King Fahd University of Petroleum & Minerals
Department of Civil Engineering

ADVANCED STRUCTURAL ANALYSIS
(CE 511)

Instructor : Dr. Radwan S. Al-Juruf

Office No. : 16-136

Office Phone : 2559

Office Hours : To be announced in class

Text Book : No text is required.
Instructor will give handouts.

No. of Lectures	*TOPICS*
1	Introduction to the Course
1	Concepts of Indeterminacy
3	Seminars (presented by students)
3	The Flexibility Method of Analysis
11	The Stiffness Method of Analysis: - Planar Orthogonal Frames & Continuous Beams - Planar Non-Orthogonal Frames - Three-Dimensional Structures
6	Stability of Planar Structures
2	Energy Methods
2	Introduction to Structural Dynamics
1	Introduction to the Finite Element Method

Course Requirements & Grading:

Homework	----------	30%
Seminars	----------	10%
Project	----------	20%
Midterm Exam	----------	20%
Final Exam	----------	20%

King Fahd University of Petroleum & Minerals
DEPARTMENT OF CIVIL ENGINEERING

Advanced Structural Analysis
(CE 511)

Student's Name: _____

Student's No. _____

Homework No. _____

Grade: _____

Instructor: Dr. Radwan S. Al-Juruf

Note: No late HOMEWORK will be accepted.

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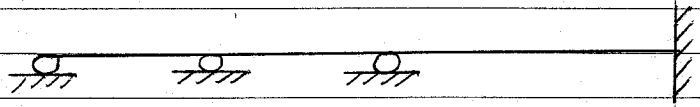
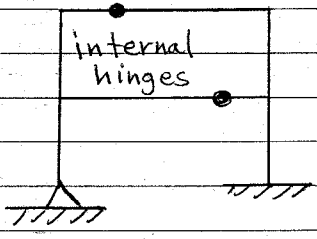
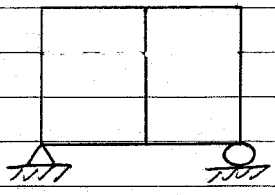
HW # 1

Determine the degree of static indeterminacy and the degree of kinematic indeterminacy for the structures shown:

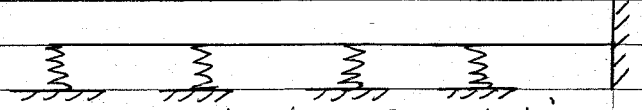
① 

② 

Plane Frame

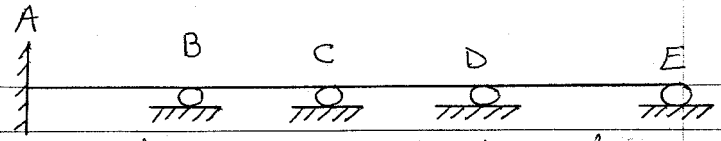
③ 

Plane Frame

④ 

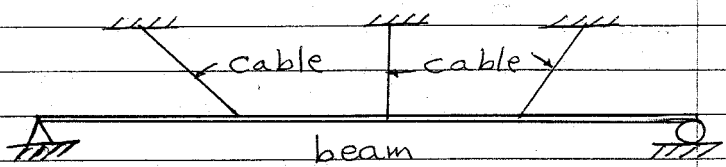
beam on elastic foundations

⑤

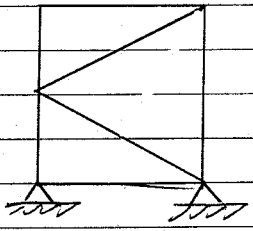


beam with settlements at B, C, D and E.

⑥

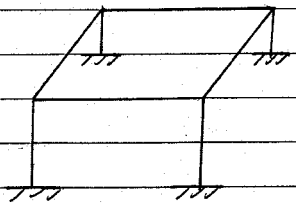


⑦



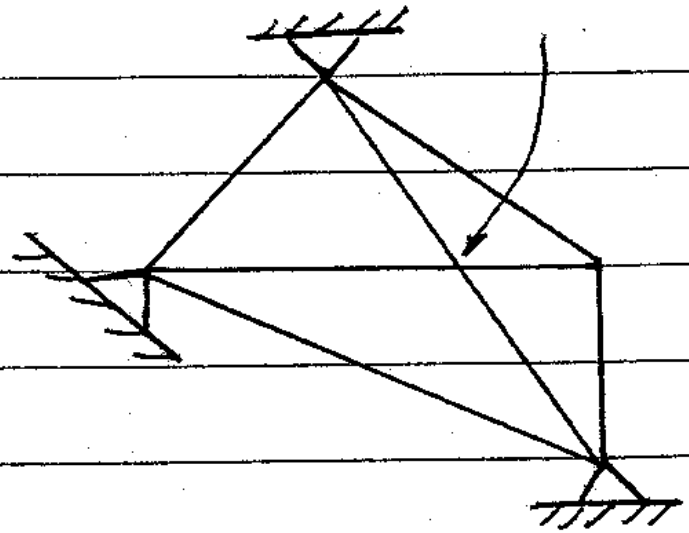
Plane Truss

⑧



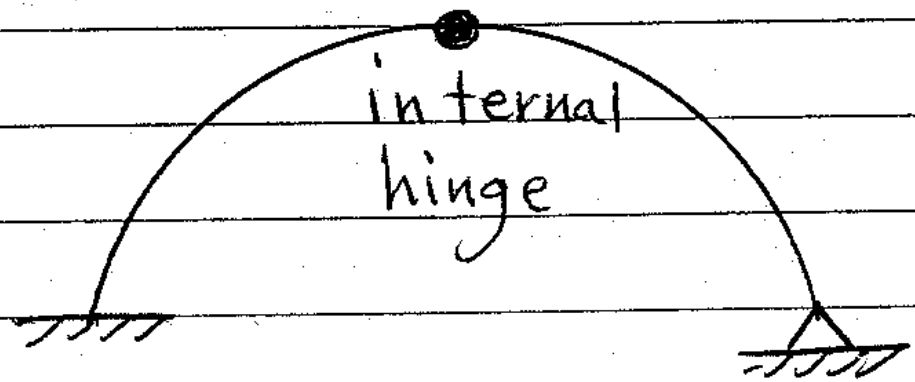
space frame

(9)



Space Truss

(10)



arch

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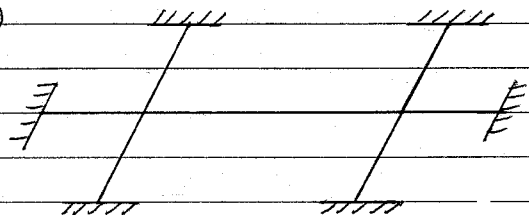
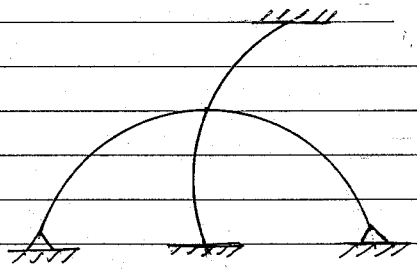
HW #2

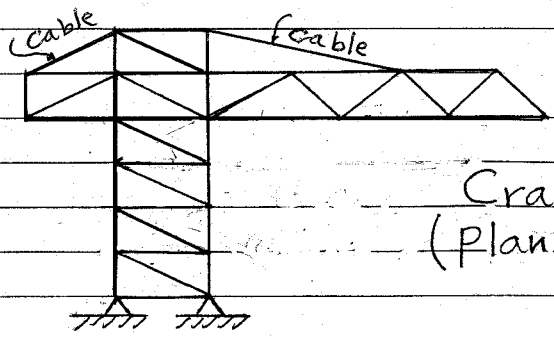
State the degree of static indeterminacy and the degree of kinematic indeterminacy for the structures shown:

① 

Plane Grid

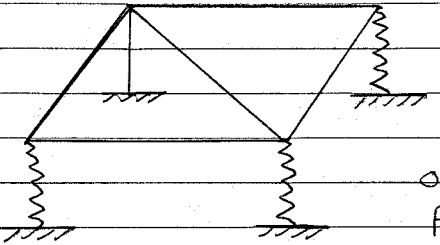
② 

Space Grid

③ 

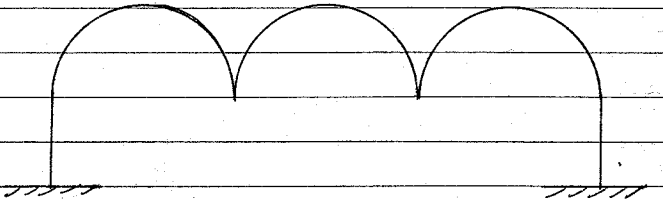
Crane (Plane Truss)

④



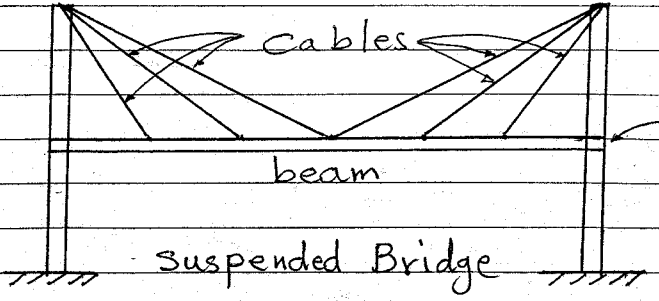
Space Frame on Elastic Foundations

⑤

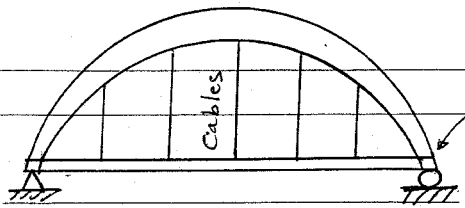


Plane Arch

⑥

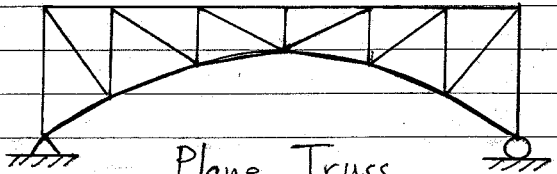


(7)



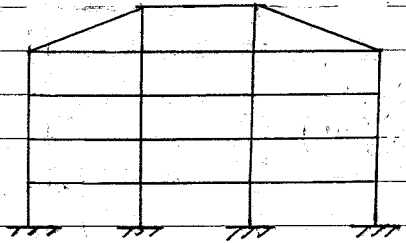
Suspended Bridge

(8)



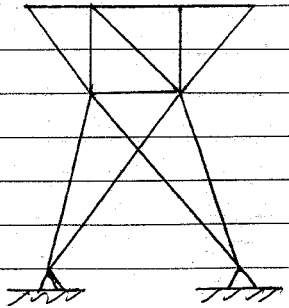
Plane Truss

(9)



Planar Frame

(10)



Power Transmission Tower (Plane Truss)

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HW # 3

Obtain a computer program that can perform matrix inversion. Do not write the program. You may copy it, buy it or get it from any source. Invert the matrix shown below

$$\begin{bmatrix} 1.0 & 0.2000 & 0 & 0 & 0.0450 & -0.0300 & 0 \\ 0.2000 & 1.2000 & 0.4000 & 0 & 0.1200 & -0.0300 & -0.1200 \\ 0 & 0.4000 & 5.6000 & 2.4000 & 0.1200 & 1.4400 & -0.1200 \\ 0 & 0 & 2.4000 & 8.8000 & 0 & 1.4400 & 0.6000 \\ 0.0450 & 0.1200 & 0.1200 & 0 & 0.0285 & 0 & -0.0240 \\ -0.0300 & -0.0300 & 1.4400 & 1.4400 & 0 & 0.5790 & 0 \\ 0 & -0.1200 & -0.1200 & 0.6000 & -0.0240 & 0 & 0.1440 \end{bmatrix}$$

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II

$$A = \begin{bmatrix} 9 & 8 & 7 & 6 \\ 0 & -3 & -4 & -5 \\ 7 & 6 & 5 & 4 \\ 1 & 0 & 2 & 0 \end{bmatrix}$$

$$B = \begin{bmatrix} 1 & 4 & 2 & 3 \\ 9 & 8 & 6 & 7 \\ -1 & -2 & 3 & 4 \\ -5 & 6 & -7 & 8 \end{bmatrix}$$

Write computer programs to calculate:

① $C = A + B$
② $E = I * A$
③ $H = A * B$
④ $D = C^T$

I is the 4x4 identity matrix.

Output all results.

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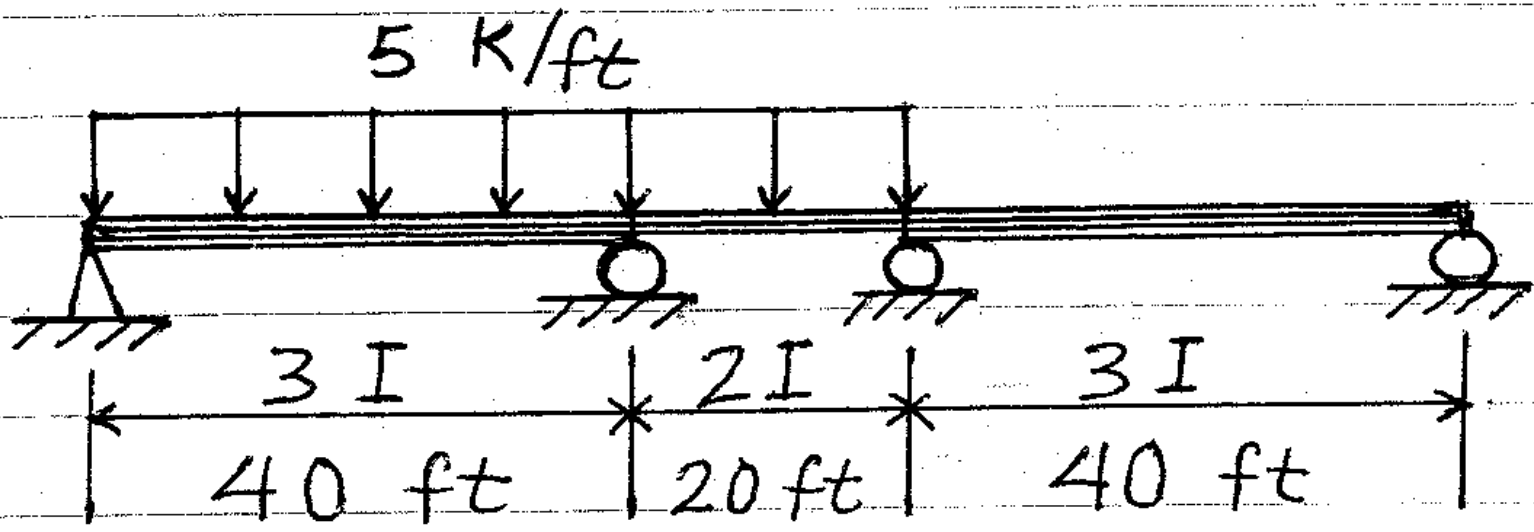
HW # 4

Using the Flexibility Method calculate all reactions.

E and I are constant.



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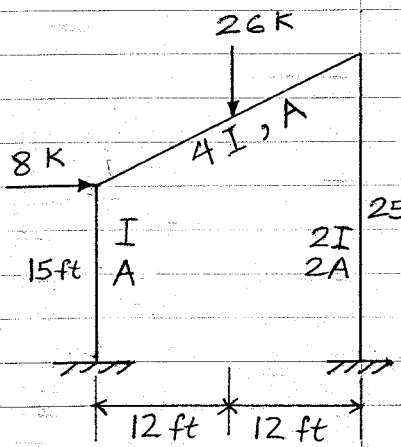
HW # 5

Calculate all redundant reactions of the frame shown by the Flexibility Method. Take the right support reactions as redundants.

$I = 0.0217\ ft^4$

$A = 0.1042\ ft^2$

E is constant



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HW # 6

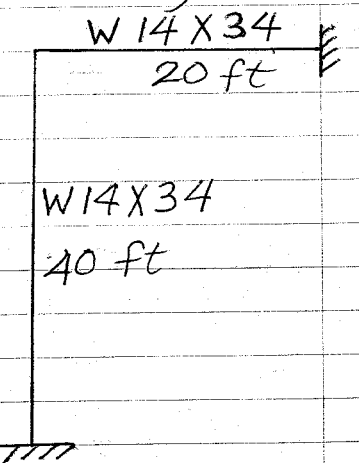
The steel frame shown below was erected when the temperature was 35° F. Calculate all reactions when the temperature becomes 135° F by the Flexibility Method.

$E = 29 \times 10^6$ psi

$\alpha = 6.5 \times 10^{-6}$ ft/ft°F

$I = 340$ in^4

$A = 10$ in^2



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HW# 7

Write a computer program to generate the member stiffness matrix (axial deformation neglected) for a member having constant E

Run a case where $E = 1\ K/ft^2$, $L = 10\ ft$ and $I = 1\ ft^4$. Output all results using the "F" format.

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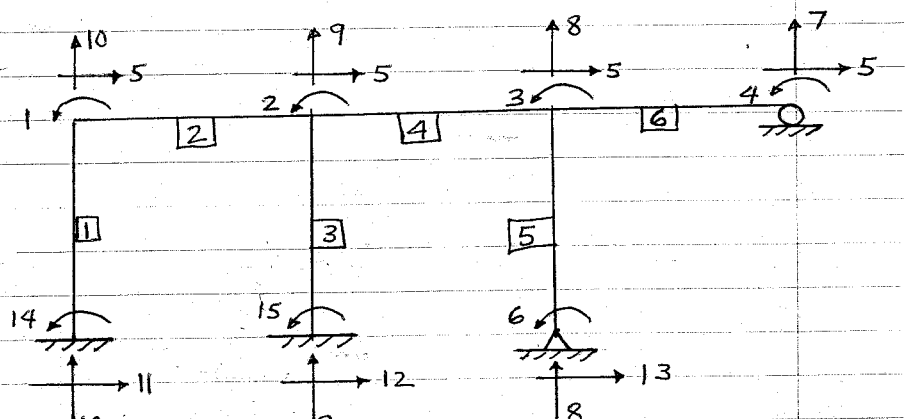
HW # 8

Write a computer program to generate the total structural stiffness matrix for orthogonal planar frames and beams.

Run the frame shown.



$L = 10\,ft$, $E = 1\ \frac{K}{ft^2}$ and $I = 1\ ft^4$ for all members. Output all results.

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HW # 9

Analyze the beam shown by the stiffness method, i.e. calculate:

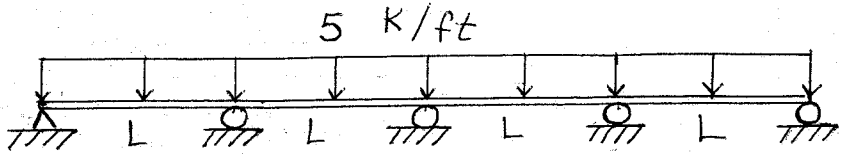
① All unknown nodal displacements

② All reactions

③ The shear forces and the moments for all ends of members.

$E = 1$ K/ft^2, $I = 1$ ft^4 and $L = 10$ ft for all members

Show results on complete and clear drawings.



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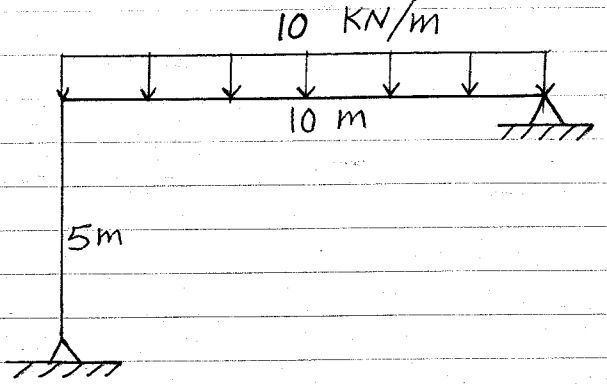
HW # 10

Analyze the frame shown completely by the stiffness method. E and I are constant. Show all results on complete and clear drawings.



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HW # 11

Solve problem 5-1 in the handouts. Show all results on complete and clear drawings.

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HW # 12

Solve problem 6-23 in the handouts.

Show results on complete and clear drawings.

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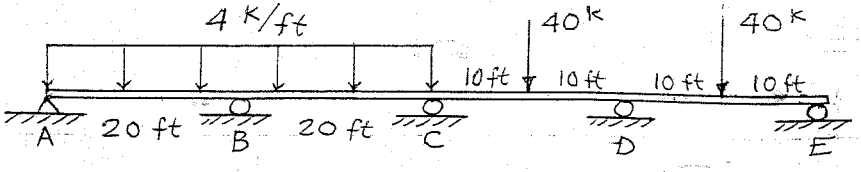
HW # 13

Computer Program Testing

Using your developed computer program run the problems shown below. Show the following on complete and clear drawings:

1. All displacements
2. All final member end actions
3. All reactions

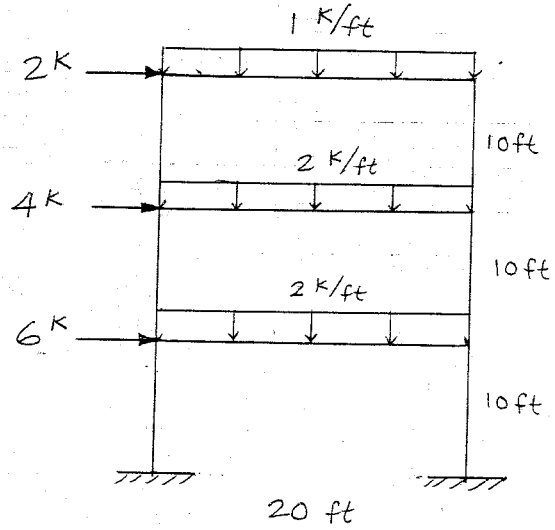
Problem # 1



The beam is W33 X 118

Supports B, C and D Settle 0.5 IN each.

Problem #2

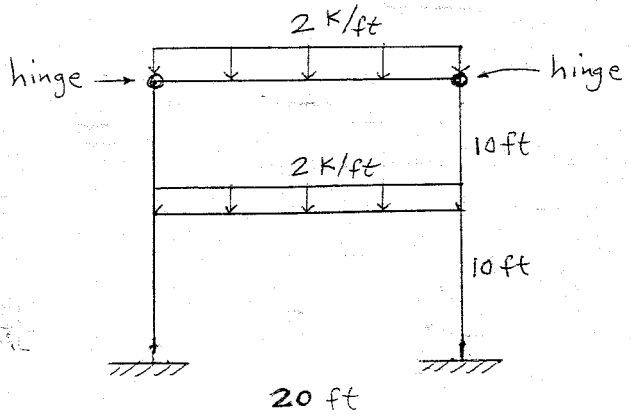


$I = 5000\ in^4$ for each beam

$I = 3000\ in^4$ for each column

$E = 30000$ ksi for all

Problem #3



$I = 4000\ in^4$ for all

$E = 30000$ ksi

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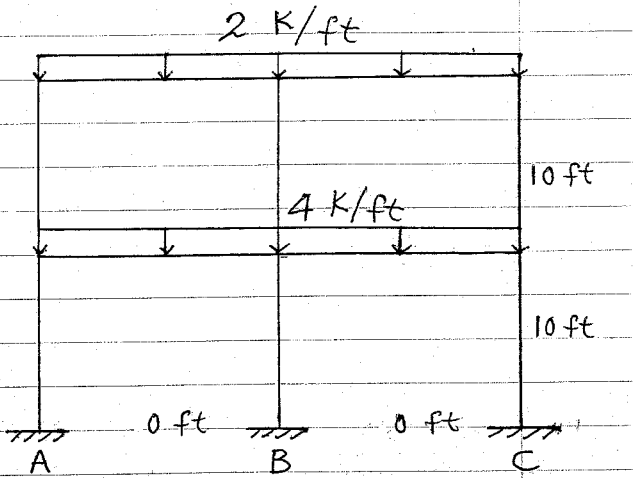
HW # 13

Using your developed computer program run the frame shown. Draw all final member end actions.



$I = 288 \ IN^4$

$E = 30000 \ ksi$

Support B settles 2 IN.

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HW #14

Solve problem 8-2 in the handouts.

Show results on complete and clear drawings.