King Fahd University of Petroleum & Minerals
DEPARTMENT OF CIVIL ENGINEERING

Advanced Structural Analysis
(CE 511)

MIDTERM EXAM (Take-Home)

Name Exam Solution

ID _____

Your solution steps and drawings must be very clear to follow.

PLEDGE:

I pledge that I did not receive any help from anyone in writing, orally or in any form concerning this exam. Also, I did not talk or write to anyone about this exam except the course instructor.

_____
Student's Signature

Problem # 1 (20%)

Analyze the beam shown by the flexibility method. Show all results on clear and complete drawings.

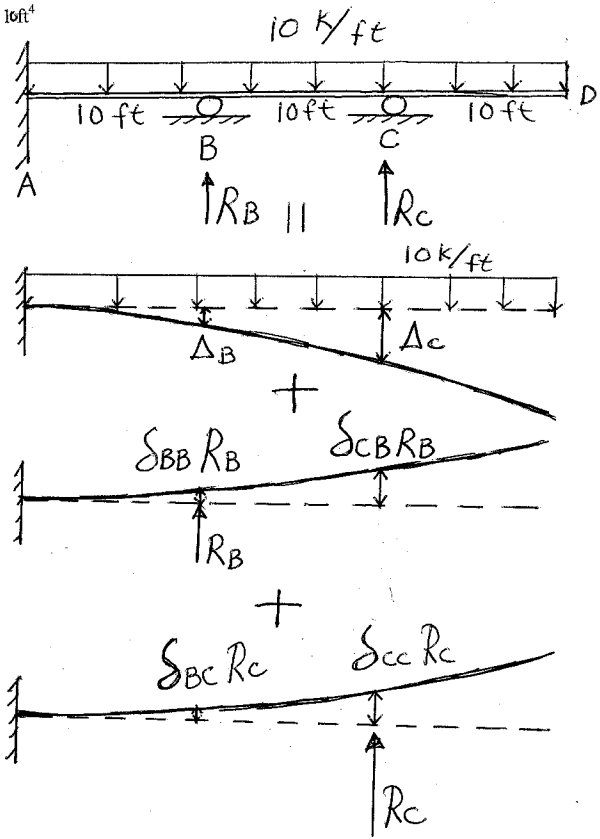
Support B settles 0.1 ft.

Support C settles 0.2 ft.

$E = 10000\ k/ft^2$

$I = 10ft^4$

Redundants



$$\begin{Bmatrix} \Delta_B \\ \Delta_C \end{Bmatrix} + \begin{bmatrix} \delta_{BB} & \delta_{BC} \\ \delta_{CB} & \delta_{CC} \end{bmatrix} \begin{Bmatrix} R_B \\ R_C \end{Bmatrix} = \begin{Bmatrix} -0.1 \\ -0.2 \end{Bmatrix}$$

$\Delta_B = -1.79$ ft

$\Delta_C = -5.67$ ft

$\delta_{BB} = 3.33 \times 10^{-3}$ ft

$\delta_{BC} = 8.33 \times 10^{-3}$ ft

$\delta_{CB} = 8.33 \times 10^{-3}$ ft

$\delta_{CC} = 26.67 \times 10^{-3}$ ft

Solving the equations yields:

$\therefore R_B = -22.86^K = 22.86^K \downarrow$

$\therefore R_C = 212.14^K \uparrow$

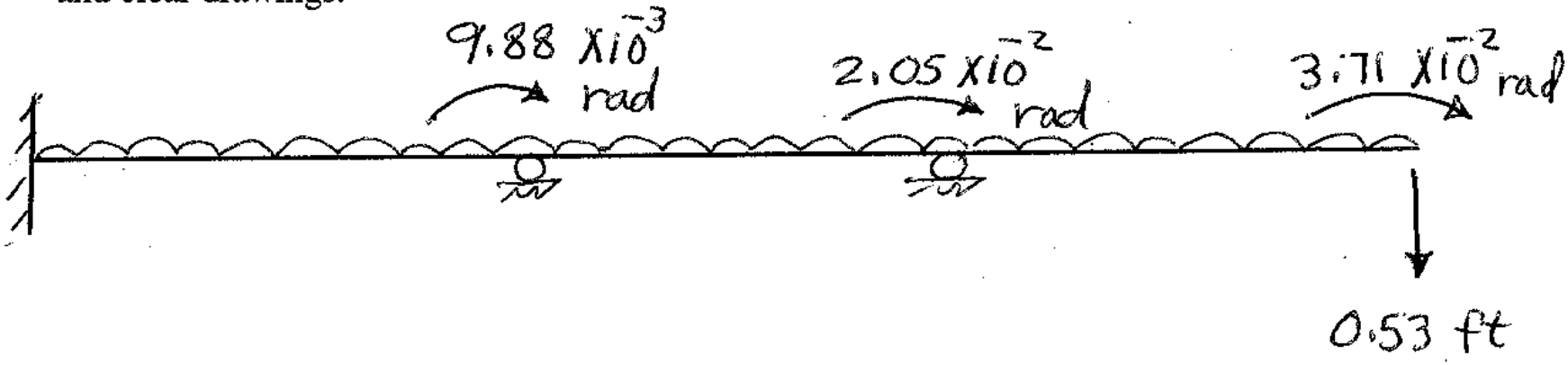
from statics:

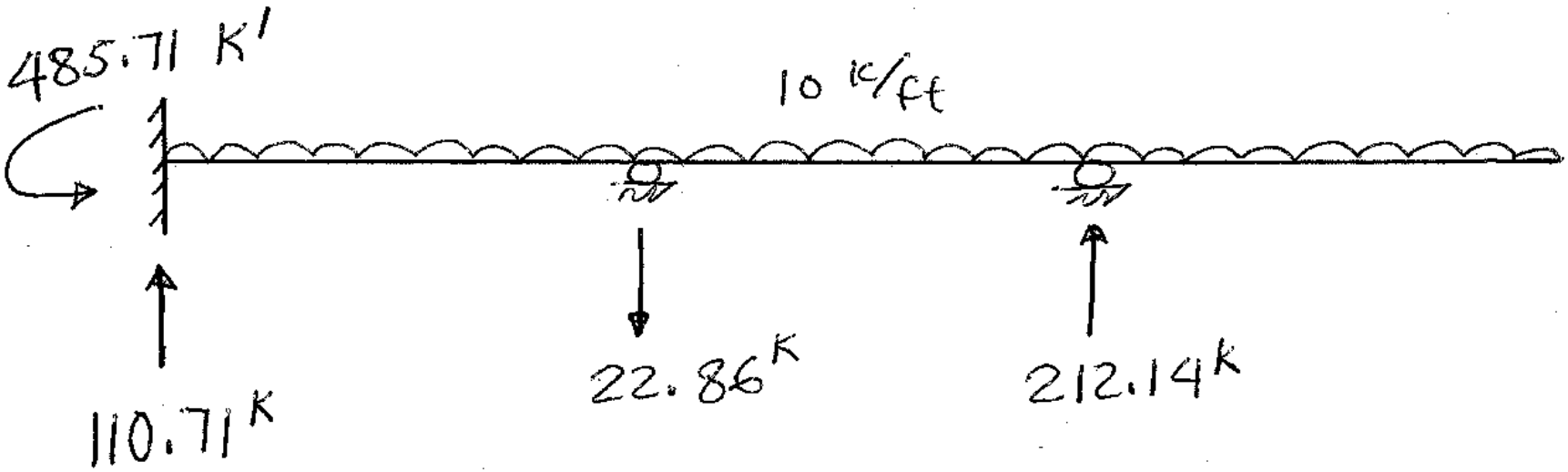
$R_A = 110.71^K \uparrow$

$M_A = 485.71^{K\text{-ft}}$ ↶

Problem # 2 (20%)

Analyze the beam in problem # 1 by the stiffness method. Show all results on complete and clear drawings.





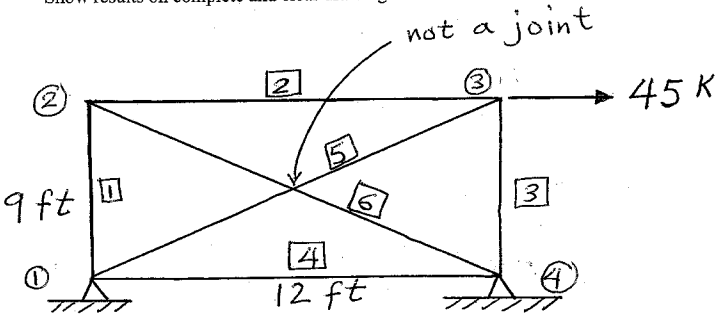
Problem # 3 (20%)

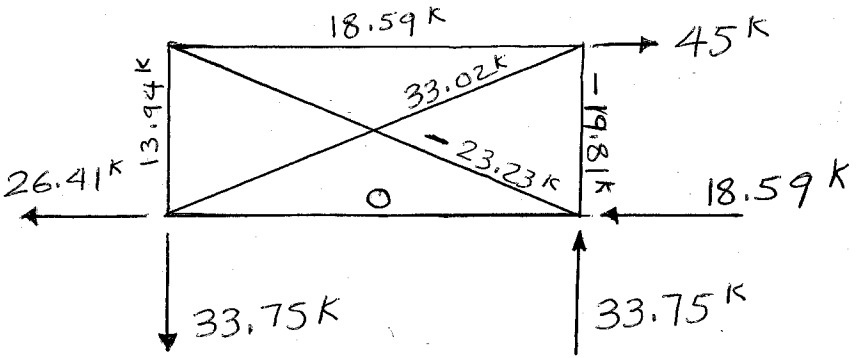
Analyze the truss shown by the flexibility method.

Let

$E = 10000\ k/ft^2$	for all
$I = 1\ ft^4$	for all
$A = 0.5\ ft^2$	for all

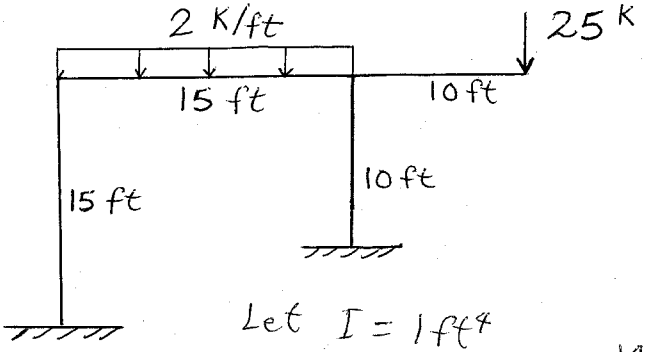
Show results on complete and clear drawings.





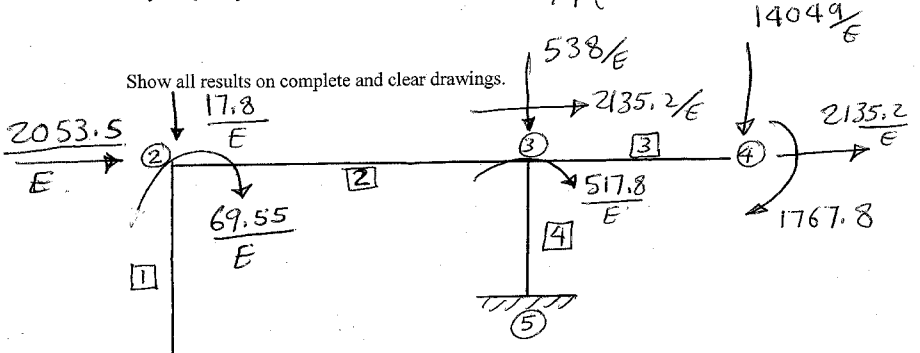
Problem # 4 (20%)

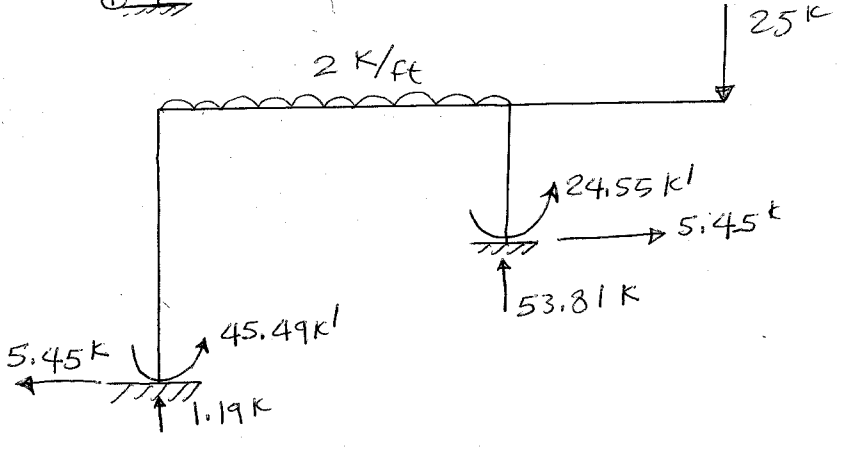
Analyze the frame shown by the stiffness method. E & I are constant.



Let $I = 1\,ft^4$

Show all results on complete and clear drawings.

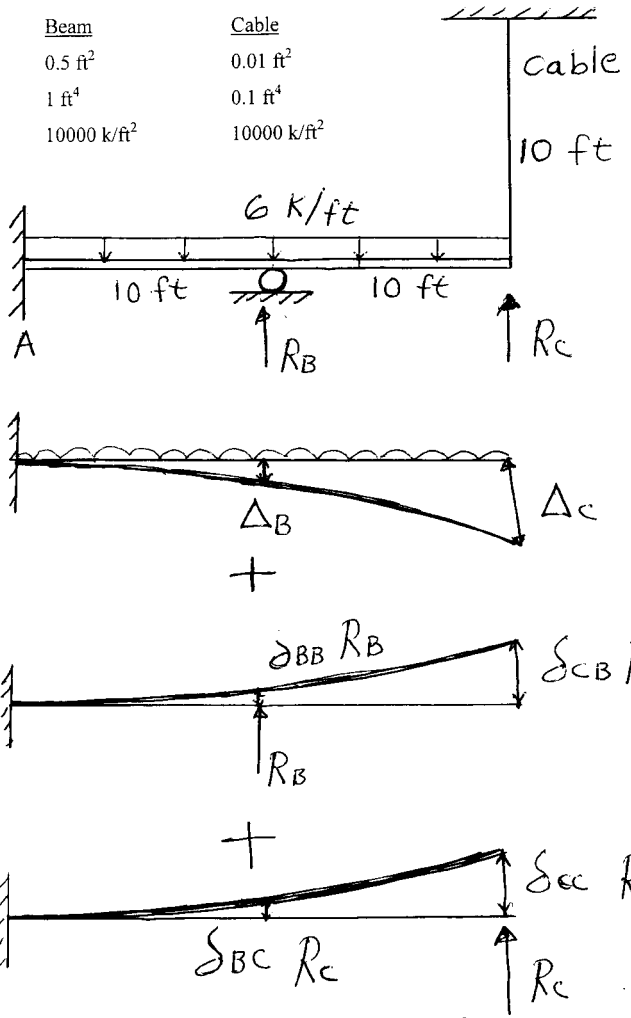




Problem # 5 (20%)

Calculate all reactions by the flexibility method. Show all results on complete and clear drawings.

	Beam	Cable
A	0.5 ft^2	0.01 ft^2
I	1 ft^4	0.1 ft^4
E	10000 k/ft^2	10000 k/ft^2



$$\begin{Bmatrix} \Delta_B \\ \Delta_C \end{Bmatrix} + \begin{bmatrix} \delta_{BB} & \delta_{BC} \\ \delta_{CB} & \delta_{CC} \end{bmatrix} \begin{Bmatrix} R_B \\ R_C \end{Bmatrix} = \begin{Bmatrix} 0 \\ \frac{R_C(10)}{0.01 \times 10000} \end{Bmatrix}$$

$$\Delta_B = -4.25 \text{ ft}$$

$$\Delta_C = -12$$

$$\delta_{BB} = 3.33 \times 10^{-2}$$

$$\delta_{BC} = 8.33 \times 10^{-2}$$

$$\delta_{CB} = 8.33 \times 10^{-2}$$

$$\delta_{CC} = 26.67 \times 10^{-2}$$

$$\begin{Bmatrix} -4.25 \\ -12 \end{Bmatrix} = 10^{-2} \begin{bmatrix} 3.33 & 8.33 \\ 8.33 & 26.67 \end{bmatrix} \begin{Bmatrix} R_B \\ R_C \end{Bmatrix} = \begin{Bmatrix} 0 \\ .1R_C \end{Bmatrix}$$

$$10^{-2} \begin{bmatrix} 3.33 & 8.33 \\ 8.33 & 26.67 \end{bmatrix} \begin{Bmatrix} R_B \\ R_C \end{Bmatrix} - \begin{Bmatrix} 0 \\ .1R_C \end{Bmatrix} = \begin{Bmatrix} 4.25 \\ 12 \end{Bmatrix}$$

$$10^{-2} \begin{bmatrix} 3.33 & 8.33 \\ 8.33 & 26.67 \end{bmatrix} \begin{Bmatrix} R_B \\ R_C \end{Bmatrix} - \begin{bmatrix} 0 & 0 \\ 0 & .1 \end{bmatrix} \begin{Bmatrix} R_B \\ R_C \end{Bmatrix} = \begin{Bmatrix} 4.25 \\ 12 \end{Bmatrix}$$

$$10^{-2}\begin{bmatrix} 3.33 & 8.33 \\ 8.33 & 26.57 \end{bmatrix}\begin{Bmatrix} R_B \\ R_C \end{Bmatrix} = \begin{Bmatrix} 4.25 \\ 12 \end{Bmatrix}$$

Thus R_B and R_C can be obtained.