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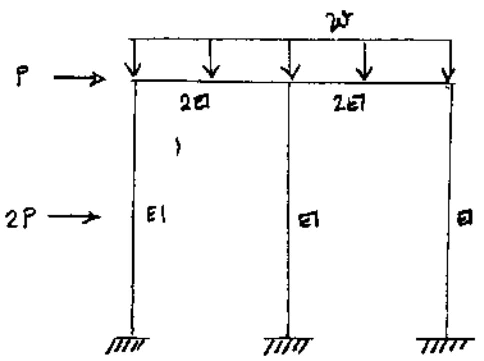
CE 461 – Structural Analysis
Final Exam

Name

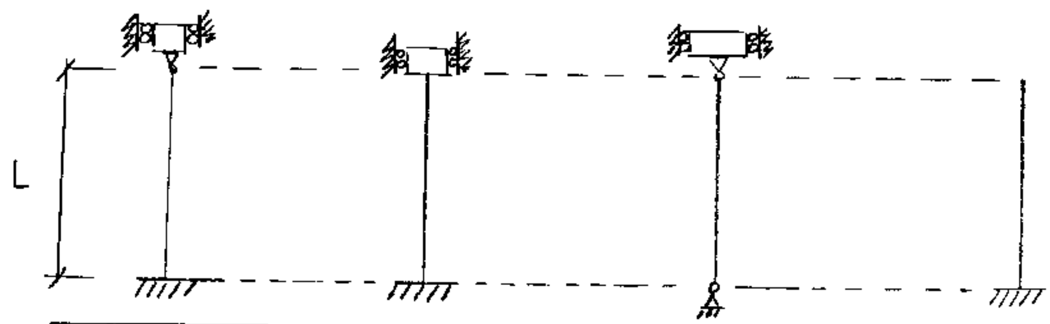
Thanks for all your hard work this semester, and best ... udies and professional endeavors. It has been a pleasure having each of you ... you would like your final exam grade and your final course grade emailed to you, please indicate so here: (*Y*) / *N*

0 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.)



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

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



Le = .7L ✓	Le = L/2 ✓	Le = L ✓	Le = 2L ✓

✓ 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.

3

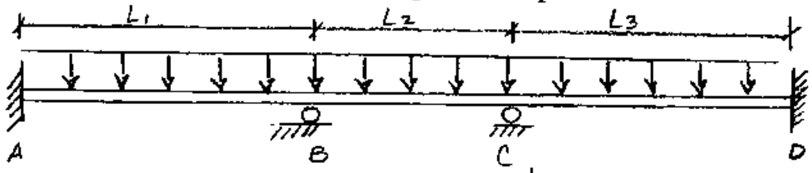
Change the connections to fixed - fixed. It will increase the critical stress ~~to~~ of the column

(Problem 4 got deleted...)

0 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. ×

8 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.



	A	B		C		D
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	-.27	
Carryover	.13		-.17	.17		-.13
Balance		.078	.095	-.095	-.075	
Carryover	.038		-.047	.047		-.038
FINAL MEMBER END MOMENTS:	86.72	-60.85	66.80	-60.80	60.65	-86.72

2 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 = CONSTANT

Assume L_1 is in inches, & write the equation in terms of L_1.

$$M_{NF} = \frac{2EI}{L}\left(2\theta_N^{0} + \theta_F - 3\psi\right) + FEM_{NF} \qquad \psi = \frac{4}{L_1}$$

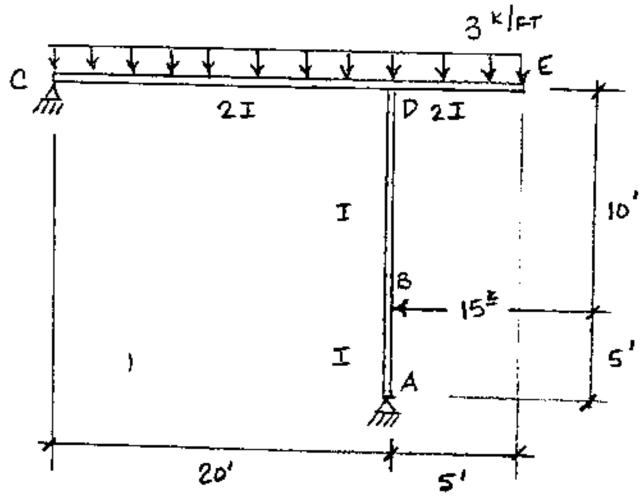
$$= \frac{2EI}{L_1}\left(\theta_F - 3\left(\frac{4}{L_1}\right)\right) + 78.1$$

what is the "f" end? ⇒ B

8. Given the following indeterminate frame,

(13) (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.

0 (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 = CONSTANT

Slope Deflection

$K_{CD} = \frac{3}{4}\frac{2I}{20} = .075$

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

$DF_{CD} = \frac{.075I}{.075+.05} = .6$

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

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

$FEM_{DC} = -\frac{wL^2}{2} = -600$ X (−4)

$FEM_{DA} = \frac{Pab^2}{L^2} = \frac{(15)(10)(5)^2}{15^2} = 16.7$ ✓

$FEM_{AD} = \frac{Pa^2b}{L^2}$ $\frac{(15)(5)(15)}{15^2} = 75$ X (−2)

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

$M_{AD} = 0$ ✓

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

$M_{DA} = .2EI(\theta_D) - 20.8$

$0 = M_{CD} = \frac{2E2I}{20}(2\theta_C + \theta_D) +$

$M_{DC} = \frac{3E2I}{20}(\theta_C - 0) + \left(-600 - \frac{600}{2}\right)$ X

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

(−3)

$\Sigma M_D = M_{DA} + M_{DC} = 0$ +37.5

$0 = (.3EI\,\theta_D - 900) + .2EI\,\theta_D - 20.8$

$.5EI\,\theta_D - 920.8 = 0$

$EI\theta_D = \frac{920.8}{.5}$

$EI\theta_D = 1841.6$

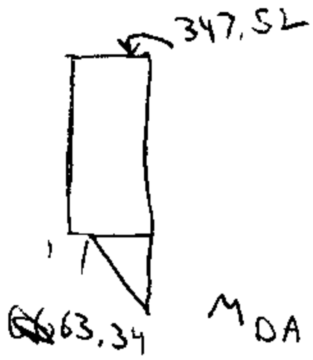
$M_{DC} = .3EI(1841.6) - 900 = -347.52$

$M_{DA} = .2EI(1841.6) - 20.8 = 347.52$

Continued

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

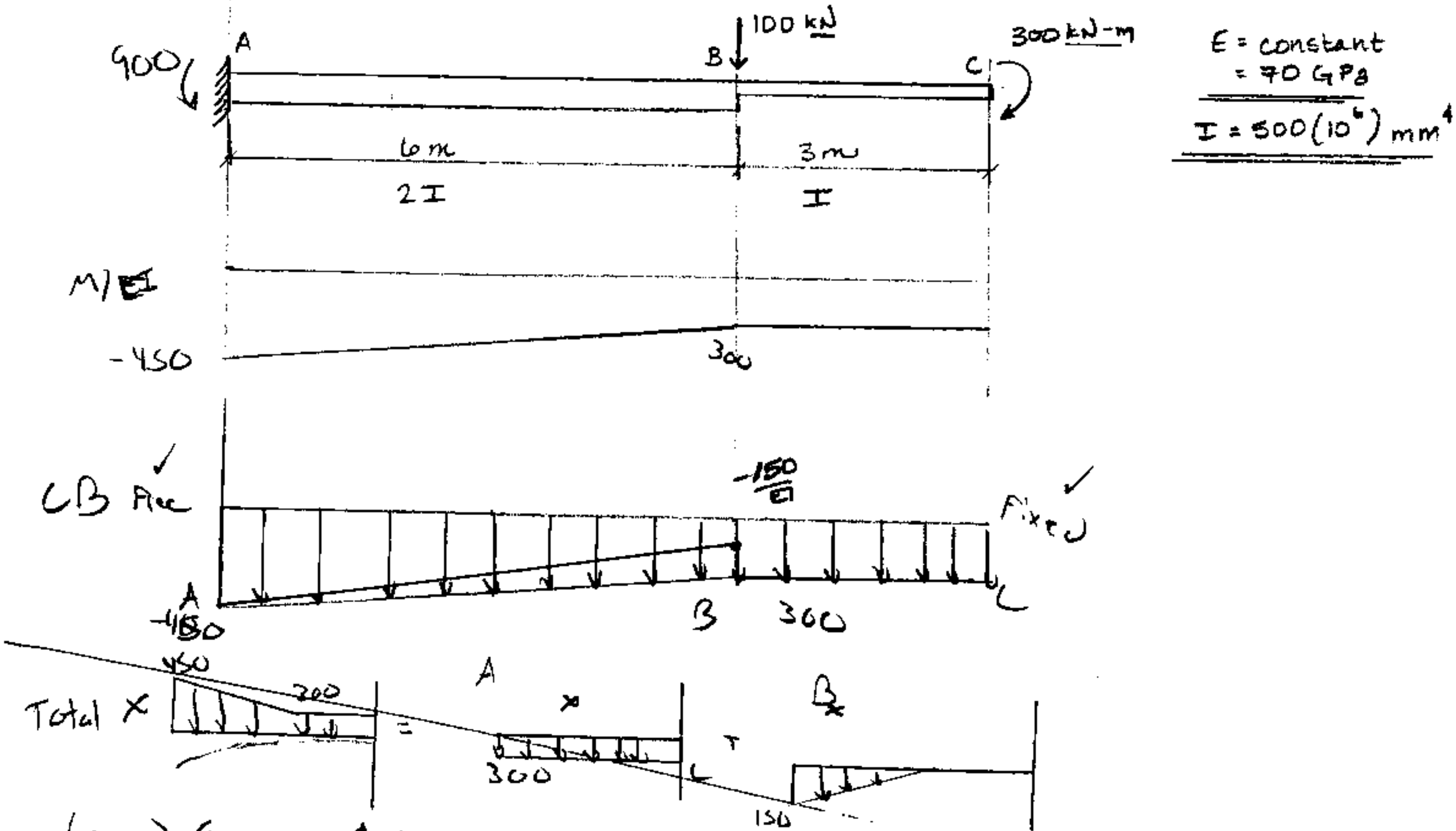
$$A_x = -12.66$$



(13) 9. (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)**



Canned Eq — CAN'T USE FOR THIS!!!

$$\Sigma F_x = -\frac{300}{EI}(9\,m) + -\frac{150}{EI}\frac{(6)}{2} + V_C = 0 \qquad V_C = +3150$$

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

$$I = 500(10^6)\,mm^4 \frac{m^4}{1000^4\,mm} = 5\cdot10^{-4}\,m^4$$

$$M_C = \frac{-15300}{EI} \qquad \frac{-15300}{70\cdot10^9 \cdot 5\cdot10^{-4}}$$

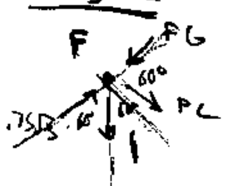
~~$-4.37\cdot10^{-4}\,m$~~

(6) 10. (20 pts.) Draw the influence line for the force in member CF for the following determinate truss.

Load	Rxns A	E
A	1	0
B	.75	.25
C	.5	.5
D	.25	.75
E	0	1

$F_{FL} = 0$

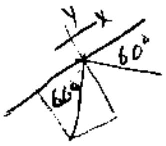
Pos 2



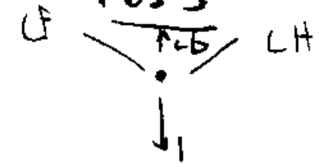
$\Sigma F_y = -1 \sin 60° + FL \sin 60°$

$\Sigma F_x = -1 \cos 60 + FL \cos 60°$

$FL = 1$



Pos 3



$FL = 0$

FL = 1 symmetric

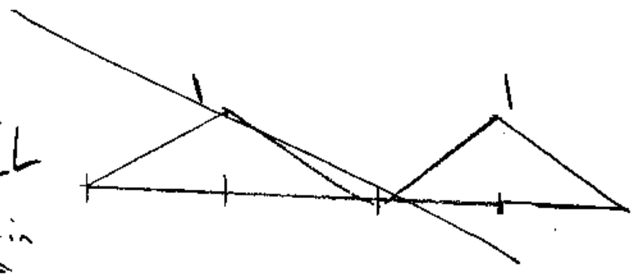
.25√3

Pos 5

$FL = 0$

IL

Force in CF



Extra Credit No. 2 (2 pts.)
What's the magic number? ☺

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