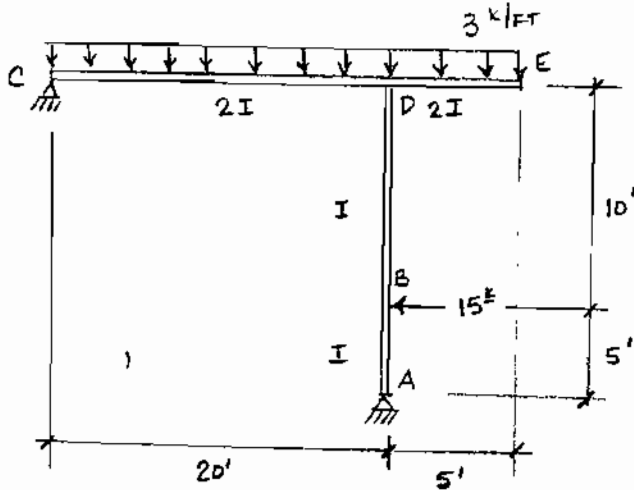
what is the "f" end? $\Rightarrow B$

8. Given the following indeterminate frame,

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(a) (22 pts.) Solve for the member end moments using either the **slope-deflection method** or **moment distribution method**. Please begin the problem by stating which approach you have chosen.

(b) (8 pts.) Draw the shear and moment diagrams for member AD. Be sure to draw moment positive on the compression-side of the member.



$E = \text{CONSTANT}$
Slope Deflection

$$K_{CO} = \frac{3EI}{4 \cdot 20} = .075$$

$$K_{DA} = \frac{3EI}{4 \cdot 15} = .05$$

$$DF_{CO} = \frac{0.75 + .05}{.75 + .05} = .6$$

$$DF_{DA} = \frac{.05}{.075 + .05} = .4$$

$$FEM_{CD} = \frac{wL^2}{2} = \frac{3 \cdot 20^2}{2} = 600$$

$$FEM_{DC} = -\frac{wL^2}{2} = -600$$

$$FEM_{DA} = \frac{P_{AB}L^2}{L^2} = \frac{(15)(10)(15)^2}{15^2} = 16.7$$

$$FEM_{AD} = \frac{P_{AB}L^2}{L^2} = \frac{(15)(15)(15)^2}{15^2} = 75$$

$$M_{AO} = 0$$

$$M_{DA} = \frac{3EI}{15} (\theta_D) + \left(\frac{16.7 - 75}{2} \right)$$

$$M_{DA} = .2EI(\theta_D) - 26.8$$

$$\sum M_D = M_{DA} + M_{DC} = 0$$

$$0 = (.3EI \theta_D - 900) + .2EI \theta_D - 26.8$$

$$.5EI \theta_D - 926.8 = 0$$

$$EI \theta_D = \frac{926.8}{.5}$$

$$EI \theta_D = 1853.6$$

$$M_{DC} = .3EI(1853.6) - 900 = -347.52$$

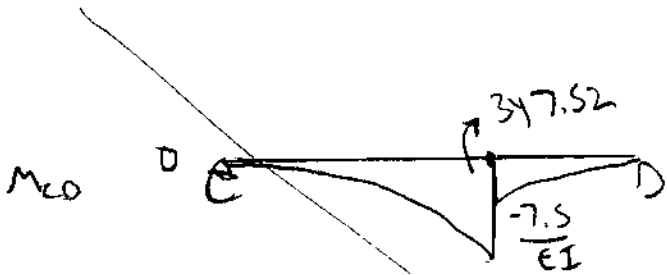
$$M_{DA} = .2EI(1853.6) - 26.8 = 347.52$$

$$M_{AP} = \frac{2EI}{20} (20\theta_A - 34) + FEM_{AP}$$

$$0 = M_{CD} = \frac{2EI}{20} (20\theta_C + \theta_D) + \dots$$

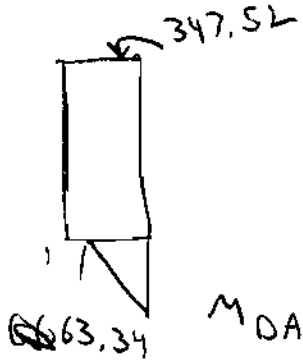
$$M_{DC} = \frac{3EI}{20} (\theta_C - 0) + \left(\frac{-600 - \frac{600}{2}}{2} \right)$$

$$M_{DC} = .3EI(\theta_D) - 900$$



$$\sum M_D = 347.52 - 15(10) + A_x(15)$$

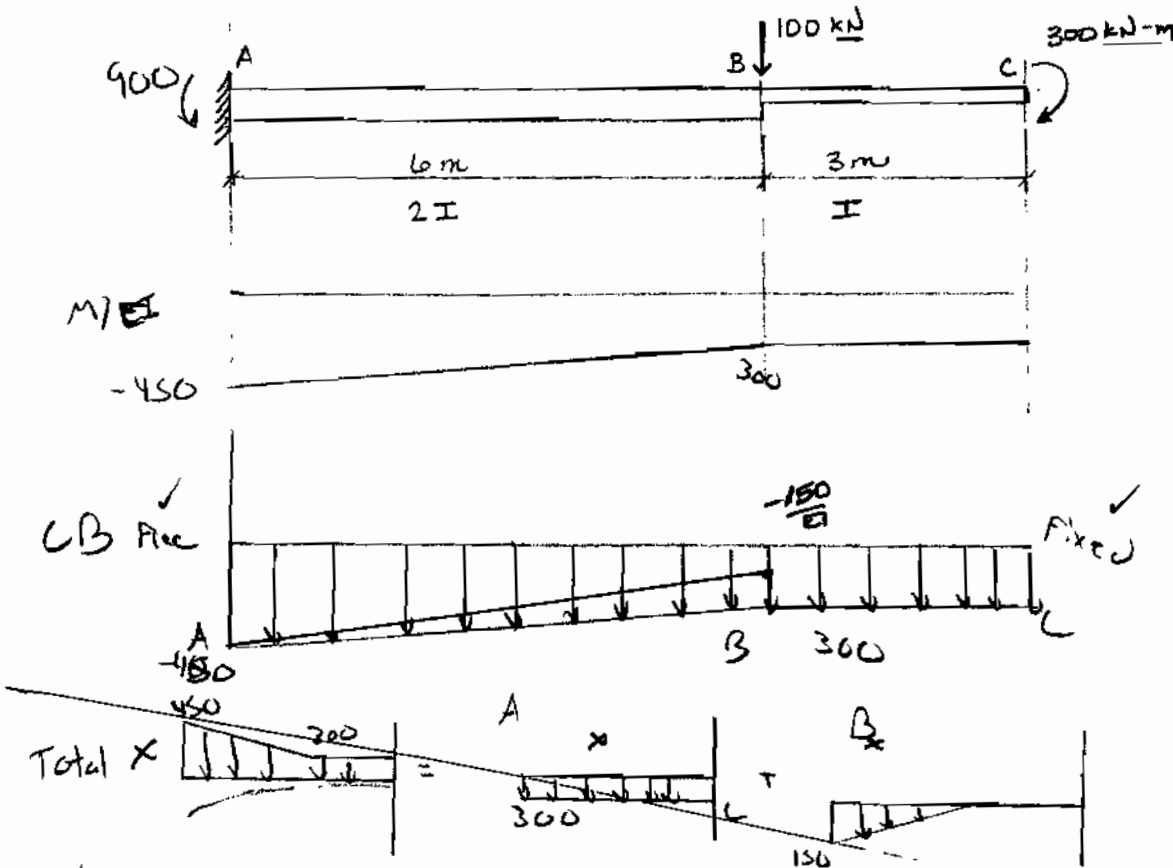
$$A_x = -12.66$$



13. (25 pts.) Solve for the deflection at point C in the following beam. You may choose from one of the methods listed below.

a. Conjugate Beam Method

b. Castigliano's Second Theorem (Method of Least Work)



$E = \text{constant} = 70 \text{ GPa}$
 $I = 500(10^6) \text{ mm}^4$

Learned Eq — CAN'T USE FOR THIS!!!

$$\sum F_x = -\frac{300}{EI}(9m) + -\frac{150}{EI}\left(\frac{6}{2}\right) + V_C = 0 \quad V_C = +3150$$

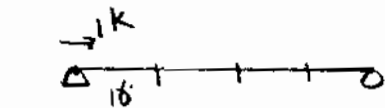
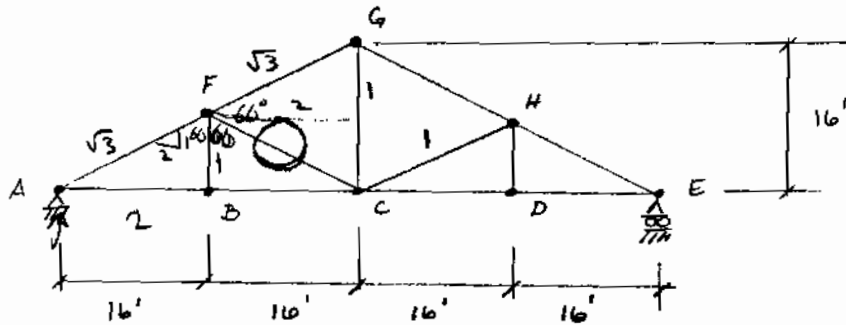
$$\sum M_C = -300(9)(4.5) + -150\left(\frac{6}{2}\right)7m - M_C = 0$$

$$I = \frac{500(10^6) \text{ mm}^4}{1000^4 \text{ mm}} \text{ m}^4 = 5 \cdot 10^{-4} \text{ m}^4$$

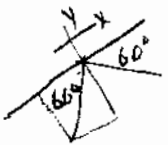
$$M_C = \frac{-15300}{EI} = \frac{-15300}{70 \cdot 10^9 \cdot 5 \cdot 10^{-4}}$$

~~$-4.37 \cdot 10^{-4} \text{ m}$~~

10. (20 pts.) Draw the influence line for the force in member CF for the following determinate truss.



| Load | Runs A | E |
|------|--------|-----|
| A | 1 | 0 |
| B | .75 | .25 |
| C | .5 | .5 |
| D | .25 | .75 |
| E | 0 | 1 |

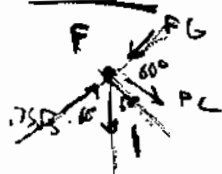


Pos 1 FB 0 Force



$\sum F_x = 2$ $F_{FC} = 0$

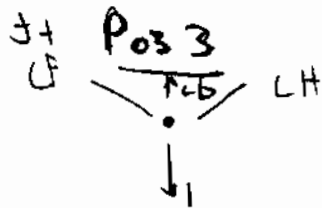
Pos 2



$\sum F_y = -1 \sin 60^\circ + F_{FC} \sin 60^\circ$

$\sum F_x = -1 \cos 60^\circ + F_{FC} \cos 60^\circ$

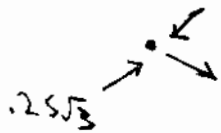
$F_{FC} = 1$



Pos 3

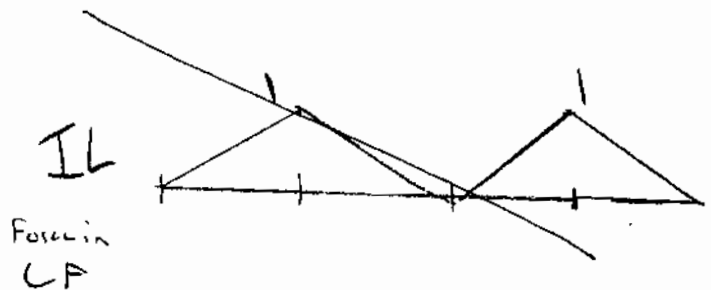
$F_{FC} = 0$

Pos 4



$F_{FC} = 1$ Symmetric

Pos 5
 $F_{FC} = 0$



Extra Credit No. 1 (3 pts.)

Describe the role of the following fictional figure with regard to the slope-deflection method.



(Green Giant)

Plays the role for holding FEMs

3

Extra Credit No. 2 (2 pts.)

What's the magic number? ☺

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