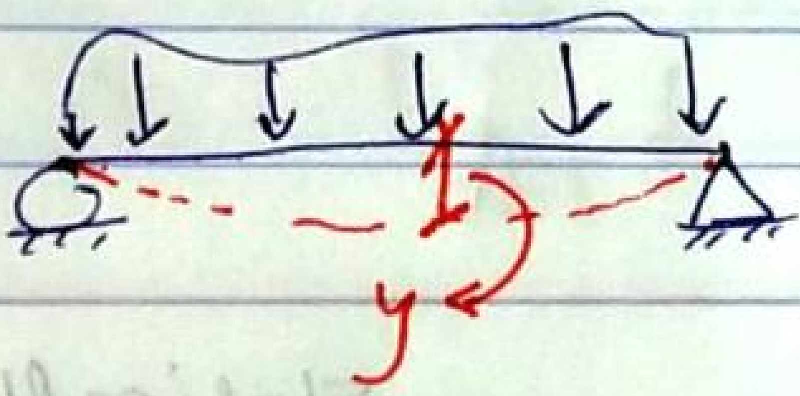
lecture # 1 :-

- Deflection method:-

1. Elastic beam theory
2. Direct Integration method
3. moment area method
4. Conjugate beam method
5. Energy method
6. principle of Virtual work.

- $\boxed{\text{Elastic Beam theory}}$ - second derivative for the deformed shape (curvature (Kappa))

$= M/EI$

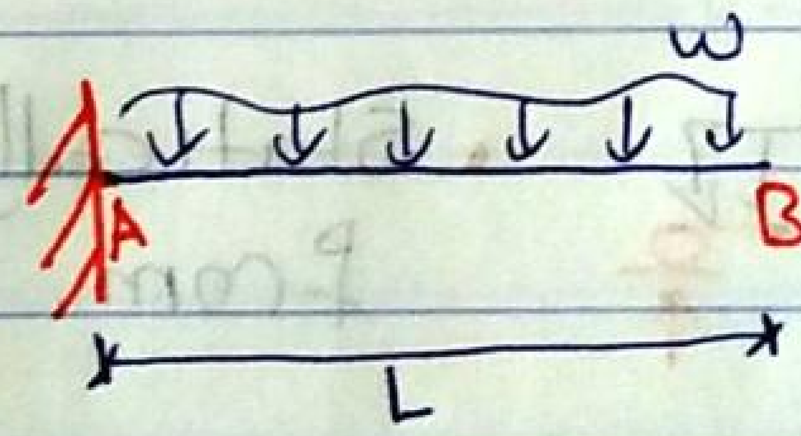


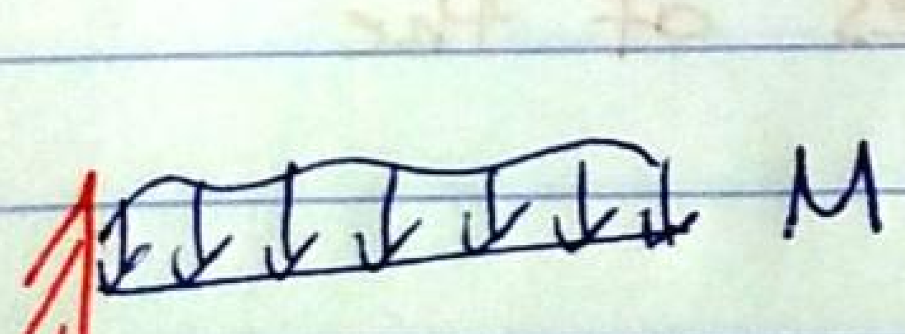
$$\frac{d^2y}{dx^2} = \frac{M}{EI}$$

$$\theta = \int \frac{M}{EI}\,dx$$

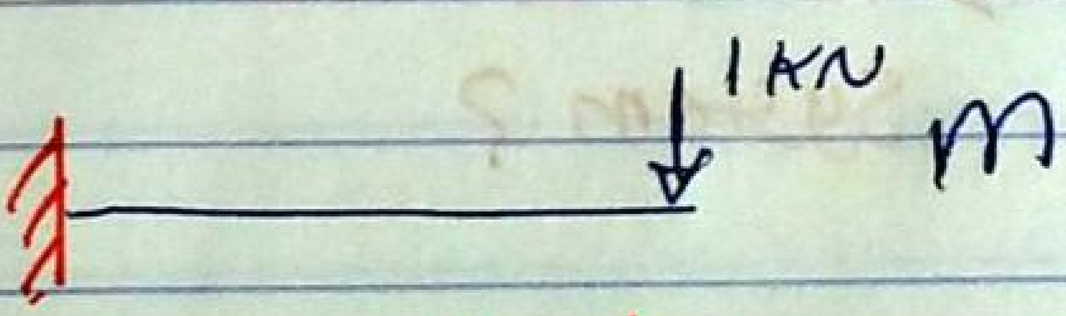
$$y = \int\left(\int \frac{M}{EI}\,dx\right)dx$$

- $\boxed{\text{Example}}$ - Find Δ_B Using the principle of virtueal work?





Real load system



virtual load system

$$\underset{\text{Virtual}}{1} \cdot \underset{\text{Real}}{\Delta_B} = \int m \, \underset{\text{Virtual}}{d\theta} \rightarrow \frac{M}{EI}dx \text{ Real load system}$$

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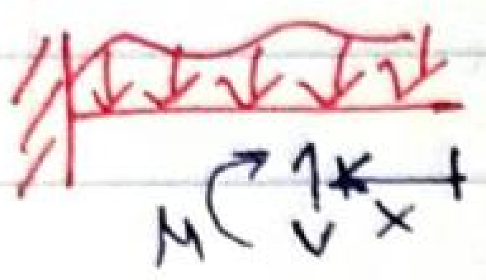
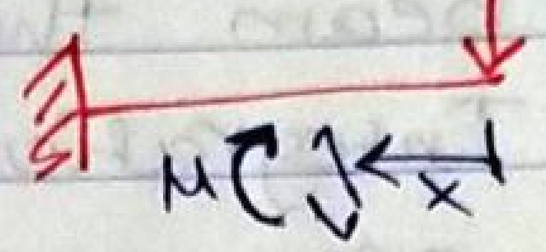
* Condition:- < Real / Virtual → أن يكون القطوع من نفس المكان





ΣM at cut $=0$

$M + wx\left(\frac{x}{2}\right) = 0$

$0 \le x \le L$

$M = -\frac{wx^2}{2}$

Σm at cut $=0$

$m + x = 0$

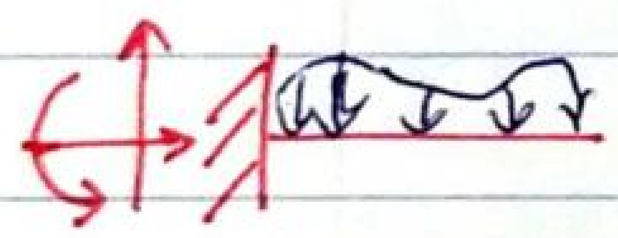
$0 \le x \le L$

$m = -x$

$$1 \cdot \Delta_B = \int_0^L (-x)\left(\frac{-w\frac{x^2}{2}}{EI}\right) dx$$

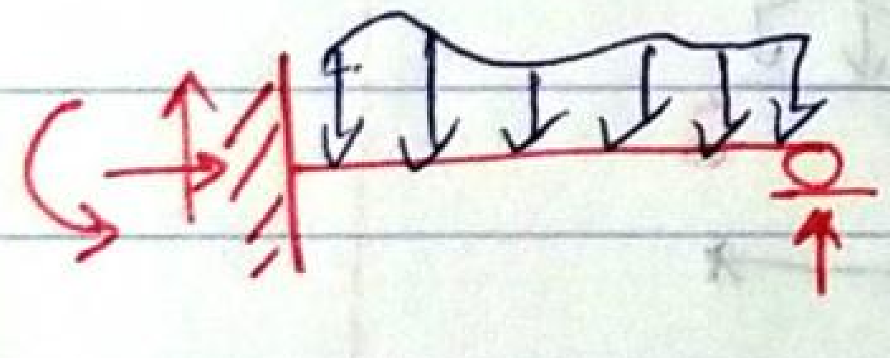
$$\Delta_B = \int_0^L \frac{wx^3}{2}\frac{dx}{EI} = \frac{wx^4}{8}\Big|_0^L = (+)\frac{wL^4}{8EI} \downarrow$$

→ أي أن الاتجاه المفروض صحيح.



- Statically determinate ≫ Cantilever

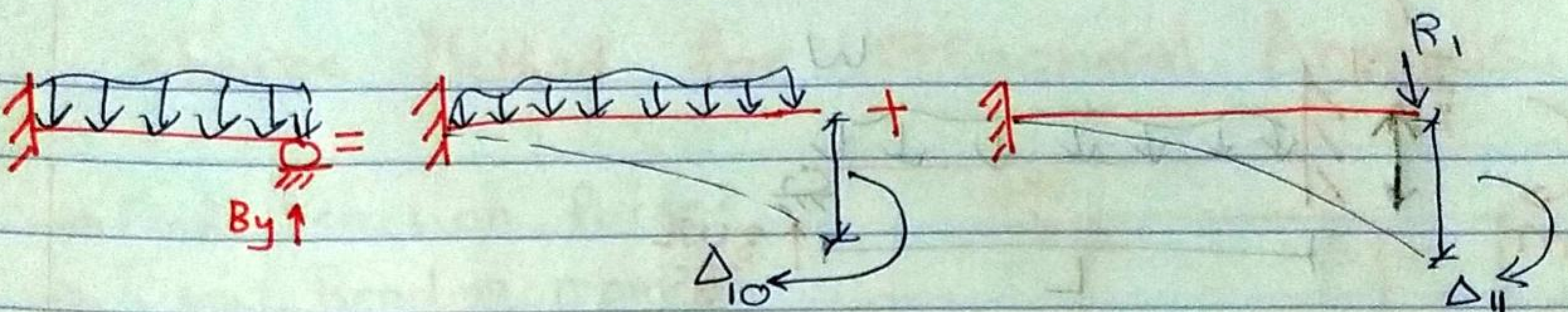
3 unknown = 3 Equilibrium Equations.



- Statically Indeterminate from the 1^{st} degree ≫ propped cantilever.

→ To Find the Reaction forces of the system?

$R_1 = B_y$



primary system $\qquad$ Primary + R

condition ⟹
det + Stable
+ applied loading

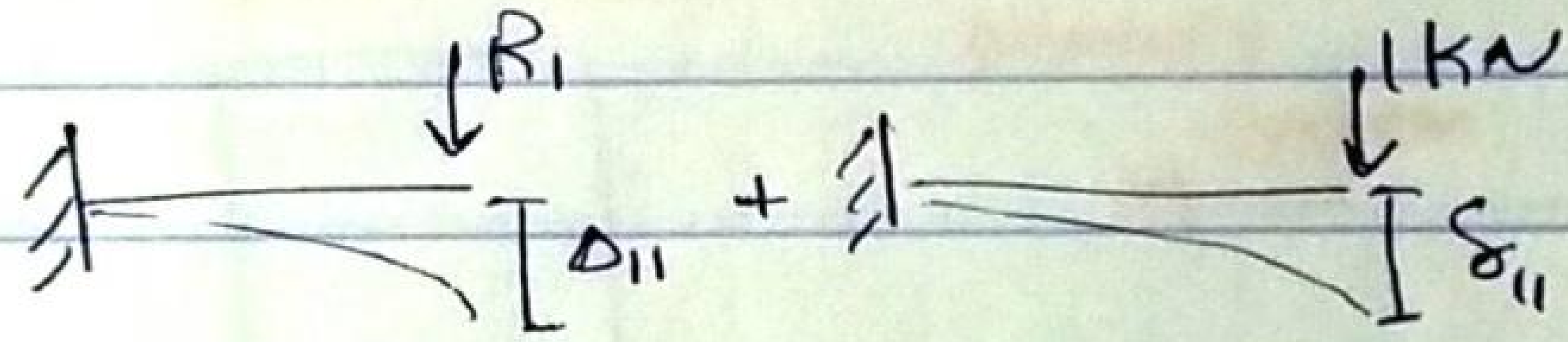
Δ_{10} → force causing the deformation.
↙ position and type of deformation

Compatability Equation:-

$$0 = \Delta_{10} + \Delta_{11}$$

$$0 = \frac{wL^4}{8EI} + \frac{R_1 L^3}{3EI}$$

$\Delta_{11} \Rightarrow$



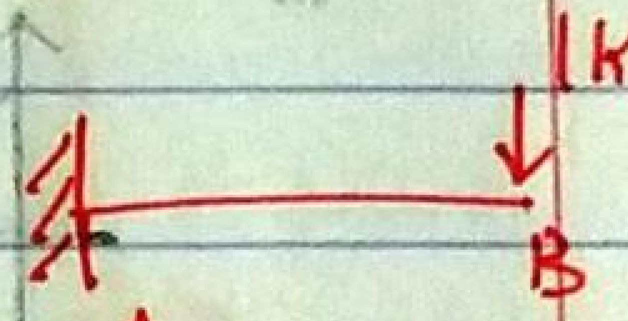
cond. Small deformation
• linear Elastic

$\rightarrow \Delta_{11} = \delta_{11} R_1$

$$\rightarrow B_y = \frac{3wL}{8} \uparrow$$

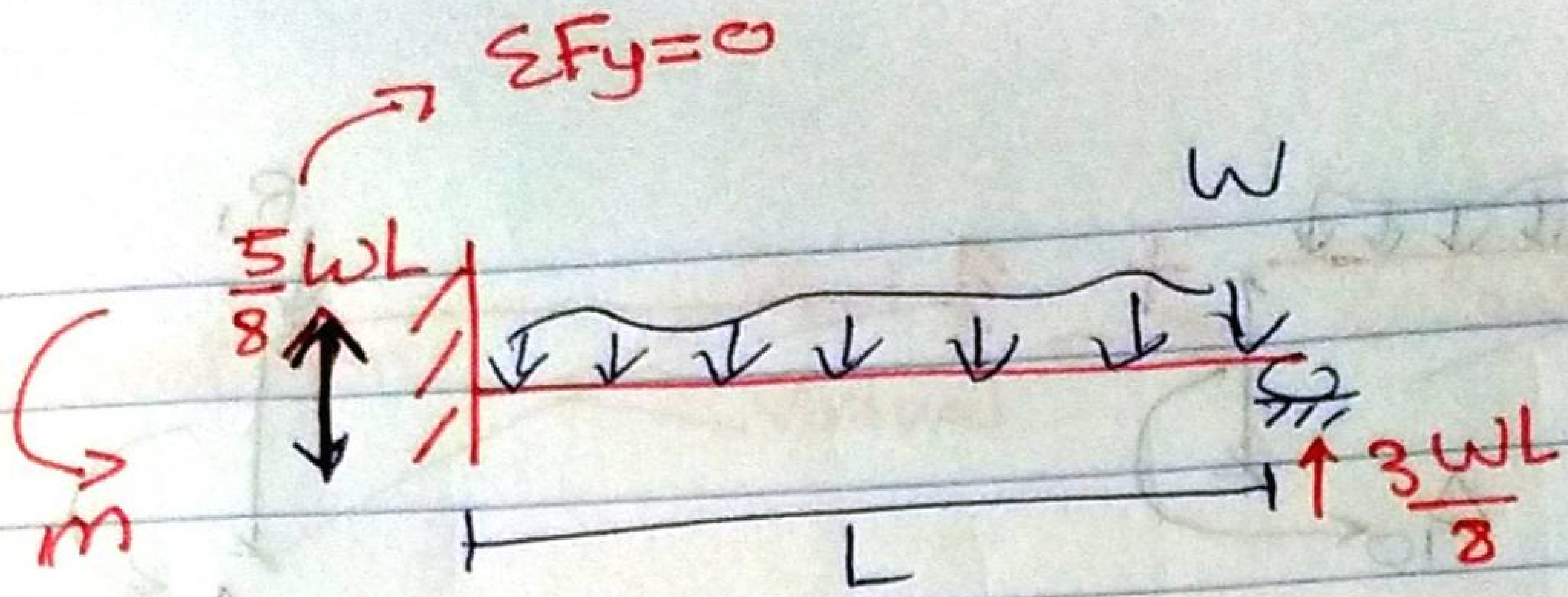
• Ex: Find Δ_B?

from the Sample Before



$$1 \times \Delta_B = \int_0^L (-x)(-x)\,dx / EI$$

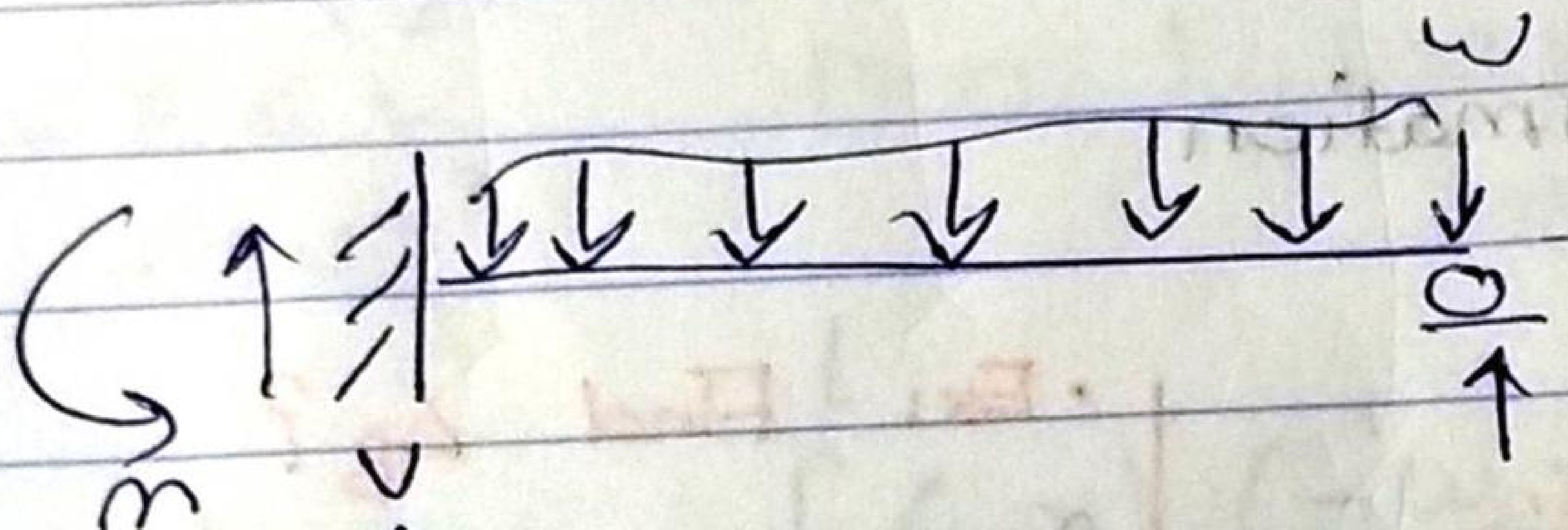
$$\Delta_B = \frac{L^3}{3EI} \downarrow$$



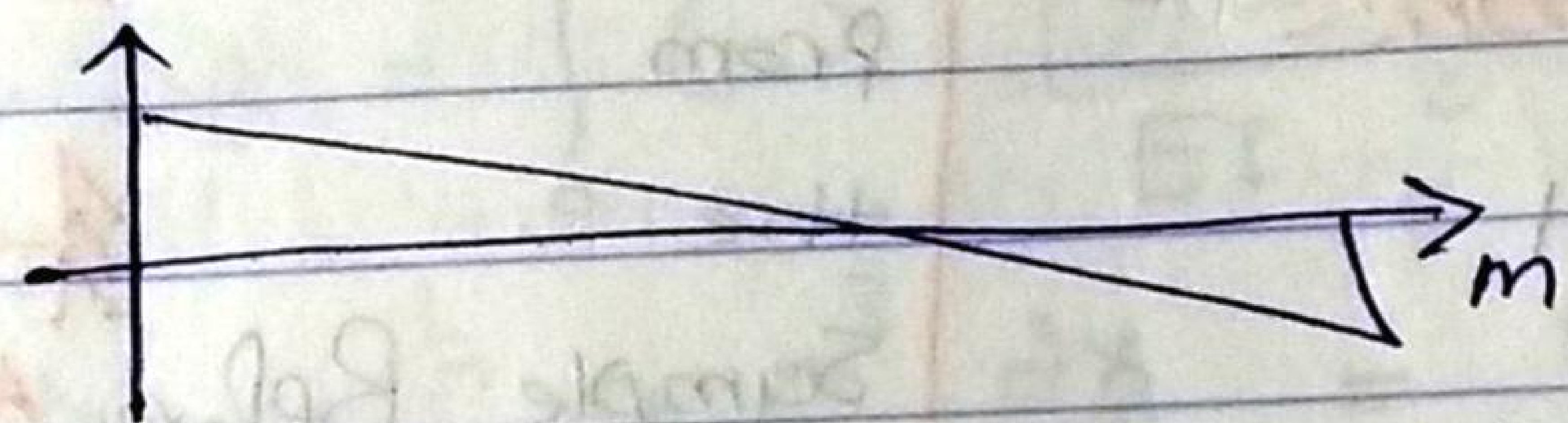
$$\Sigma M = 0$$

$$m = \frac{wL^2}{2} + \frac{3wL^2}{8} = 0$$

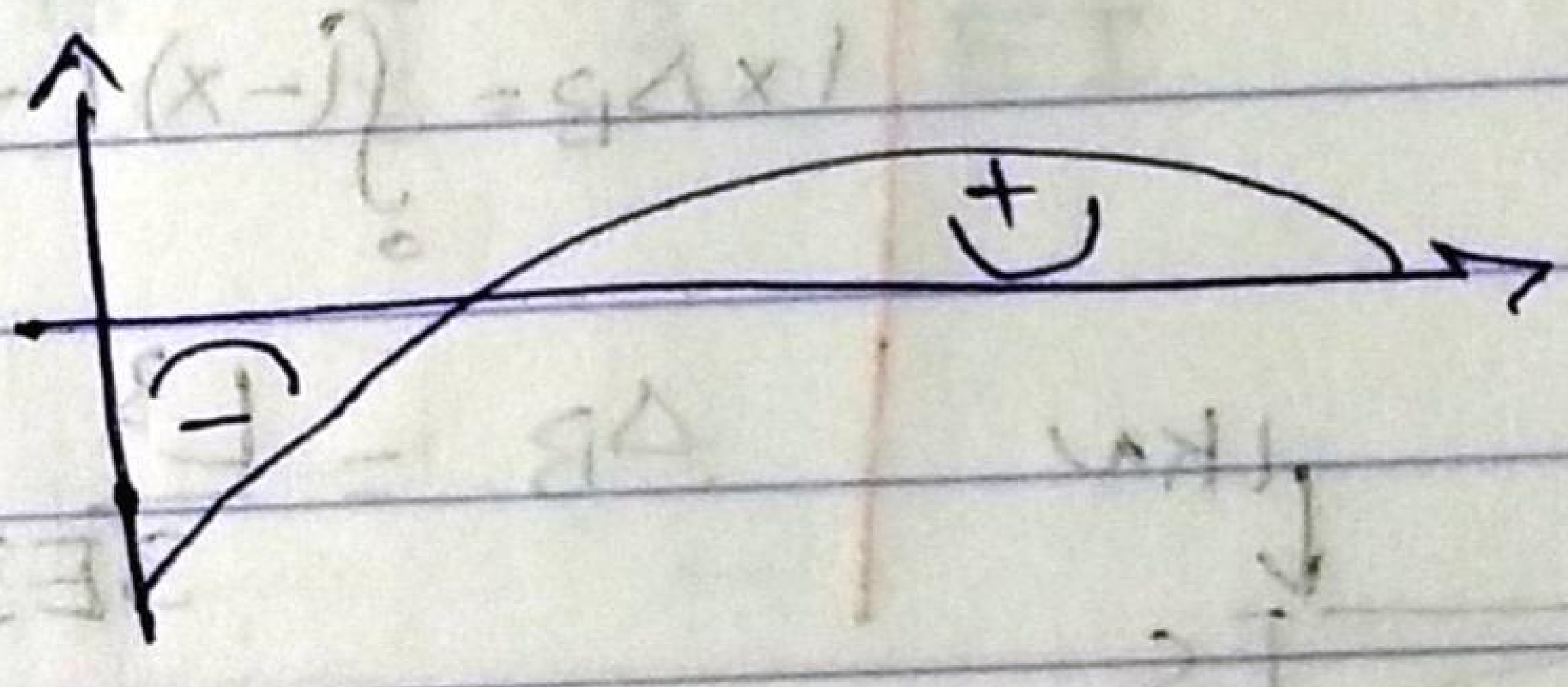
$$m = \frac{wL^2}{8} \circlearrowleft$$



Load



Shear



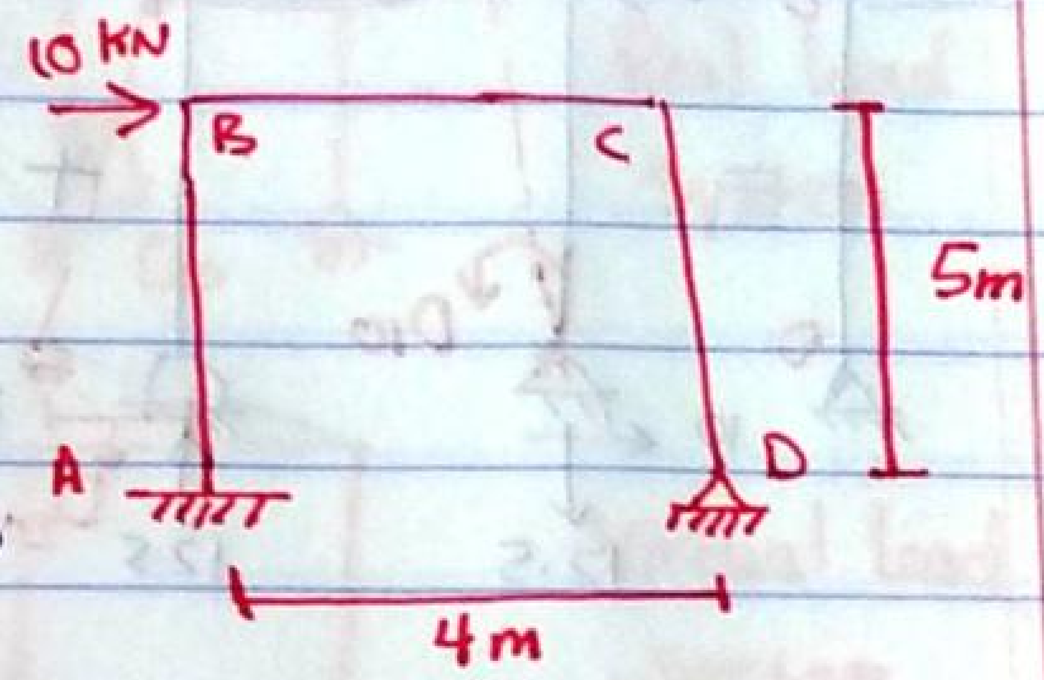
moment

Lecture #2

• Force Method for structural Analysis:-

→ Find Reaction force?
→ Draw Bending moment diagram?
→ sketch Deformed Shape?
→ find the drift at the fram?

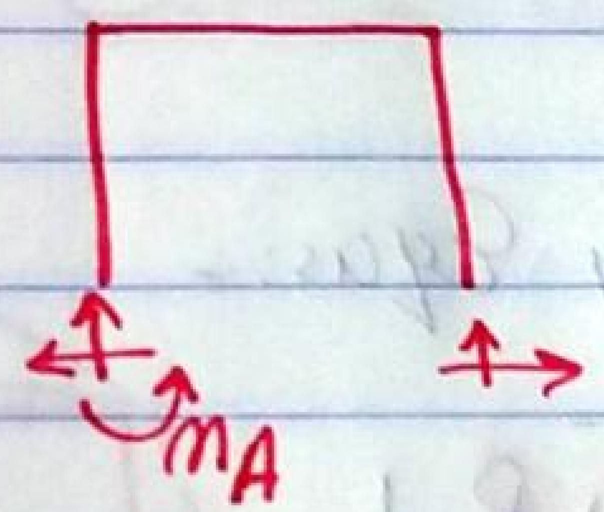
$\boxed{EI \text{ is constant}}$



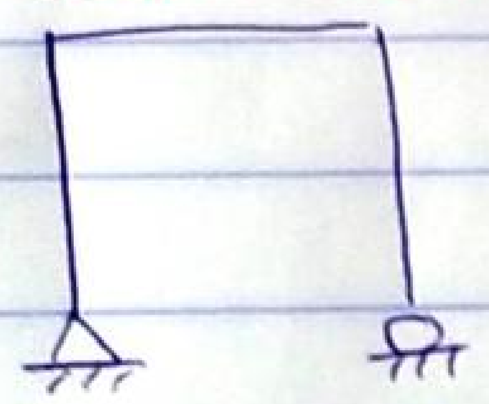
• **Drift:-** is the horizantal displacement of frame.

※ unknowns = 5
※ Equations = 3

In dete. system from the 2^{nd} degree.

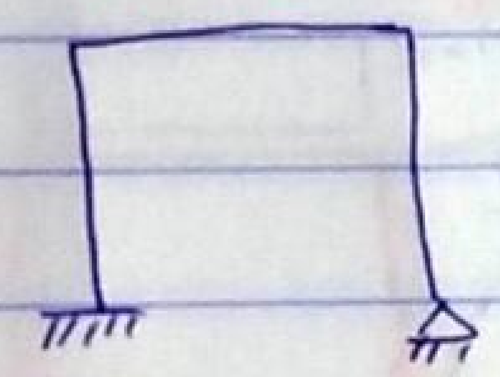


static det.



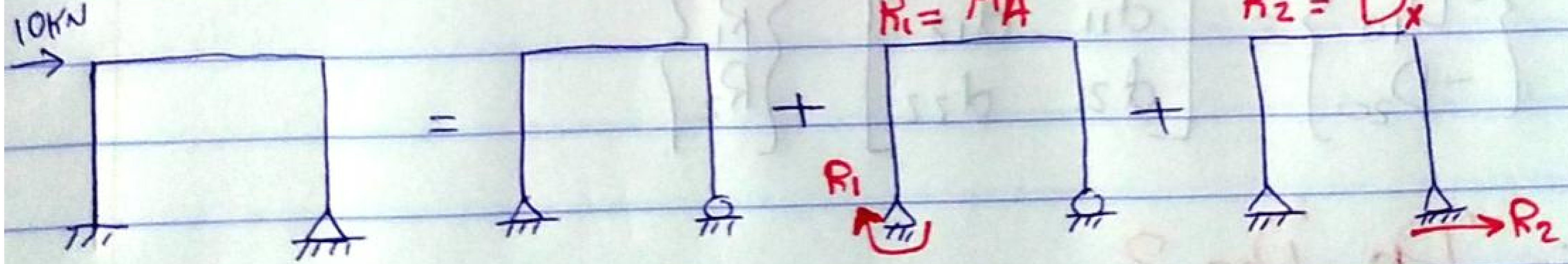
primary system

Static Ind.



$\{M_A, D_x\}$

min number of supports for stability



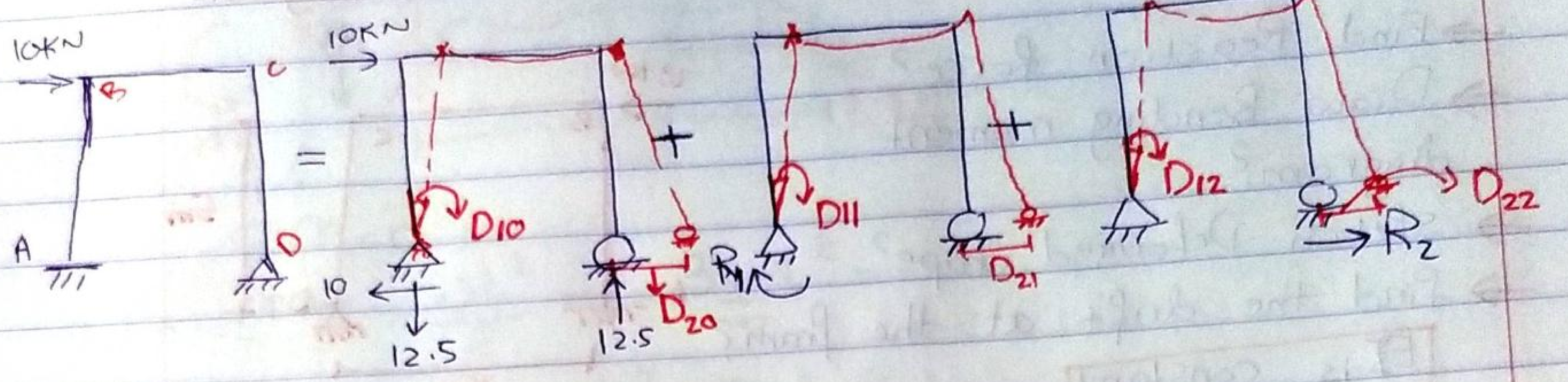
statically Ind. to 2^{nd} degree

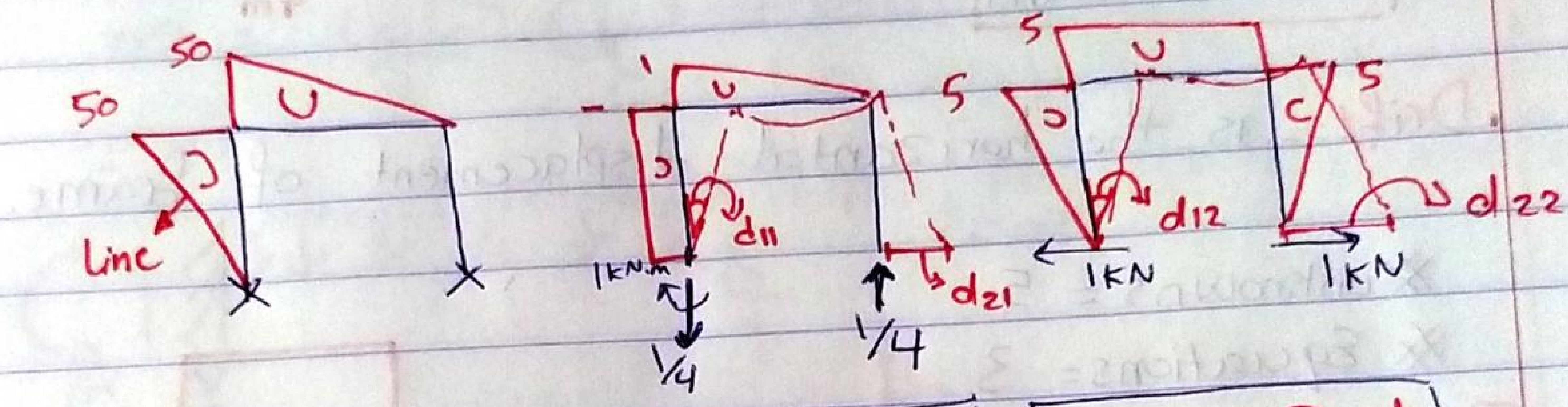
Primary stable + det. + applied loading

Primary $+ R_1$

Primary $+ R_2$

$R_1 = M_A$
$R_2 = D_x$





$$\boxed{\begin{matrix} D_{11} = R_1 d_{11} \\ D_{21} = R_1 d_{21} \end{matrix}} \qquad \boxed{\begin{matrix} D_{12} = R_2 d_{12} \\ D_{22} = R_2 d_{22} \end{matrix}}$$

- Compatibility Equs:-

for θ_A :-

$0 = D_{10} + R_1 d_{11} + R_2 d_{12}$

- Compatibility Equs:-

for Horizantal dis:-

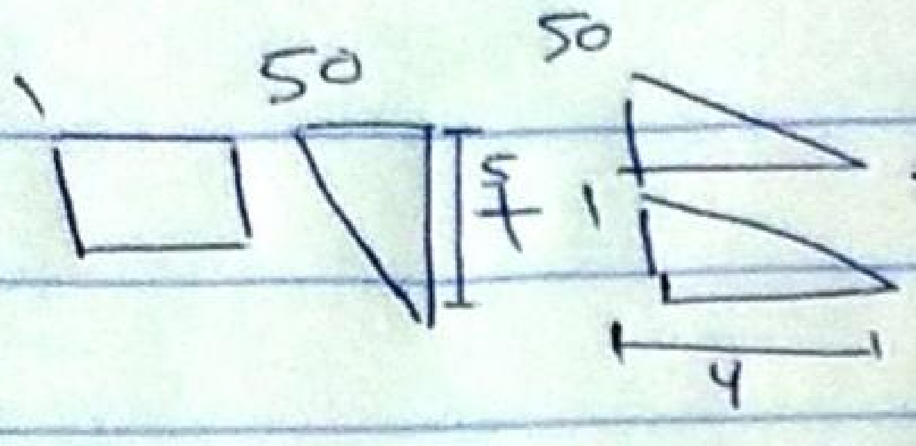
$0 = D_{20} + R_1 d_{21} + R_2 d_{22}$

$\Longrightarrow$ solving By matrix

$$-D_{10} = R_1 d_{11} + R_2 d_{12}$$
$$-D_{20} = R_1 d_{21} + R_2 d_{22}$$

$$\begin{Bmatrix} -D_{10} \\ -D_{20} \end{Bmatrix} = \begin{bmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{bmatrix} \begin{Bmatrix} R_1 \\ R_2 \end{Bmatrix}$$

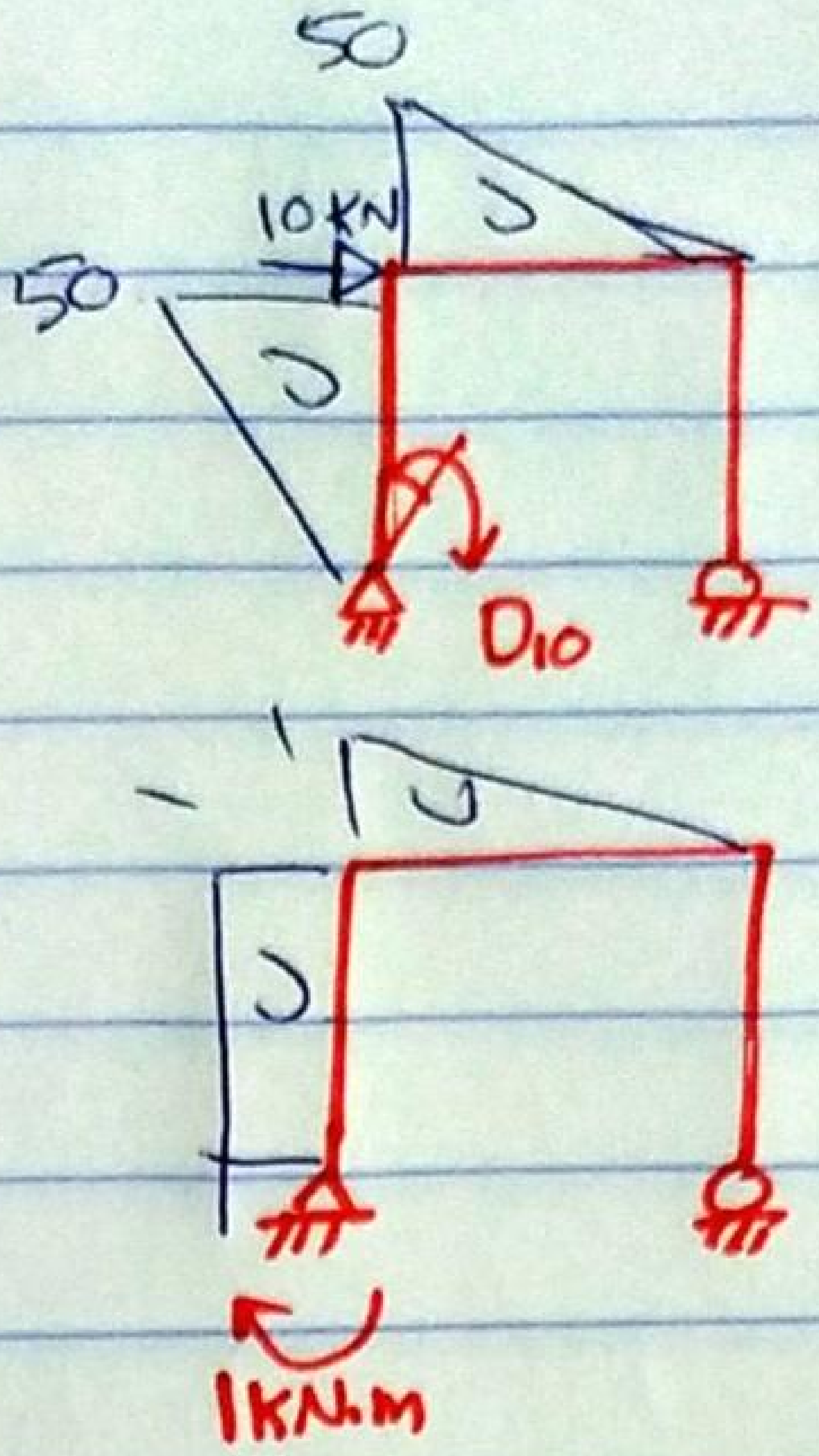
$\rightarrow$ Find :- D_{10}, D_{20} ?

$D_{10} =$  $+ (0)(0)$

$$= \frac{1}{2}\frac{(50)(1)(5)}{EI} + \frac{1}{3}\frac{(50)(1)(4)}{EI}$$

$$= \frac{191.67}{EI}$$

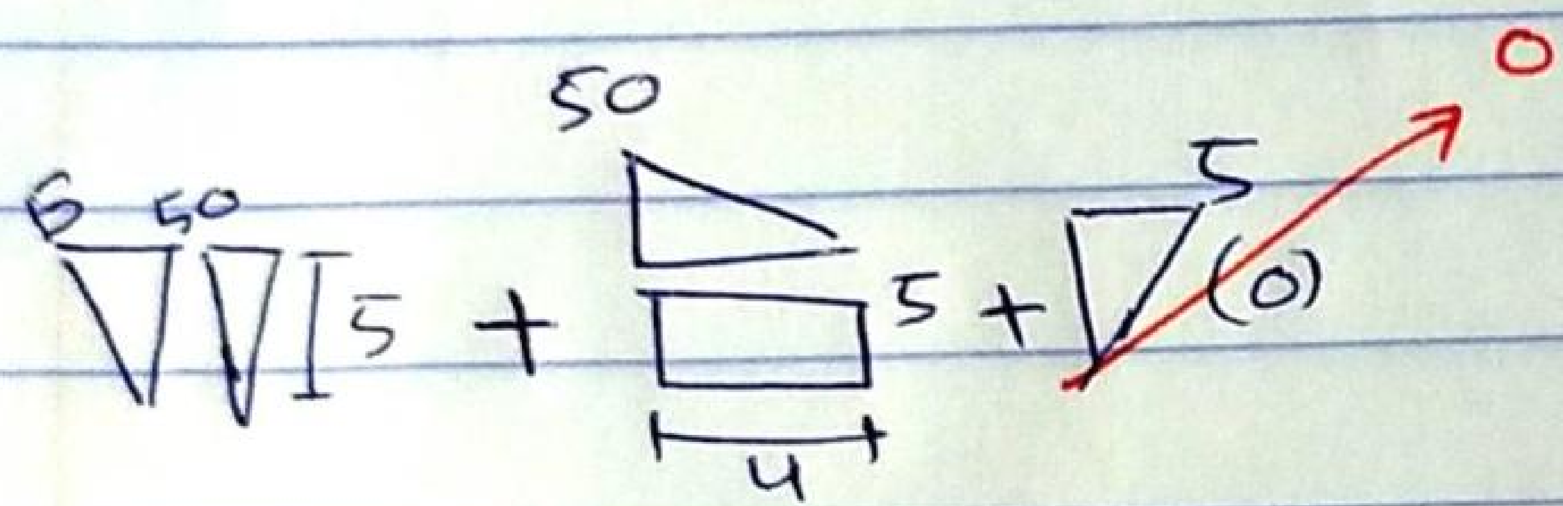
From the Integration Table.



Real load system

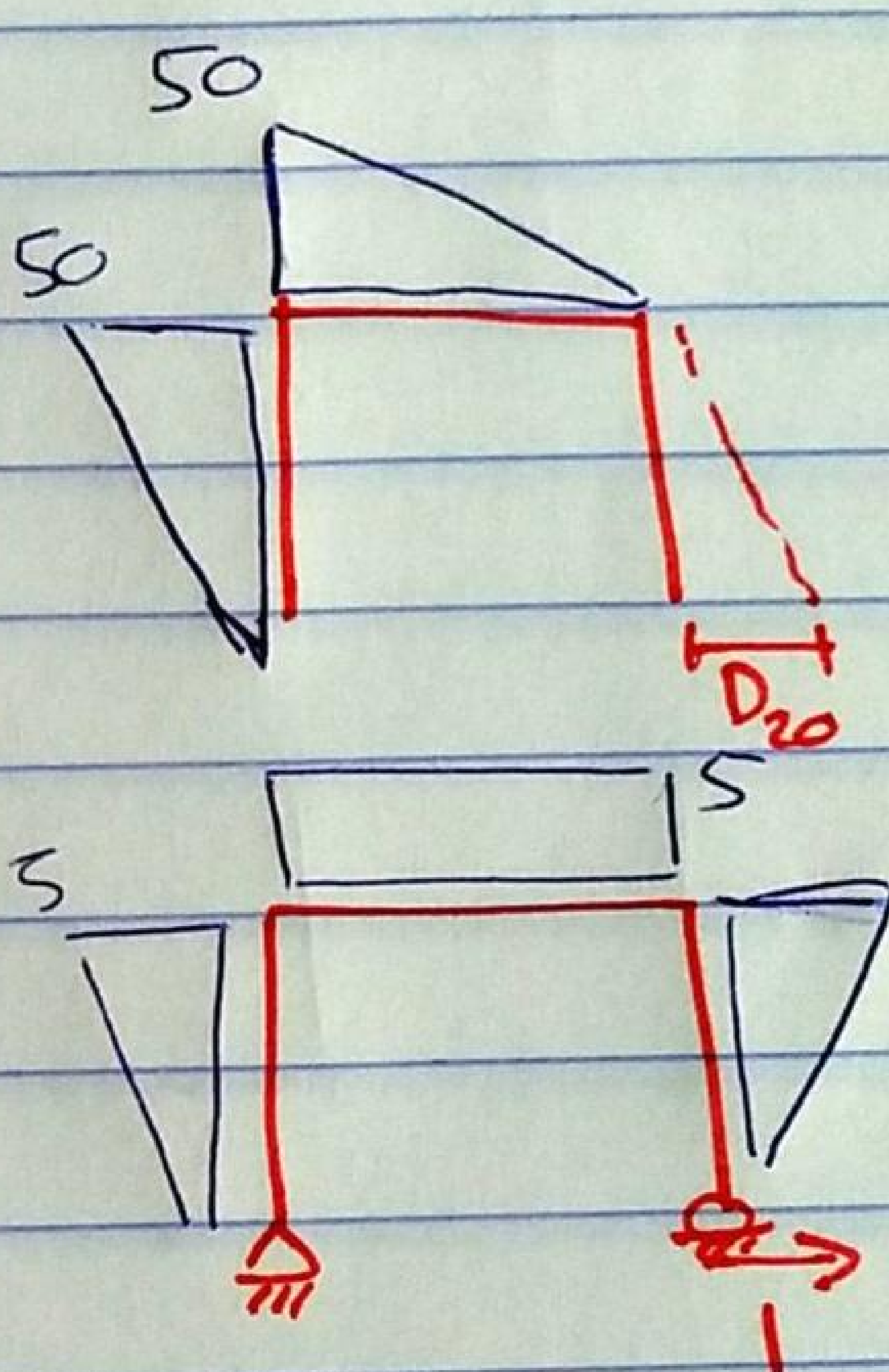
Virtual load system

Note:- إذا اتجاهات التقعر متشابهة يكون الحد موجب، وإذا اختلفت يكون الحد سالب.

$D_{20} =$ 

$$= \frac{1}{3}\frac{(50)(5)(5)}{EI} + \frac{1}{2}\frac{(50)(5)(4)}{EI}$$

$$= \frac{916.66}{EI}$$



Real load system

Virtual load system