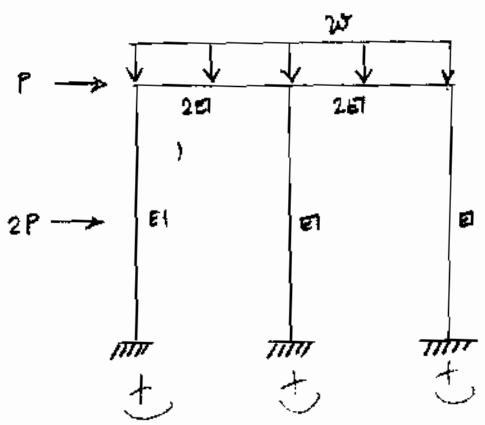
90/100 [redacted]

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*

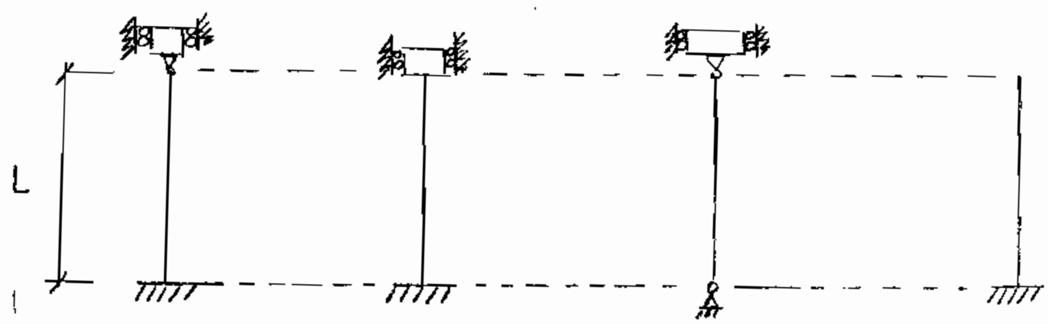
3 1. (3 pts.) Which method of indeterminate analysis that we covered in class would probably be the most *efficient* choice (least computationally intensive) to determine support reactions for the following frame? You only have a pencil, calculator, and paper as tools with which to solve the problem. 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.)



6° indet.

[illegible] deflection [illegible] best [illegible] Moment Distribution [illegible] It is [illegible] than θ-Δ method as it is iterative.

0 2. (4 pts.) Please supply the effective lengths for each of the following columns.



$P = \frac{\pi^2 EI}{L_e^2}$

Le = ~~3L~~	Le = ~~.7L~~	Le = ~~.5L~~	Le = ~~ ~~

2 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.

You could add more restraints to [illegible],

or [illegible] make it fixed-fixed [illegible]

Does not make it any more stable, just increases buckling capacity

(Problem 4 got deleted...)

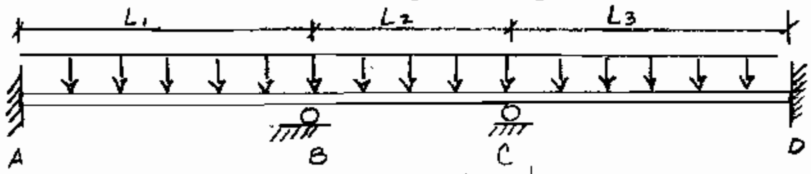
3 5. (3 pts.) What does a distribution factor in the moment distribution procedure physically describe?

[illegible] the [illegible] amount of [illegible]

it takes to rotate the [illegible] 1 rad.

sum @ ea jt = 1.

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.



D.F.s.	⊃	0.444	0.556	0.556	0.444	⊃
FEMs	+78.1	-78.1	50	-50	78.1	-78.1
[illegible]		12.48	15.62	-15.62	-12.49	
[illegible]	6.24		-7.81	7.81		-6.24
B		3.47	4.34	-4.34	-3.47	
C	1.74		-2.17	2.17		-1.74
B		.963	1.21	-1.21	-.963	
C	.482		-.61	.61		-.482
B		.268	.34	-.34	-.268	
C	.134		-.17	.17		-.134
B		.075	.095	-.095	-.075	
FINAL MEMBER END MOMENTS:	86.7	-60.85	60.85	-60.85	60.85	-86.7

← iterated to w/in 1/10 accuracy

4 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.

$$M_{nf} = \frac{2EI}{L}\left(2\theta_n + \theta_f - 3\psi\right) + FEM_{nf}$$

$$M_{AB} = \frac{2EI}{L_1}\left(2\theta_A^{0} + \theta_B - 3\left(\frac{4''}{L_1}\right)\right) + FEM_{AB}$$

([illegible] distributed load has value w [illegible]) $FEM_{AB} = \frac{wL_1^2}{12}$

[illegible]

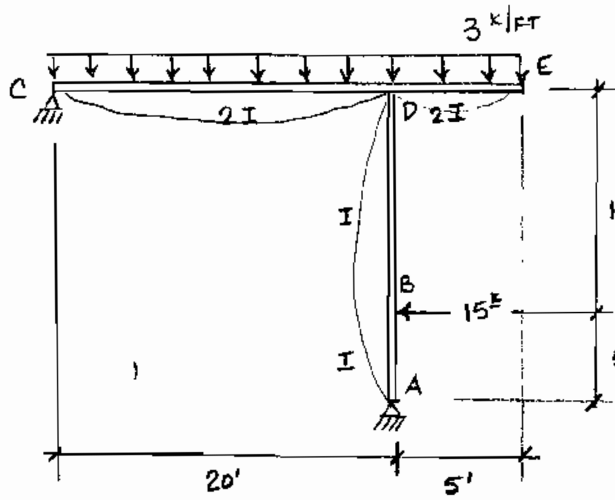
$$\boxed{M_{AB} = \frac{2EI}{L_1}\left(\theta_B - 3\left(\frac{4''}{L_1}\right)\right) + \left(\frac{w(L_1)^2}{12}\right)}$$

30 GREAT JOB!! :)

8. Given the following indeterminate frame,

(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.

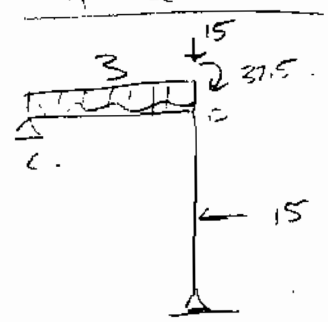


E = CONSTANT

S-D METHOD

Degrees of freedom = θ_D.

simplified structure:



$M_{AD} = 0$.

M_{DA} (modified) $= \frac{3EI}{15}\left(\theta_D - \cancel{\psi}\right) + \left[FEM_{DA} - \frac{FEM_{AD}}{2}\right]$.

$FEM_{CD} = wL^2/12 = \frac{3(20)^2}{12} = 100$

$FEM_{DC} = -100$

$M_{CD} = 0$

M_{DC} (modified) $= \left(\frac{3E2I}{20}\right)\left(\theta_D - \cancel{\psi}\right) + \left[FEM_{DC} - \frac{FEM_{CD}}{2}\right]$

$FEM_{DA} = \frac{Pab^2}{L^2} = 16.667$

$FEM_{AD} = \frac{Pa^2b}{L^2} = -33.33$

equilibrium at D.

$M_{DE} = 37.5$

M_{DA}

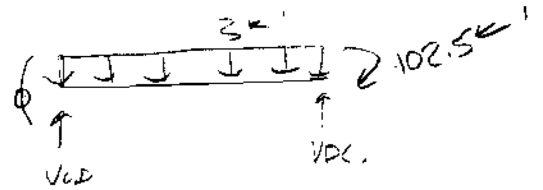
$\left(\frac{EI\theta_D}{5} + 33.33\right) + \left(\frac{3}{20}\right)EI\theta_D - 150.) + 57.5 = 0$

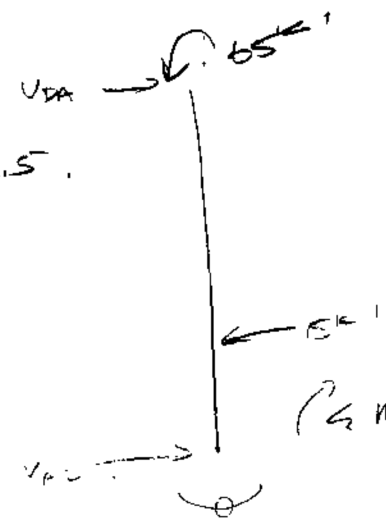
$.5EI\theta_D = +79.17$

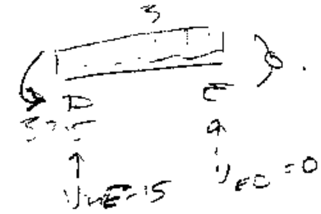
$EI\theta_D = +158.34$

$65^{k'}$ ✓ $M_{DC} = -102.5$ ✓ $M_{DE} = 37.5$ ✓

$\Sigma M_D = 0$ ✓ check







$\circlearrowright \sum M_C = 0 = -3(20)(10) + V_{DC}(20) - 102.5$

$\therefore V_{DC} = 35.13^k$

$\therefore V_{CD} = 24.88^k$

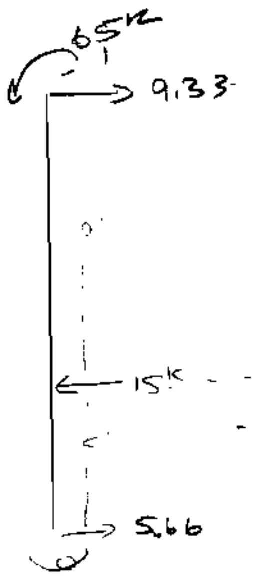
$\circlearrowleft \sum M_A = 0 = 15(5) - V_{DA}(15) + 65$

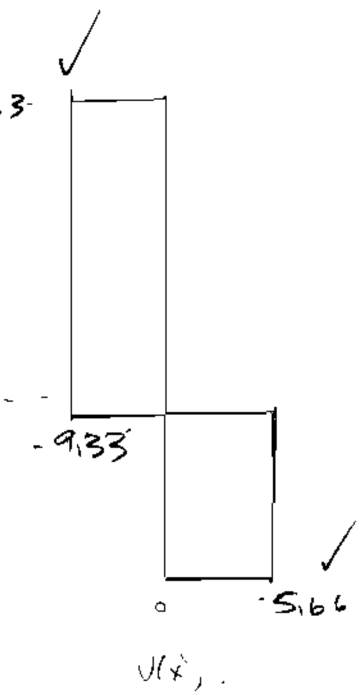
$\therefore V_{DA} = 9.33^k$

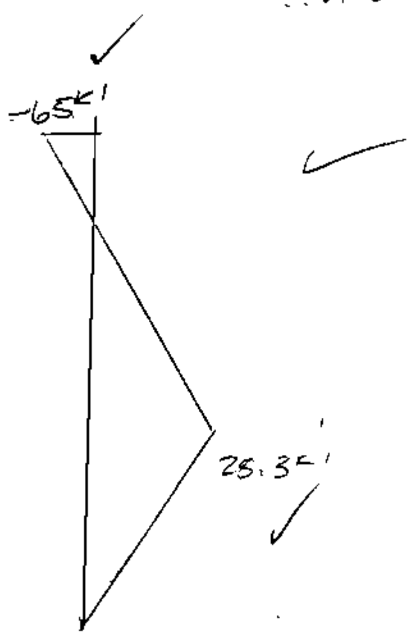
$\therefore V_{AD} = 5.66k$

B

member AD.







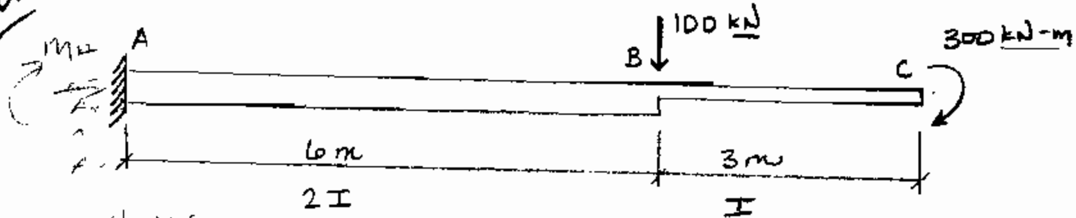
(+) compression side

9. (25 pts.) Solve for the deflection at point C in the following beam. You may choose from one of the methods listed below.

25
GOOD!

a. Conjugate Beam Method

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



E = constant
= 70 GPa

$I = 500(10^6)\ mm^4$

equations.

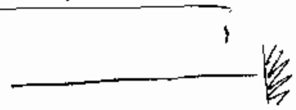
$\circlearrowleft \sum M_A = M_A + 100(6) + 300 = 0$

$M_A = -900$ kN·m

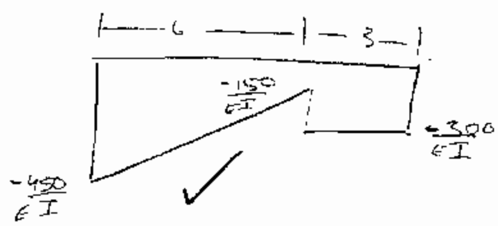
$\sum F_y = A_y - 100$ $\therefore A_y = 100$

Moment dia.

Conj. beam

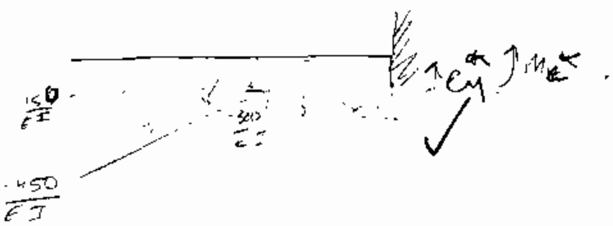


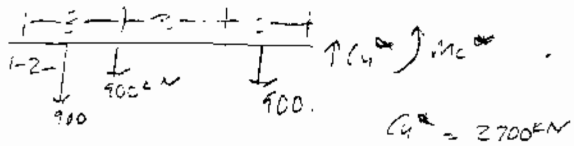
Curvature dia. (w/ proportioned I's).



load w/ curvature dia.

$\Delta_C = M_C^*$





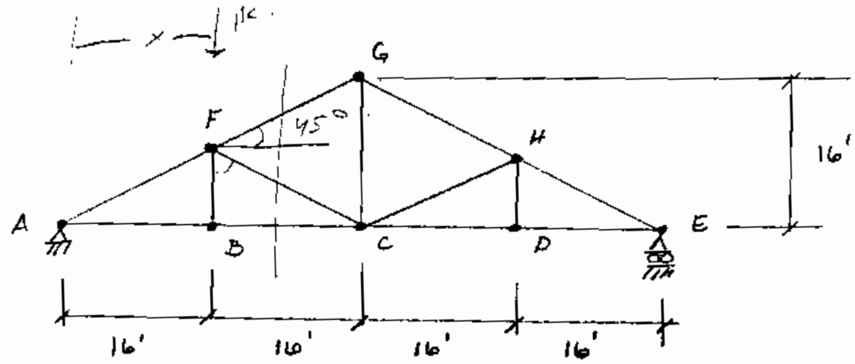
$C_y^* = 2700$ kN

$\sum M_C^* = -900(4.5) - 900(5) - 900(7) = -\frac{13050}{EI} = M^*$

$= \frac{-13050\ kN\ m^3}{70\times10^6 \frac{kN}{m^2}\ 500(10^6)\ mm^4 \left(\frac{1\ m}{10^3\ mm}\right)^4} = \frac{-13050\ kN\ m^3}{70\times10^6 \frac{kN}{m^2}\ 500\times10^{-6}\ m^4} =$ $\boxed{\Delta_C = -.3729\ m}$

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

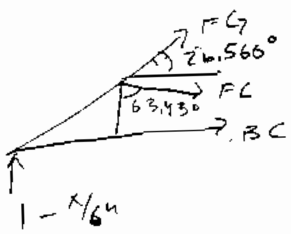
10



superpos.

$\circlearrowleft \Sigma M_A = -1x + E_y(64)$ $\qquad E_y = x/64$ ✓

$\Sigma F_y = A_y + E_y - 1$ $\qquad A_y = 1 - x/64$ ✓



$\Sigma F_y = (1 - x/64) + FG \sin 26.566 - FC(\cos 63.43°) = 0$

$2 - x/32$

$\Sigma F_x = \cancel{B}C + FG \cos 26.566 + FC(\sin 63.43°) = 0$

$\circlearrowleft \Sigma M_F = BC(8) - (1 - x/64)(16)$

$\therefore BC = 2 - x/32$

Solve simultaneously.

$2(-1 + x/64 = FG(.4472) - FC(.4473))$

$-2 + x/32 = FG(.8944) + FC(.8944)$

$-4 + x/16 = FG(1.789)$

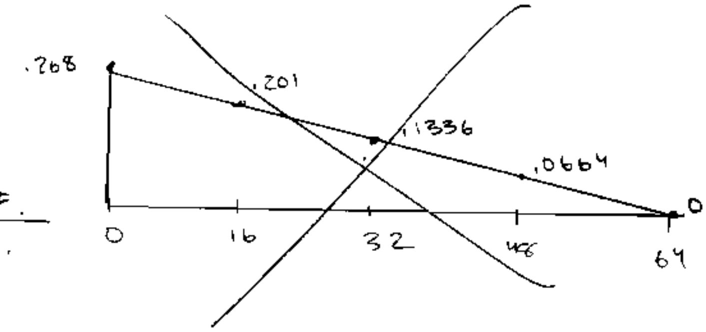
$FG = -2.24 + .035x$

$\frac{-2 + 2.24 - x/32 - .035x}{.8944} = FC = .268 - .0042x$ (eqn for IL)

U.L.(6)

$CF_x = .268 - .0042x$

I.L for CF.



@ $x=0$ $CF_{1L} = .268$

@ $x=16'$ $CF_{1L} = .201$

@ $x=32'$ $CF_{1L} = .1336$

@ $x=48'$ $CF_{1L} = .0664$

@ $x=64'$ $CF_{1L} = -.0008$

3

Extra Credit No. 1 (3 pts.)
Describe the role of the following fictional figure with regard to the slope-deflection method.

(Green Giant)

he ~~locks the joints~~
he holds the joints w/his hands to
make them fixed-fixed members

2

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

43