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## ENGINEERING ANALYSIS II (EA2)

### Lecture # 25: Ch6. Structures in Equilibrium

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#### Lecture Outlines:

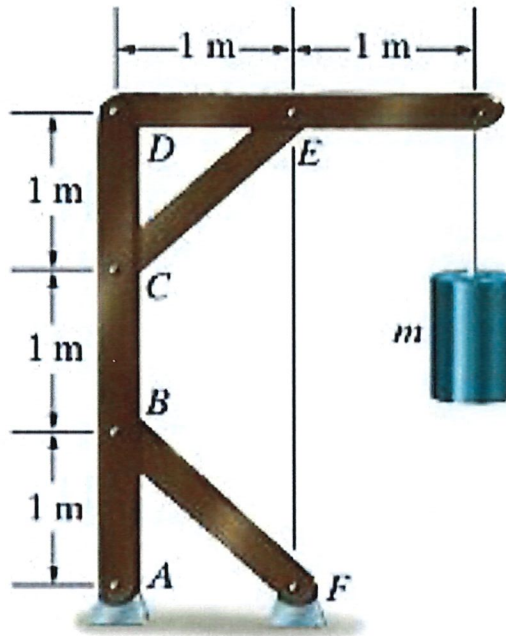
1. Frame Class Example 2.

#### References:

1. Bedford, A., & Fowler, W. *Engineering Mechanics: Statics* (5<sup>th</sup> ed.).
2. Prof. Alarcon's lecture notes.

## Class Problem 2:-

**6.83** The mass  $m = 50$  kg. Bar  $DE$  is horizontal. Determine the forces on member  $ABCD$ , presenting your answers as shown in Fig. 6.25.



### Notes:

- ① Solve for reactions and try to solve as many reactions as you can.
  - ② Separate each member. Each joint will show ~~two~~ unknowns. These unknowns are forces in  $x$  and  $y$  directions.
  - ③ A joint/a point <sup>is</sup> connecting two members or more, or a member with a support.
- Ex:- In this Example, the point where the mass is suspended is not regarded as a joint.

1] FBD of the whole frame:-

$$W = m * g$$

$$= 50 * 9.81 = \underline{490.5 \text{ N}}$$

$$\Rightarrow \sum F_x = 0 \quad \therefore R_{Ax} + R_{Fx} = 0 \quad (1)$$

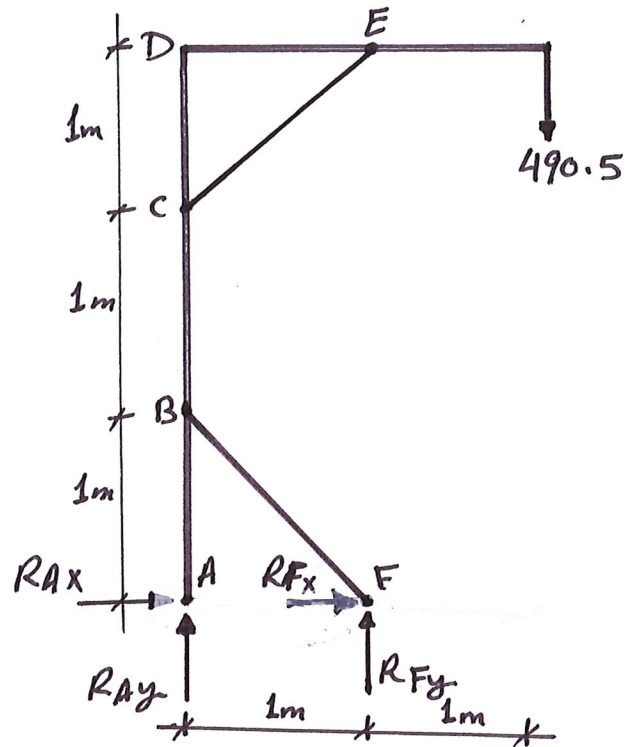
$$\Rightarrow +) \sum M_F = 0$$

$$\therefore -R_{Ay} * 1 - 490.5 * 1 = 0$$

$$\therefore \boxed{R_{Ay} = -490.5 \text{ N}}$$

$$\Rightarrow \sum F_y = 0$$

$$\therefore R_{Ay} + R_{Fy} - 490.5 = 0 \Rightarrow \boxed{R_{Fy} = 981 \text{ N}}$$



2] FBD of Each member:-

\* For member BF:- (See FBD in the next Page)

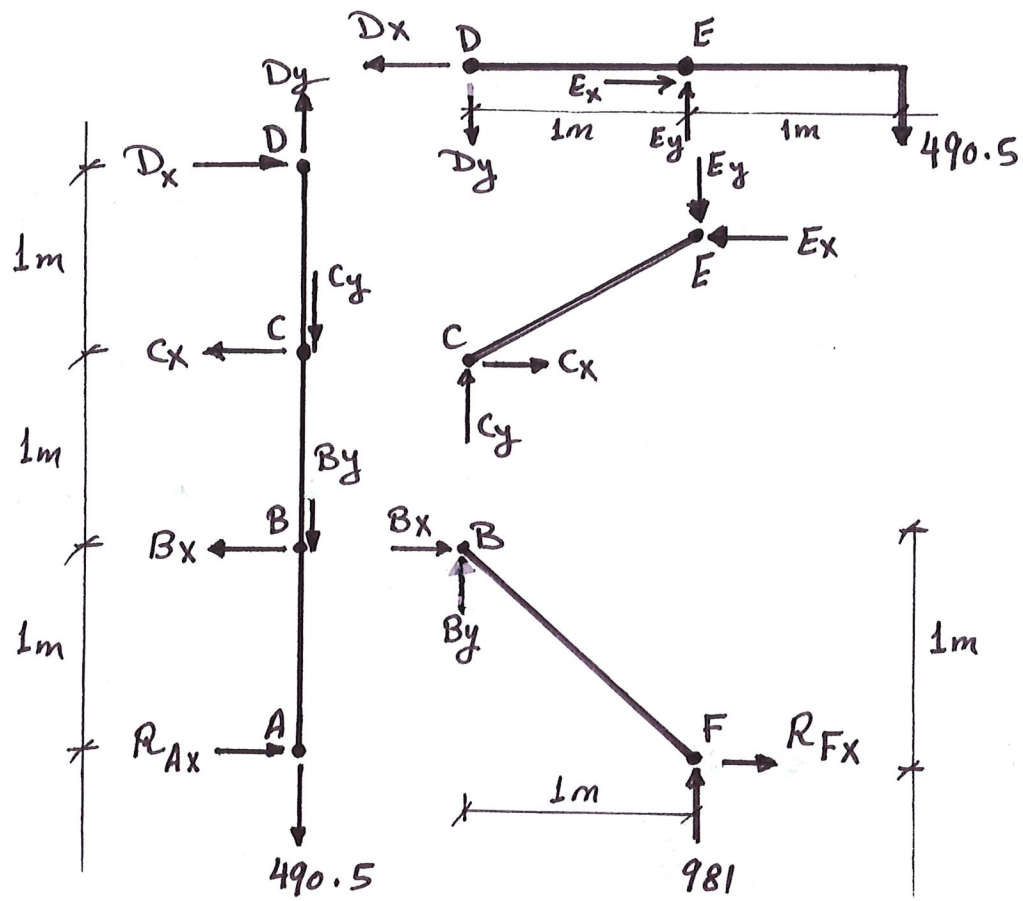
$$\Rightarrow \sum F_y = 0 \quad \therefore B_y + 981 = 0$$

$$\therefore B_y = -981 \text{ N}$$

$$\Rightarrow \sum M_F = 0 \quad \therefore -B_x * 1 - B_y * 1 = 0$$

$$\therefore -B_x * 1 + 981 * 1 = 0$$

$$\therefore \boxed{B_x = 981 \text{ N}}$$



$$\sum F_x = 0 \quad \therefore R_{Fx} + B_x = 0 \Rightarrow R_{Fx} = -981 \text{ N}$$

$$\text{From ①} \quad \therefore R_{Ax} - 981 = 0 \Rightarrow \boxed{R_{Ax} = 981 \text{ N}}$$

\* From member DE:-

$$\sum M_E = 0$$

$$\therefore D_y * 1 - 490.5 * 1 = 0 \Rightarrow \boxed{D_y = 490.5 \text{ N}}$$

\* From member ABCD:-

$$\Rightarrow \sum F_y = 0$$

$$\therefore \underset{\substack{\uparrow \\ 490.5}}{D_y} - \underset{\substack{\uparrow \\ ?}}{C_y} - \underset{\substack{\uparrow \\ -981}}{B_y} - 490.5 = 0 \Rightarrow \boxed{C_y = 981 \text{ N}}$$

$$\Rightarrow \sum M_D = 0$$

$$\therefore -C_x * 1 - \underset{\substack{\uparrow \\ 981}}{B_x} * 2 + \underset{\substack{\uparrow \\ 981}}{R_{Ax}} * 3 = 0 \Rightarrow \boxed{C_x = 981 \text{ N}}$$

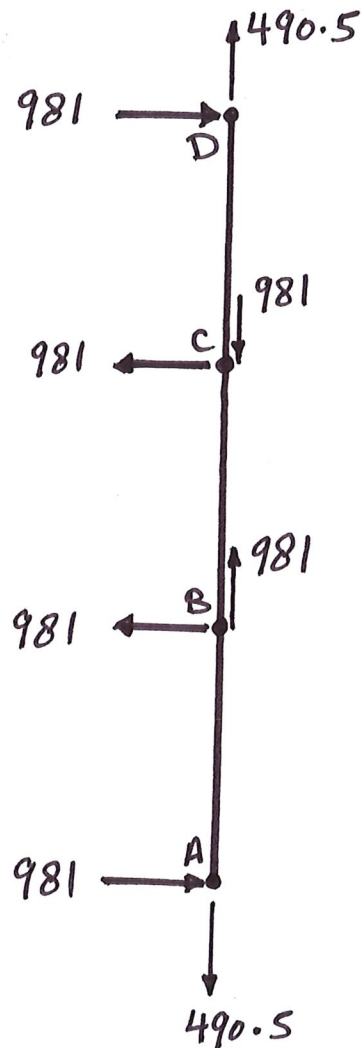


$$\Rightarrow \sum F_x = 0$$

$$\therefore R_{Ax} - B_x - C_x + D_x = 0$$

$$981 - 981 - 981 + D_x = 0 \Rightarrow \boxed{D_x = 981 \text{ N}}$$

So, the forces in member ABCD are :-



All forces are in 'N'