

### Answer of Mid-Term Exam

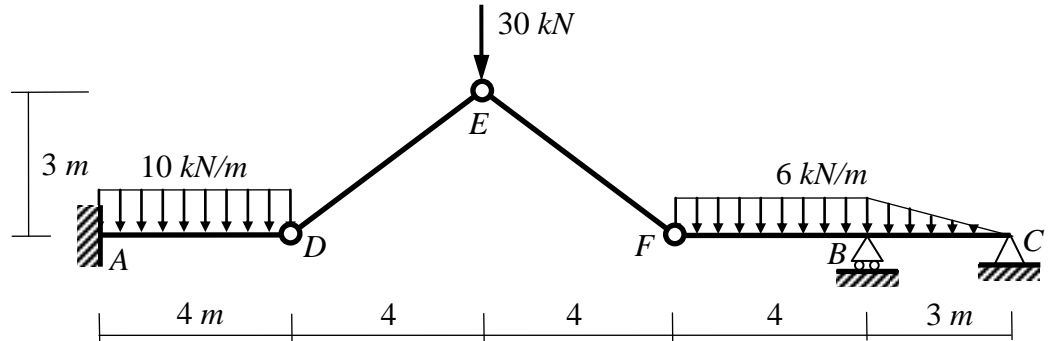
- Attempt all questions.
- The Exam consists of 3 questions in 1 page.
- Maximum grade is **20 Marks**.

**Question (1): (9 Marks)**

For the shown structure, determine the reactions at the supports **A, B** and **C**.

**Note:**

In your answer sheet, draw the final reactions (direction and magnitude) on the structure.



**Part DEF:**

$$+\circlearrowleft \sum M_D = 0: 30(4) - F_y(8) = 0 \rightarrow F_y = +15 \uparrow$$

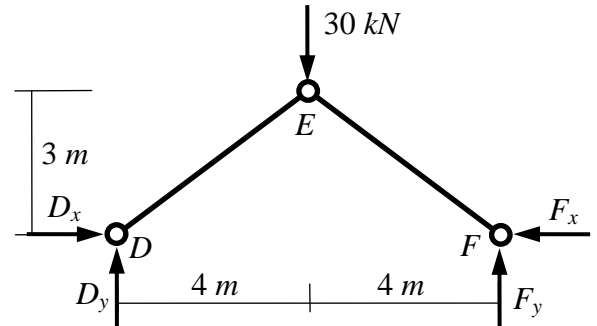
$$+\uparrow \sum F_y = 0: D_y + F_y - 30 = 0 \rightarrow D_y = +15 \uparrow$$

**Part EF**

$$+\circlearrowleft \sum M_E = 0: F_x(3) - E_y(4) = 0 \rightarrow F_x = +20 \leftarrow$$

**Part DEF:**

$$+\rightarrow \sum F_x = 0: D_x - F_x = 0 \rightarrow D_x = +20 \rightarrow$$

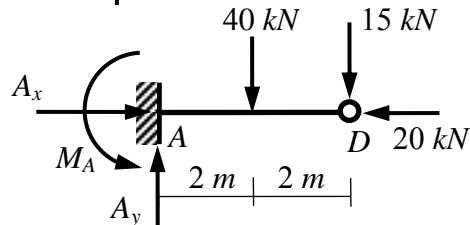


**Part AD:**

$$+\rightarrow \sum F_x = 0: A_x - 20 = 0 \rightarrow A_x = +20 \rightarrow \boxed{A_x = 20 \text{ kN } \rightarrow}$$

$$+\uparrow \sum F_y = 0: A_y - 40 - 15 = 0 \rightarrow A_y = +55 \uparrow \boxed{A_y = 55 \text{ kN } \uparrow}$$

$$+\circlearrowleft \sum M_A = 0: 40(2) + 15(4) - M_A = 0 \rightarrow M_A = +140 \circlearrowleft \boxed{M_A = 140 \text{ kN.m } \circlearrowleft}$$



**Part FBC:**

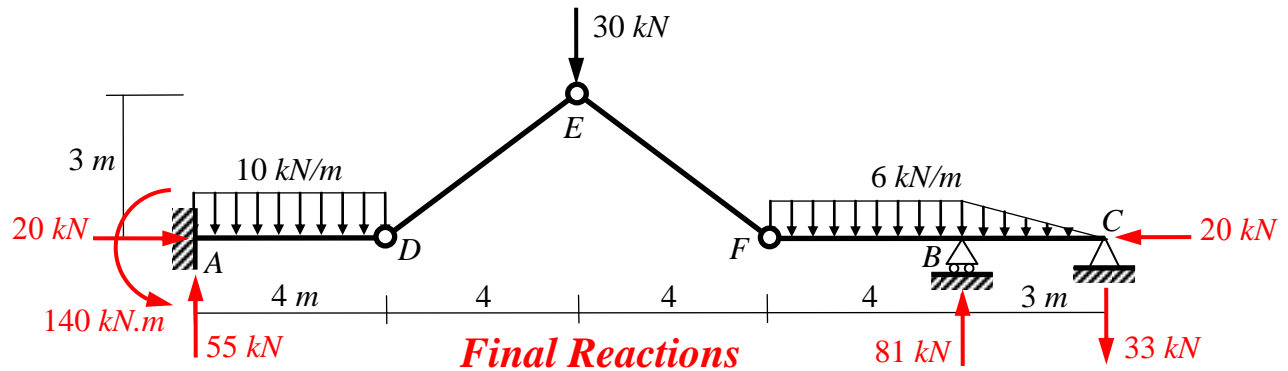
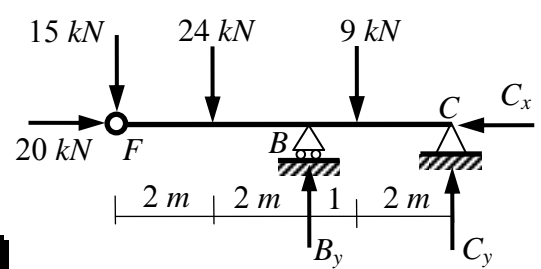
$$+\circlearrowleft \sum M_B = 0: -15(4) - 24(2) + 9(1) - C_y(3) = 0$$

$$\rightarrow C_y = -33 \uparrow \boxed{C_y = 33 \text{ kN } \downarrow}$$

$$+\uparrow \sum F_y = 0: B_y + C_y - 15 - 24 - 9 = 0$$

$$\rightarrow B_y = +81 \uparrow \boxed{B_y = 81 \text{ kN } \uparrow}$$

$$+\rightarrow \sum F_x = 0: 20 - C_x = 0 \therefore C_x = +20 \leftarrow \boxed{C_x = 20 \text{ kN } \leftarrow}$$



**Check:**

For the entire frame:  $+\uparrow \sum F_y = 55 - 40 - 30 - 24 + 81 - 9 - 33 = 0$  **O.K**

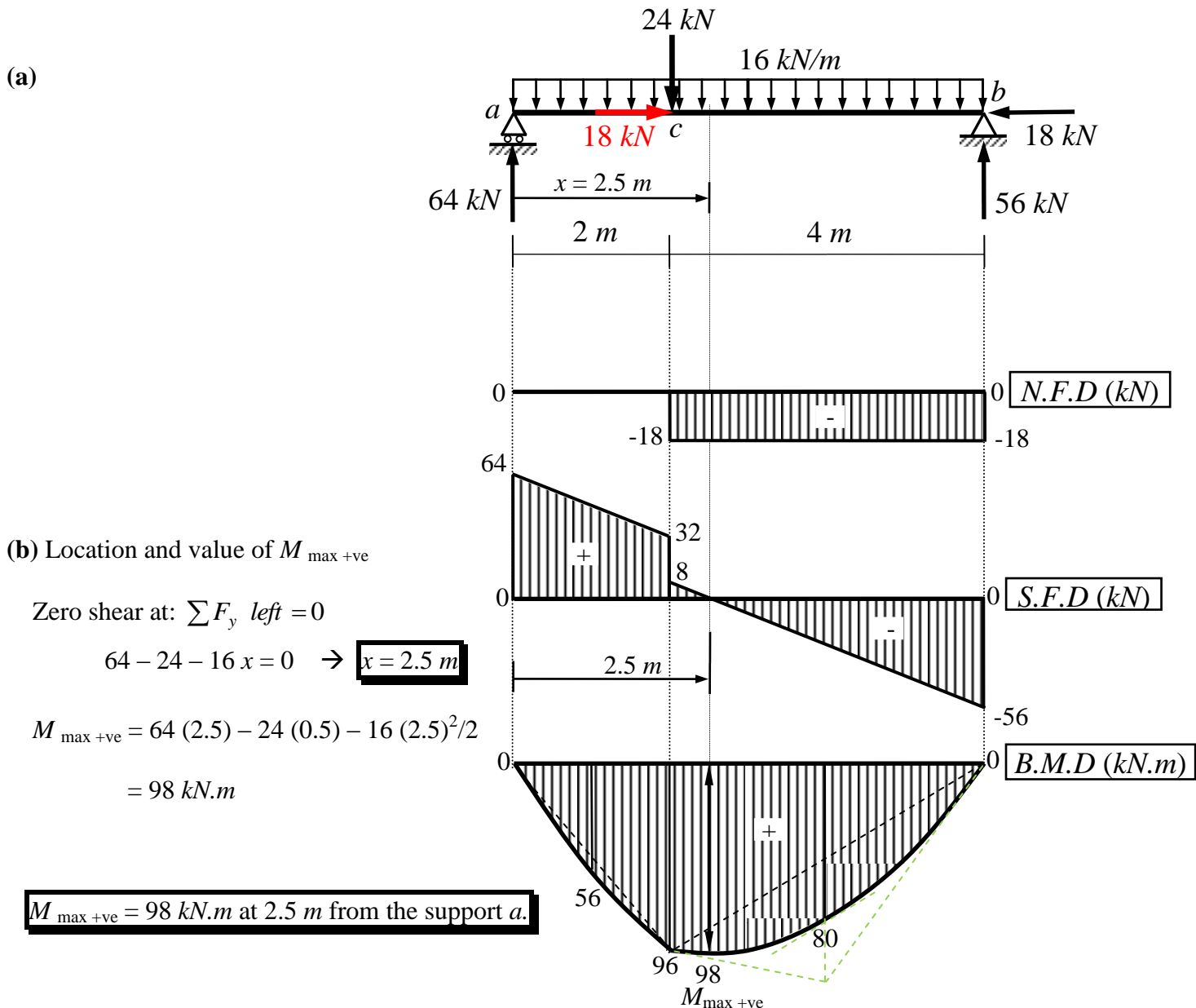
$+\circlearrowleft \sum M_E = -140 - 20(3) + 55(8) - 40(6) + 24(6) - 81(8) + 9(9) + 33(11) + 20(3) = 0$  **O.K**

**Question (2): (8 Marks)**

For the shown beam,

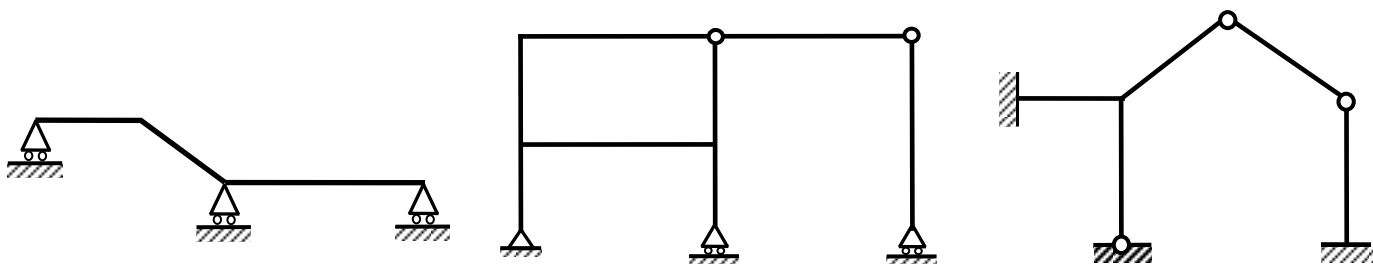
- (a) Draw the normal force, shear force and bending moment diagrams.
- (b) Determine the location and the value of the maximum positive bending moment.

**Note:** The reactions are given.



**Question (3): (3 Marks)**

Determine whether each of the shown structures is stable or unstable. If stable, determine whether it is statically determinate or indeterminate. If statically indeterminate, determine the degree of indeterminacy.



(1) Unstable.

(2) Unstable.

(3) Stable + Indeterminate to the 3<sup>rd</sup> degree.