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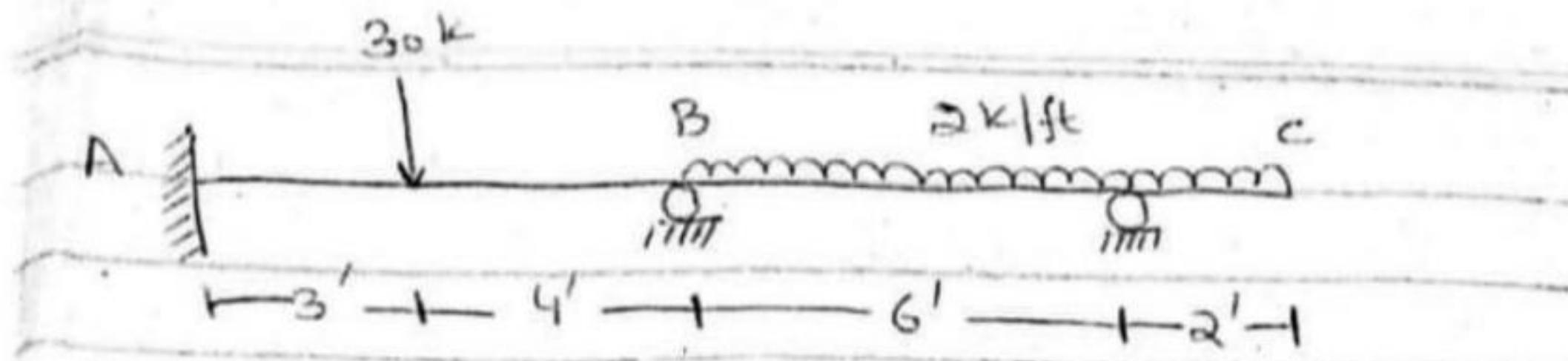
Sec : C.

Final Paper Submission.

Submitted to "SIR Adeed."

Subject : "Structure Analysis II."

# QUESTION NO = 01



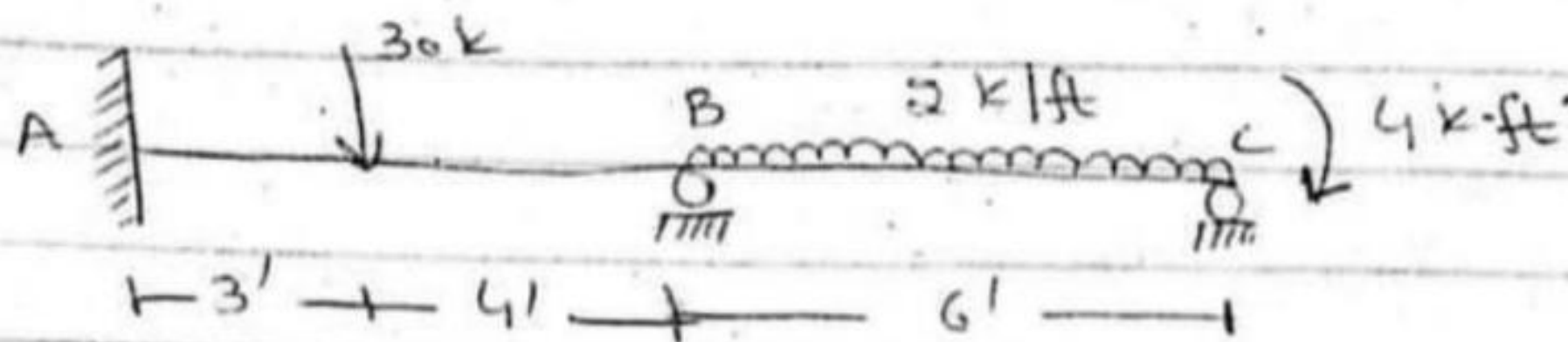
Sol:

Step #1

Determining Kinematic Indeterminacy,

$$K \cdot I = 5^{\circ}$$

So we have to reduce the extended portion.



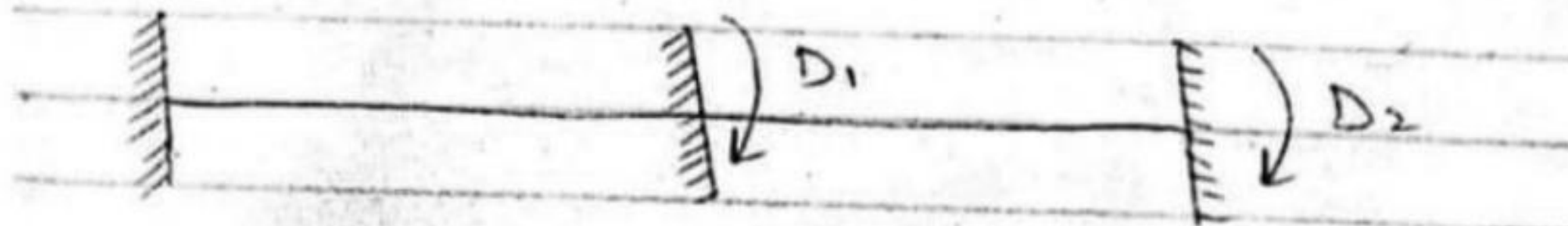
$$\Rightarrow \frac{2(2)}{1} = 4 \text{ k-ft}$$

Now :-

$$K \cdot I = 2^{\circ}$$

Step #2

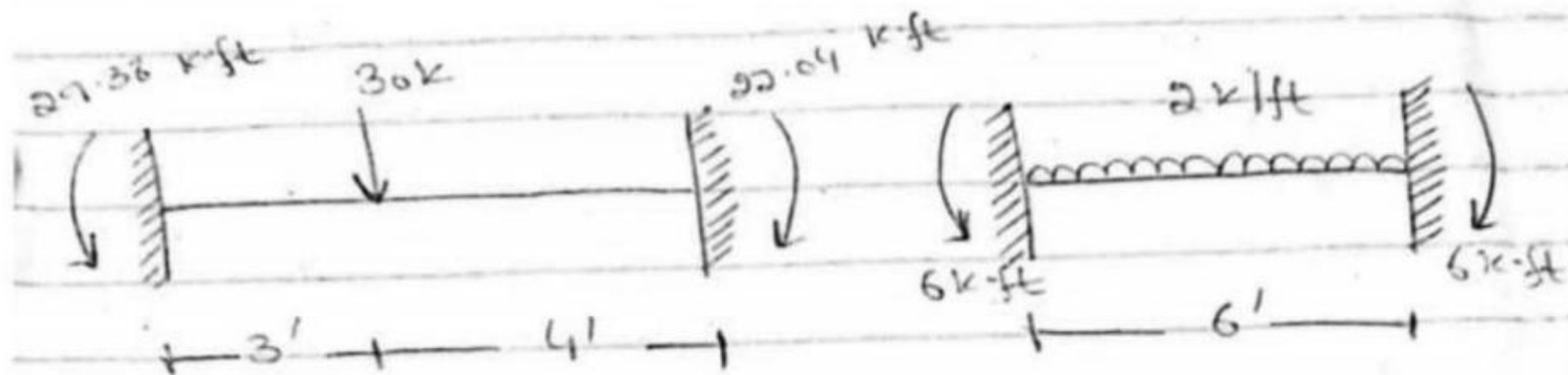
Determine Unknown Joint Displacement



$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \quad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \end{bmatrix}$$

Step #3 :-

Compute [ADL] Matrix.



=> For Pointed Load (not at mid).

=> For Left end :-

$$= \frac{Pab^2}{L^2} = \frac{(30)(3)(4)^2}{(7)^2} = 29.38 \text{ k-ft}$$

=> For Right end :-

$$= \frac{Pa^2b}{L^2} = \frac{(30)(3)^2(4)}{(7)^2} = 22.04 \text{ k-ft}$$

=> For UDL :

$$\frac{wL^2}{12} \rightarrow \frac{(2)(6)^2}{12} = 6 \text{ k-ft}$$

$$ADL_1 = +22.04 - 6 = 16.04 \text{ k-ft}$$

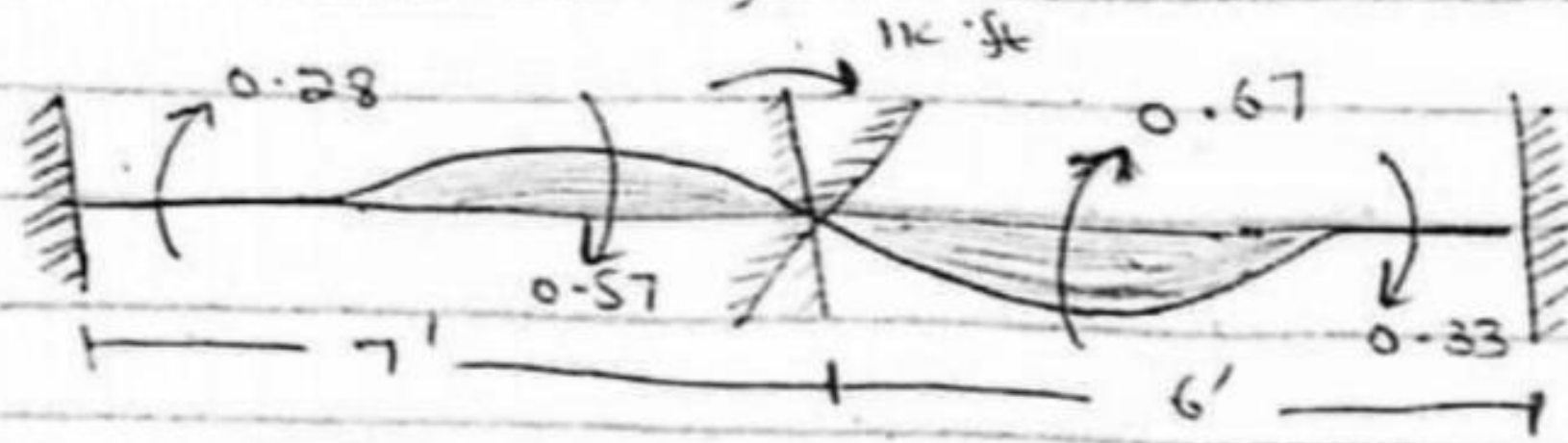
$$ADL_2 = 6 \text{ k-ft}$$

Step #4 :-

Compute [S] Matrix

$$S = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$$

a)  $D_1 = 1k$ ,  $D_2 = 0$



$$\frac{4EI}{7} = 0.57$$

$$\frac{2EI}{6} = 0.33$$

$$\frac{4EI}{6} = 0.67$$

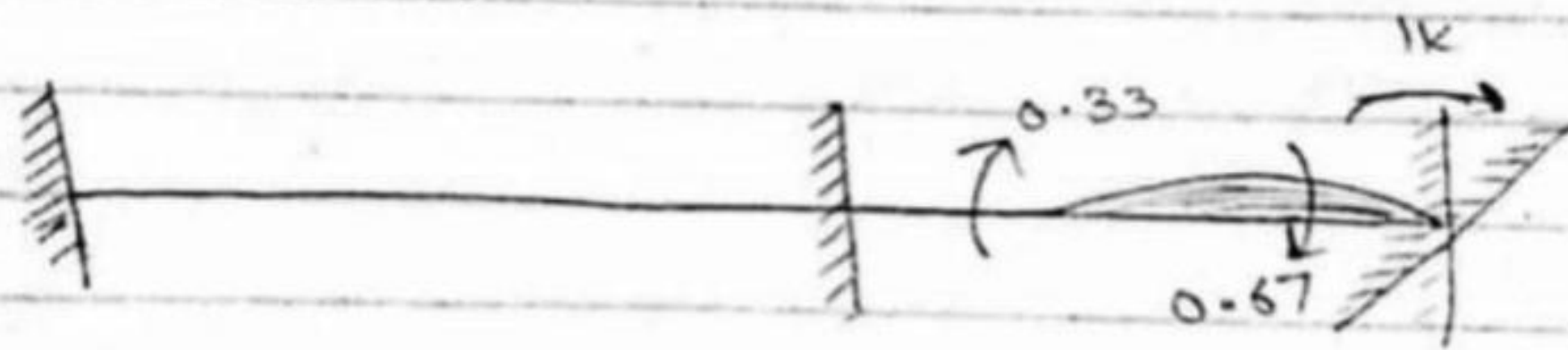
$$\frac{2EI}{7} = 0.28$$

$$S_{11} = 0.57 + 0.67$$

$$= 1.24 EA$$

$$S_{21} = 0.33 EA$$

b)  $D_1 = 0$ ,  $D_2 = 1k$



$$\frac{4EI}{6} = 0.67$$

$$\frac{2EI}{6} = 0.33$$

$$S_{12} = 0.33$$

$$S_{22} = 0.67$$

$$S = \begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}$$

Step #5

Compute [D] matrix

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}^{-1} \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} ADL_1 \\ ADL_2 \end{bmatrix}$$
$$= \frac{1}{\begin{vmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{vmatrix}} \times \text{Adj } A \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

$$|S| = (1.24 \times 0.67) - (0.33 \times 0.33)$$

$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

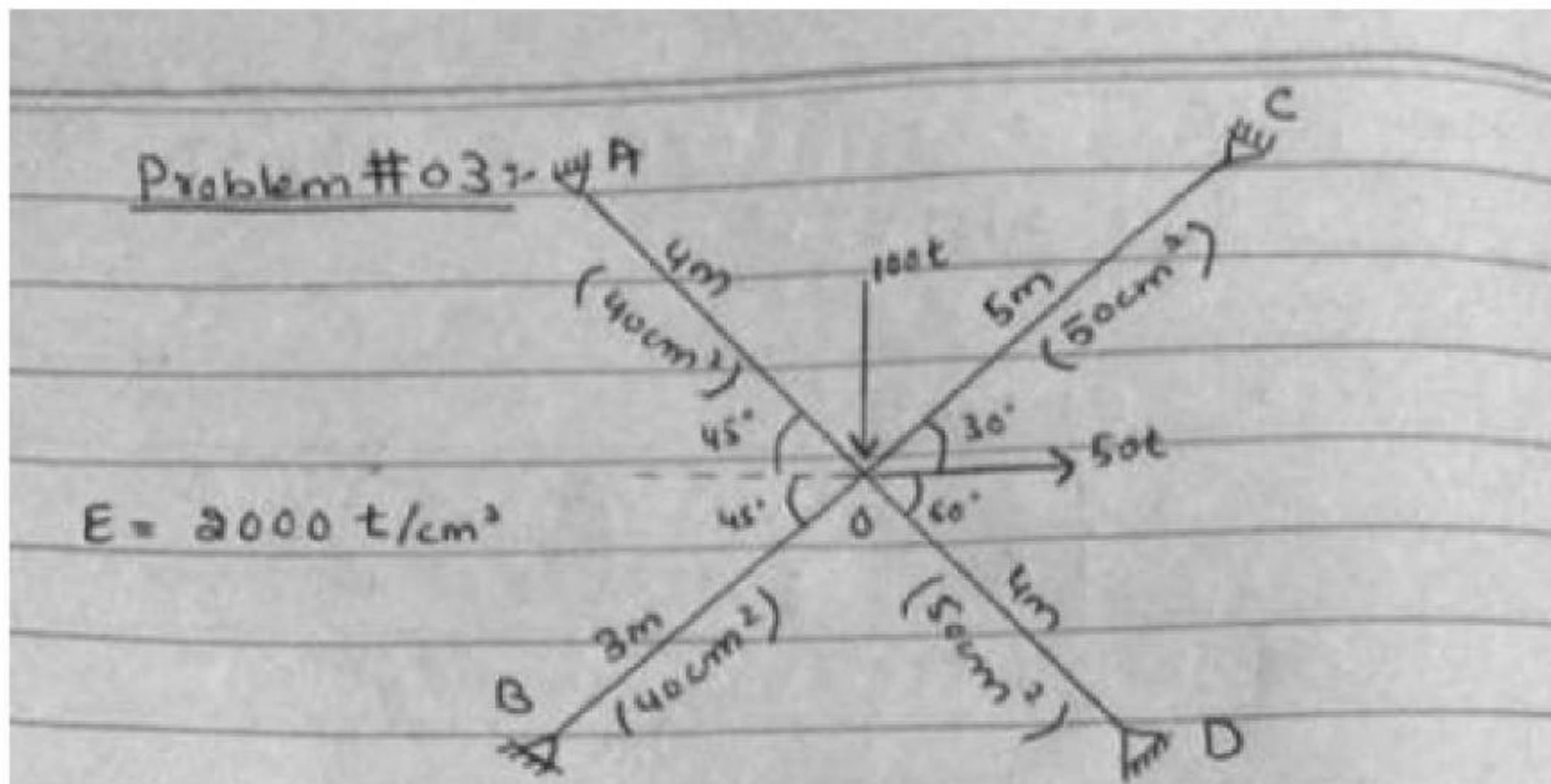
$$\text{Adj } A = \begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix}$$

Now:

$$\begin{bmatrix} AD_1 - ADL_1 \\ AD_2 - ADL_2 \end{bmatrix} = \begin{bmatrix} 0 - 16.04 \\ 4 - 6 \end{bmatrix} = \begin{bmatrix} -16.04 \\ -2 \end{bmatrix} E$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \frac{1}{0.7219} \begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix} \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

## QUESTION NO = 02



Sol: For A:

$$\sin 45^\circ = \frac{P}{h} = \frac{P}{4}$$

$$\Rightarrow P = 2.828 \text{ m}$$

$$\cos 45^\circ = \frac{b}{4}$$

$$\Rightarrow b = 2.828 \text{ m}$$

For B:

$$\sin 45^\circ = \frac{P}{3}$$

$$\Rightarrow P = 2.12 \text{ m}$$

$$\cos 45^\circ = \frac{b}{h}$$

$$\Rightarrow b = 2.12 \text{ m}$$

For C:

$$\sin 30^\circ = \frac{P}{h=5}$$

$$\Rightarrow P = 2.5 \text{ m}$$

$$\cos 30^\circ = \frac{b}{5}$$

$$\Rightarrow b = 4.33 \text{ m}$$

Now  $EA_{(A)} = 2000 \times 40 = 80,000 \text{ t}$

$$EA_{(B)} = 2000 \times 40 = 80,000 \text{ t}$$

$$EA_{(C)} = 2000 \times 50 = 100,000 \text{ t}$$

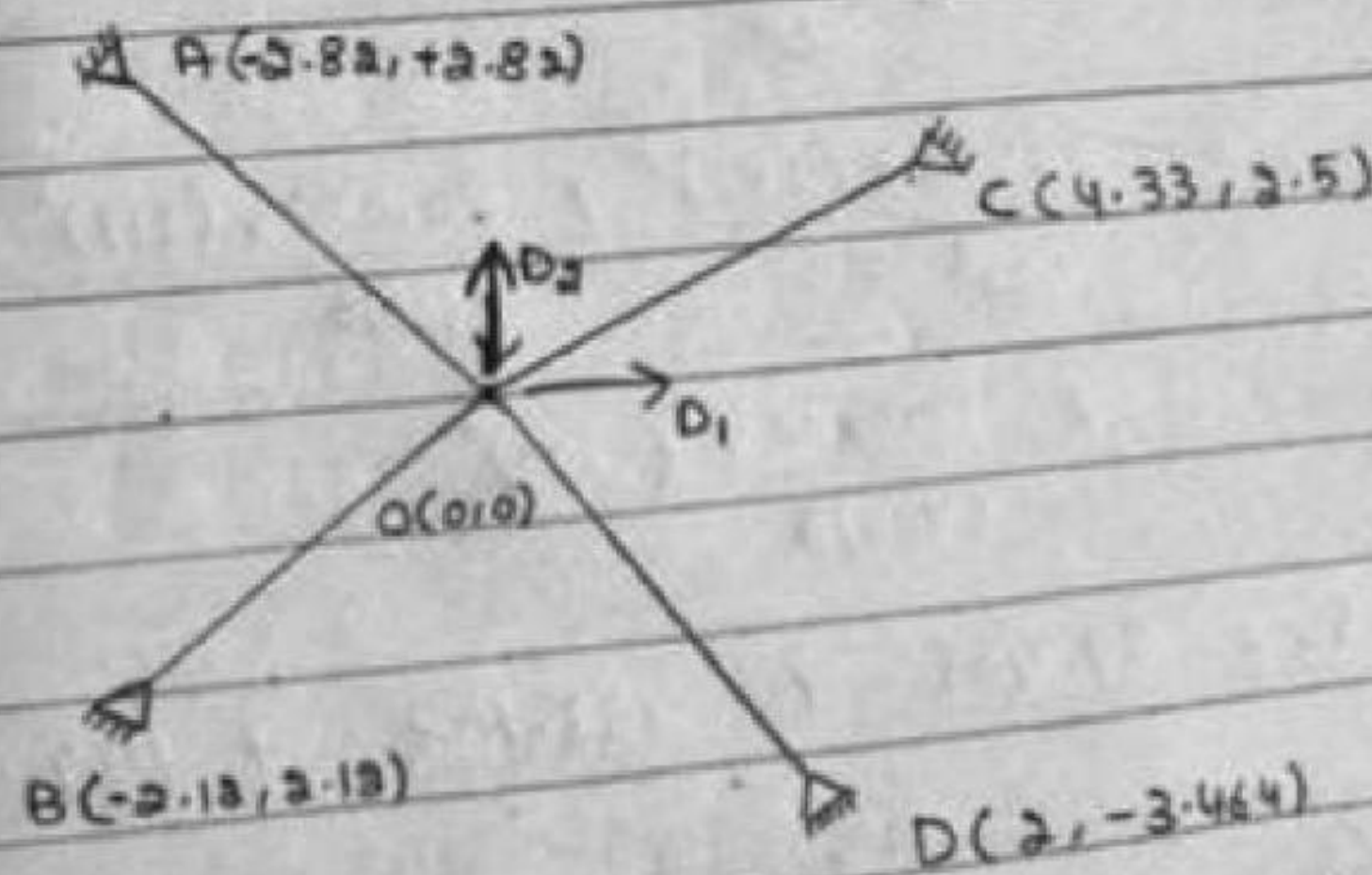
$$EA_{(D)} = 2000 \times 50 = 100,000 \text{ t}$$

Step#01: K.I

$$K.I = 2j - r$$

$$= 2(5) - 8 = 2^\circ$$

Step#02: Select unknown joint displacement



$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}, \quad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

Step # 03:  $[AMD]_{4 \times 2}$  &  $[S]_{2 \times 2}$

$$i) D_1 = 1 \quad , \quad D_2 = 0$$

$$AMD = \frac{EA}{L^2} (X_k - X_j)$$

$$AMD_{11} = \frac{80,000}{(400)^2} \times (0 + 282) = 141$$

$$AMD_{21} = \frac{80,000}{(300)^2} \times (0 + 212) = 188.44$$

$$AMD_{31} = \frac{100,000}{(500)^2} \times (0 - 433) = -173.2$$

$$AMD_{41} = \frac{100,000}{(400)^2} \times (0 - 200) = -125$$

Now  $S_{11} = \sum_{j=1}^m \frac{EA}{L^2} (X_k - X_j)^2$

$$= \frac{80,000 \times (282)^2}{400^3} + \frac{80,000 \times (212)^2}{(300)^3} + \frac{100,000 \times (-433)^2}{(500)^3} \\ + \frac{100,000 \times (-200)^2}{(400)^3}$$

$$S_{11} = 99.405 + 133.167 + 149.991 + 62.5$$

$$\boxed{S_{11} = 445.063}$$



$$S_{12} = S_{21} = \sum_{i=1}^m \frac{EA}{L^3} (X_k - X_j)(Y_k - Y_j)$$

$$= \frac{80,000 \times (282)(-282)}{(400)^3} + \frac{80,000 \times (212)(212)}{(300)^3}$$

$$+ \frac{100,000 \times (-433)(0-250)}{(500)^3} + \frac{100,000 \times (-200)(0+346)}{(400)^3}$$

$$\boxed{S_{12} = S_{21} = 12.237}$$

$$\text{ii) } D_i = 0, \quad D_i = 1k'$$

$$AMD = \frac{EA}{L^3} (Y_k - Y_j)$$

$$AMD_{1a} = \frac{80,000}{400^2} (-282) = -141$$

$$AMD_{2a} = \frac{80,000}{300^2} (212) = 188.44$$

$$AMD_{3a} = \frac{100,000}{500^2} (-250) = -100$$

$$AMD_{4a} = \frac{100,000}{400^2} (346) = 216.25$$

$$\text{Now, } S_{22} = \sum_{i=1}^m \frac{EA}{L^3} (Y_k - Y_j)^2$$

$$= \frac{80,000}{400^3} (-282)^2 + \frac{80,000}{300^3} (212)^2 + \frac{100,000}{500^3} (-250)^2$$

$$+ \frac{100,000}{400^3} (346)^2$$

$$\boxed{S_{22} = 469.628}$$

Step #04:  $[D] = [S]^{-1} \times [AD]$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 445.063 & 12.237 \\ 12.237 & 469.628 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

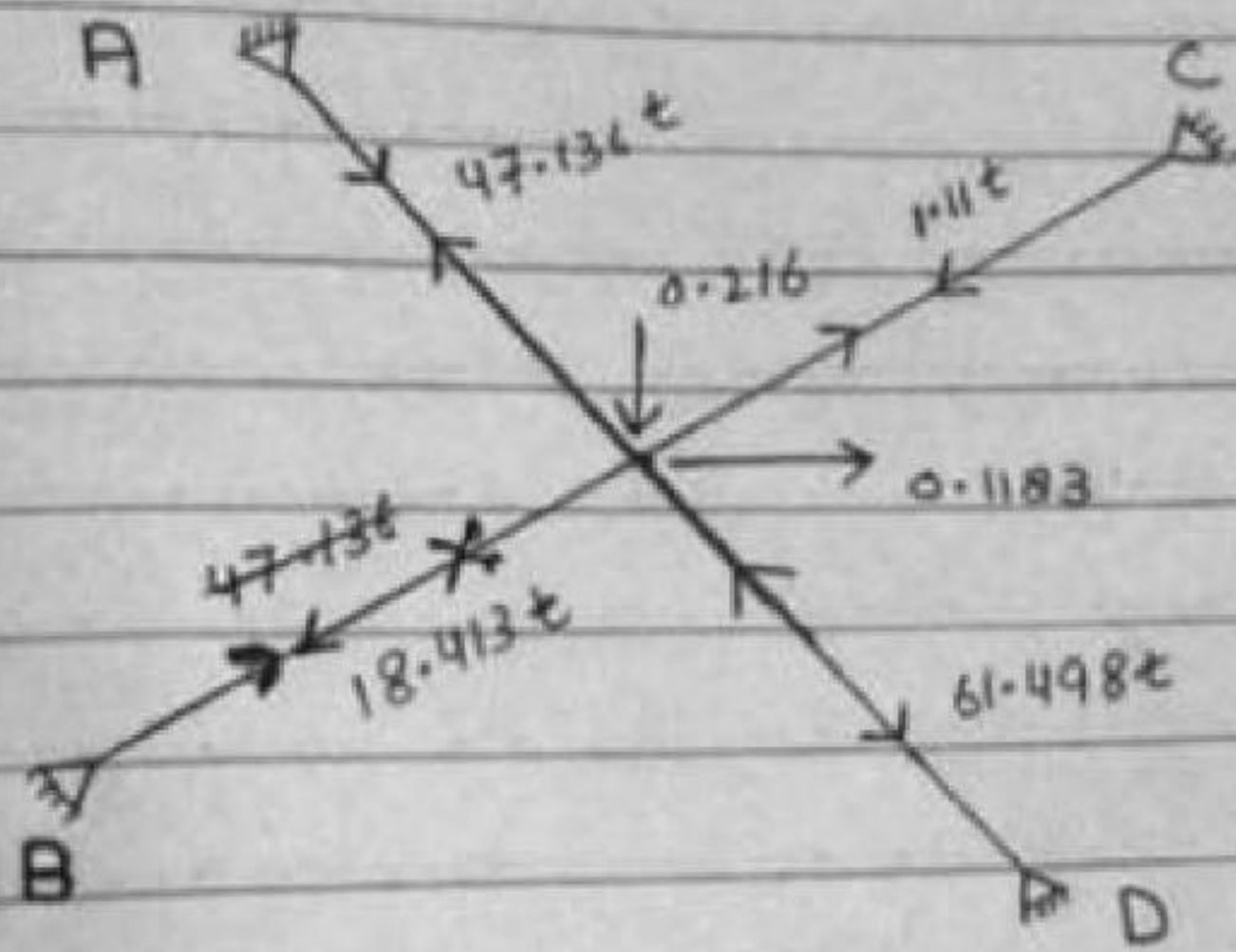
Step #06:  $[AM]$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 141 & -141 \\ 188.44 & 188.44 \\ -173.2 & -100 \\ -125 & 216.25 \end{bmatrix} \times \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

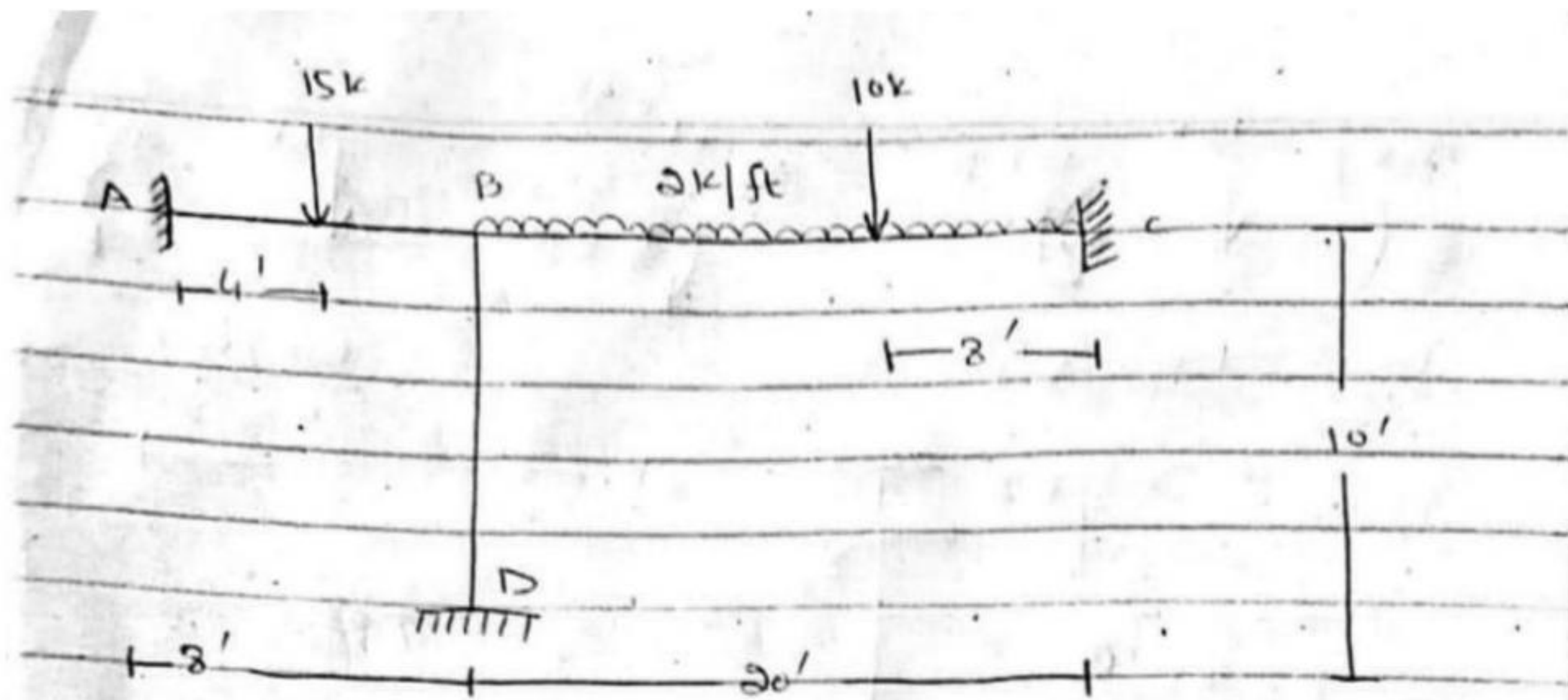
$$= \begin{bmatrix} 141 \times 0.1183 + (-141) \times (-0.216) \\ 188.44 \times 0.1183 + 188.44 \times (-0.216) \\ -173.2 \times 0.1183 + (-100) \times (-0.216) \\ -125 \times 0.1183 + 216.25 \times (-0.216) \end{bmatrix}$$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 16.68 + 30.46 \\ 22.29 - 40.70 \\ -20.49 + 21.6 \\ -14.79 - 46.71 \end{bmatrix}$$

$AM_1$	=	$47.136t$
$AM_2$		$-18.413t$
$AM_3$		$1.11t$
$AM_4$		$-61.498t$



# QUESTION NO = 03



Sol.

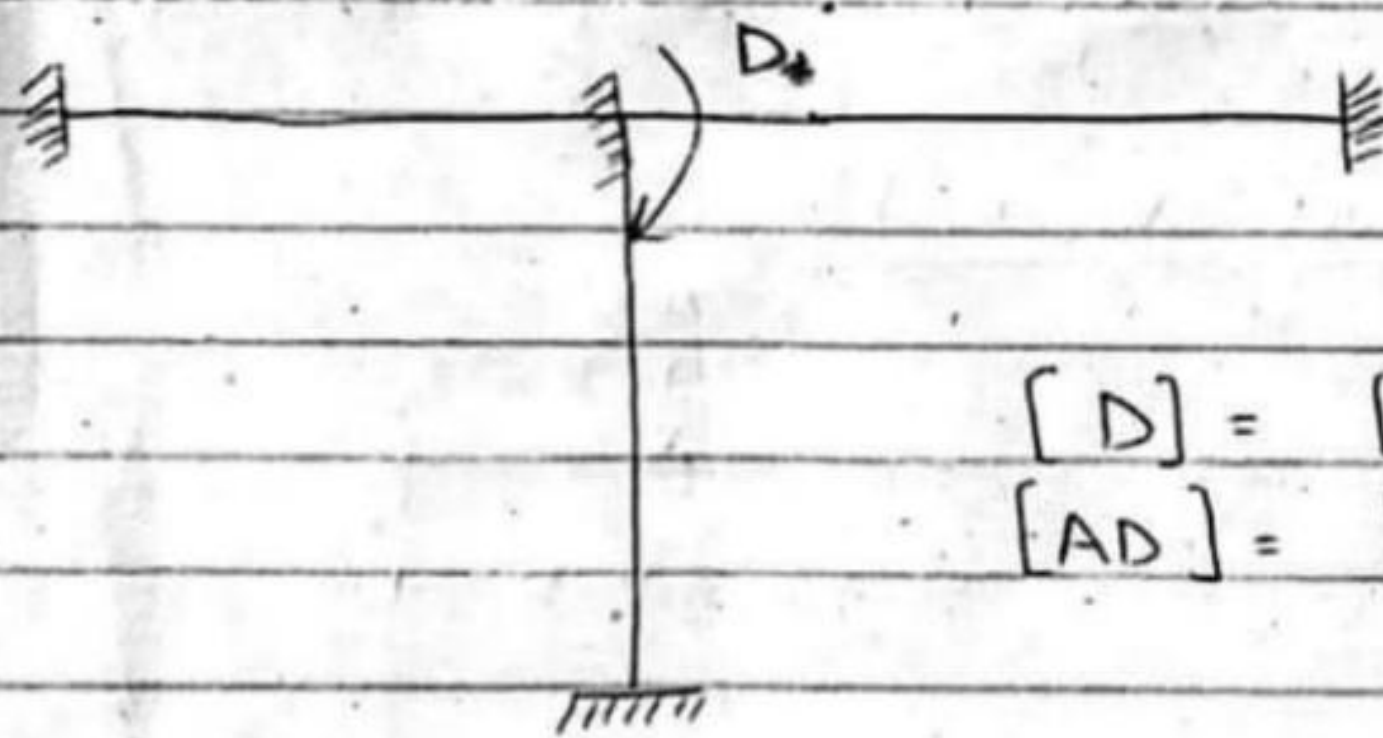
Step #1.-

Determine Kinematic Indeterminacy.

$$K.I = 1^{\circ}$$

Step #2 :-

Determine Unknown Joint Displacement.

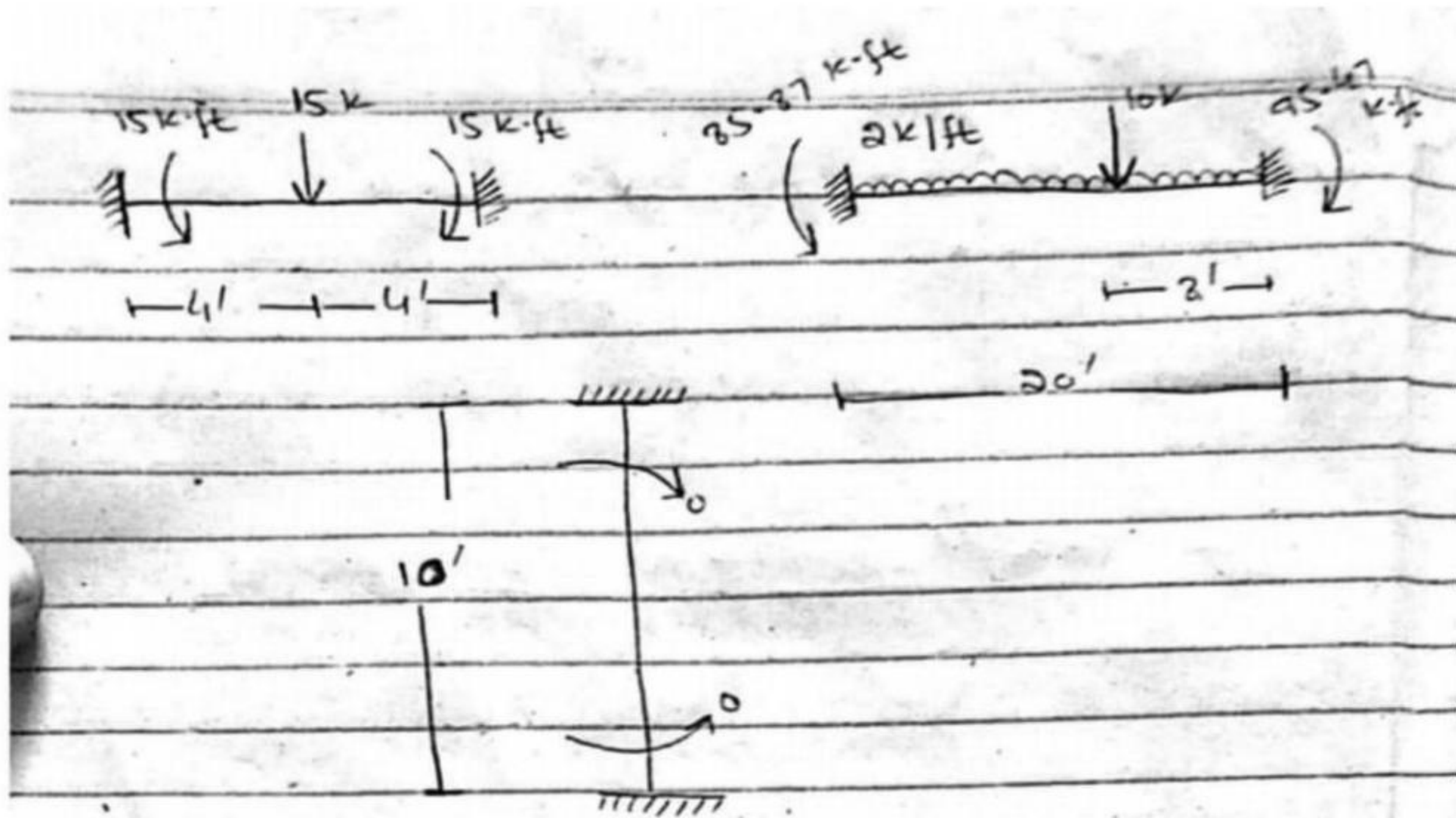


$$[D] = [?]$$

$$[AD] = [0]$$

Step #3 :-

Compute  $[ADL]$  Matrix.



=> Point Load at center :-

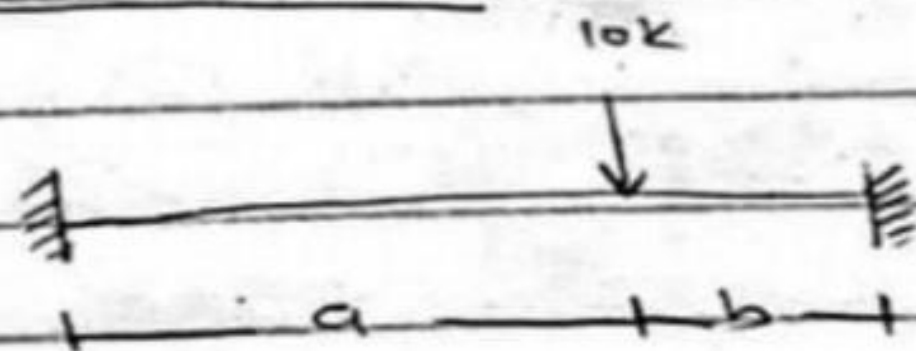
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ kip}\cdot\text{ft}$$

=> Uniformly Distributed Load :-

$$\frac{wL^2}{12} \Rightarrow \frac{(2)(20)^2}{12} = 66.67 \text{ k}\cdot\text{ft}$$

=> Point Load (Not at mid) :-

Suppose :-



For Left End :-

$$\frac{Pab^2}{L^2} \Rightarrow \frac{(10)(12)(8)^2}{(20)^2} = 19.2 \text{ k}\cdot\text{ft}$$

For Right End :-

$$\frac{Pa^2b}{L^2} = \frac{(10)(12)^2(8)}{(20)^2} = 28.8 \text{ k}\cdot\text{ft}$$

So Total Moment at left end is

$$19.2 + 66.67 = 85.87 \text{ k}\cdot\text{ft}$$

Similarly at right end:-

$$28.8 + 66.67 = 95.47 \text{ k}\cdot\text{ft}$$

$$\text{So } [AD] = -85.87 + 15 = -70.87 \text{ k}\cdot\text{ft}$$

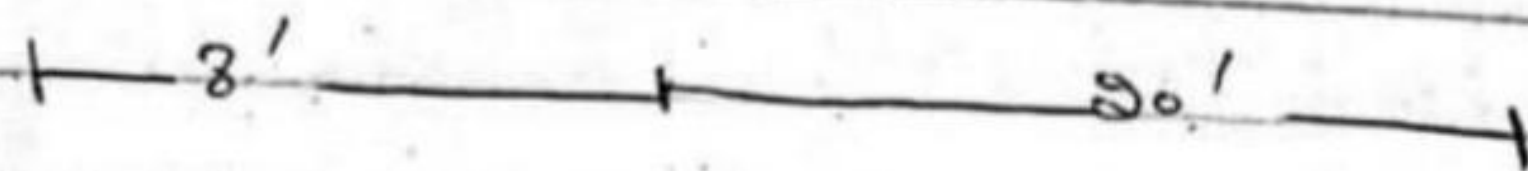
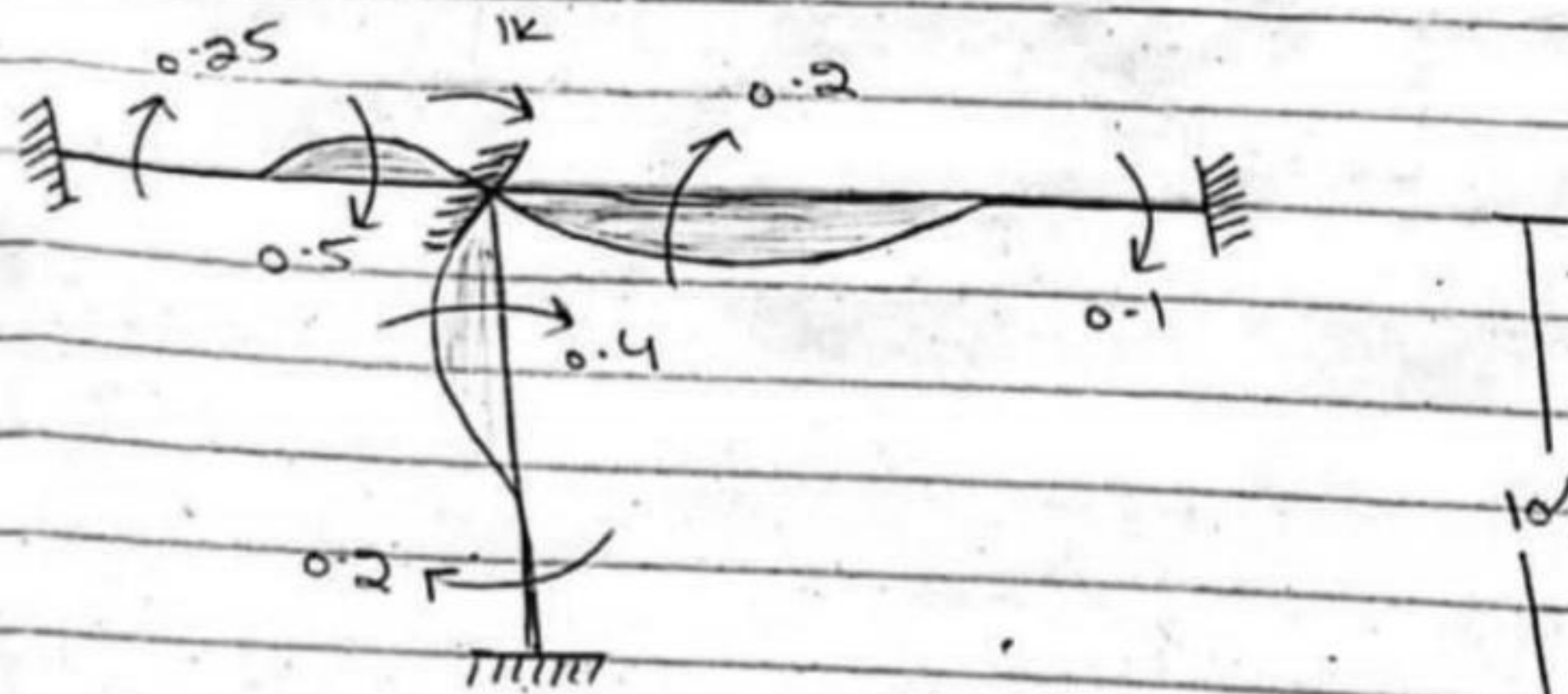
Step #4:-

Determine  $[S]$  Matrix

$$[S] = [S_{ij}]$$

Now,

$$D = 1 \text{ k}$$



$$\Rightarrow \frac{4EI}{8} = 0.5$$

$$\frac{2EI}{8} = 0.25$$

$$\Rightarrow \frac{4EI}{20} = 0.2$$

$$\frac{2EI}{20} = 0.1$$

$$\Rightarrow \frac{4EI}{10} = 0.4$$

$$\frac{2EI}{10} = 0.2$$

$$[S] = (0.5 + 0.4 + 0.2) EI$$
$$= 1.1 EI$$

$$[S] = 1.1 EI$$

Step #5:

Compute  $[D]$  Matrix

$$[D] = [S]^{-1} \times [AD] - [ADL]$$

$$[D] = \frac{1}{1.1} \times [0] - [-70.87]$$

$$= \frac{70.87}{1.1}$$

$$[D] = [64.42] \frac{1}{EI}$$

# THE END