Ministry of Higher Education
Giza Higher Institute for Eng. & Tech.
Civil Engineering Department
Course Name: **Theory of Structures (1)**
Course Code : **CIV 201**

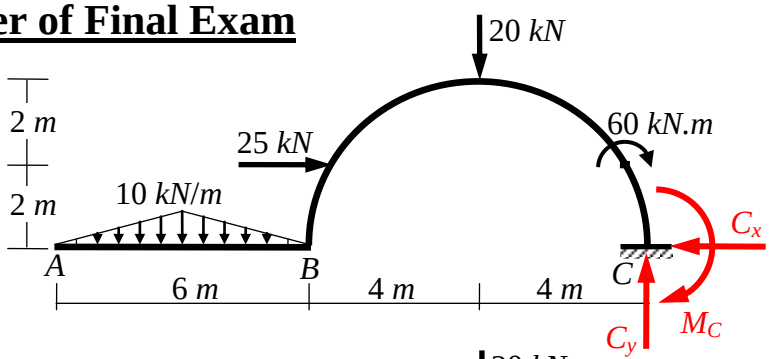
Academic Year : **2016-2017**
Semester : **First**
Level : **Second**
Time : **3 Hours**
Date : **28 / 12 / 2016**
Examiner: ***Dr. M. Abdel-Kader***

# Answer of Final Exam

## Question (1): (20 Marks)

For the structures shown in **Fig. 1a and 1b**, determine the reactions at the supports.

***Note:*** *In your answer sheet, draw the final reactions (direction and magnitude) on the structures.*




**Solution:**

## (1-a)

$+\rightarrow \sum F_x = 0:\quad 25 - C_x = 0$

$\therefore\ C_x = +25 \leftarrow$ $\quad$ $C_x = 25\ kN \leftarrow$

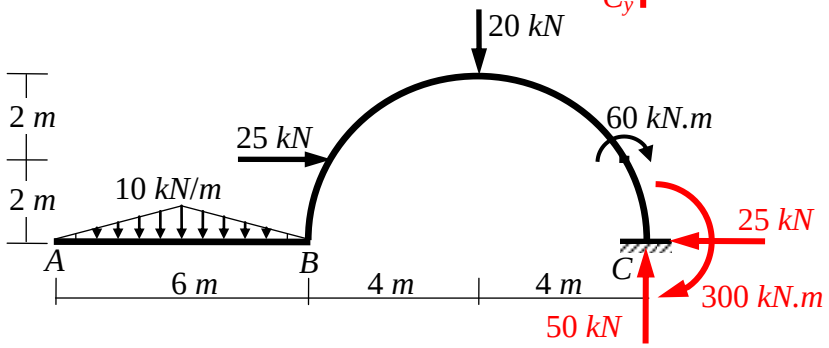
$+\uparrow \sum F_y = 0:\quad C_y - 30 - 20 = 0$

$\therefore\ C_y = +50 \uparrow$ $\quad$ $C_y = 50\ kN \uparrow$

$+\circlearrowright \sum M_C = 0:$

$-30(11) + 25(2) - 20(4) + 60 - M_C = 0$

$\therefore\ M_C = +300 \circlearrowright$ $\quad$ $M_C = 300\ kN.m \circlearrowright$




***Final Reactions***

## (1-b)

**Upper Part**

$+\rightarrow \sum F_x = 0:\quad A_x - 100 = 0$

$\therefore\ A_x = +100 \rightarrow$ $\quad$ $A_x = 100\ kN \rightarrow$

$+\circlearrowright \sum M_D = 0:\quad A_y(5) - A_x(5) + 100(1.5) = 0$

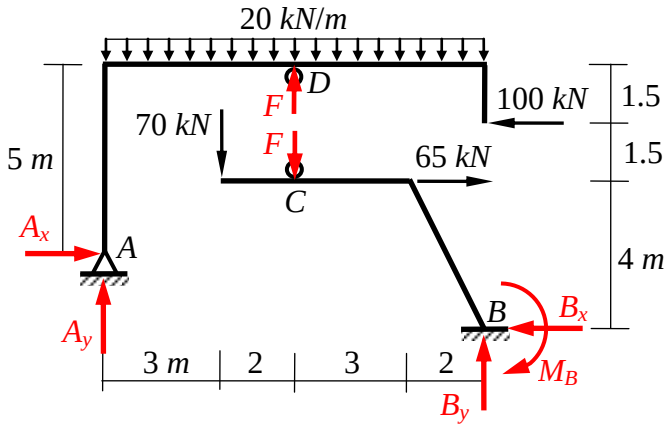
$5A_y - 500 - 150 = 0$

$\therefore\ A_y = +70 \uparrow$ $\quad$ $A_y = 70\ kN \uparrow$

$+\circlearrowright \sum M_A = 0:\quad (20\times10)(5) - F(5) - 100(3.5) = 0$

$1000 - 5F - 350 = 0$

$\therefore\ F = +130$ $\quad$ $F = 130\ kN \uparrow$




*The force in the link member CD = 130 kN Compression.*

**Check:** $+\uparrow \sum F_y = A_y + F - (20\times10) = 70 + 130 - 200 = 0$ *O.K.* ✓

**Lower Part**

$+\rightarrow \sum F_x = 0:\quad 65 - B_x = 0$

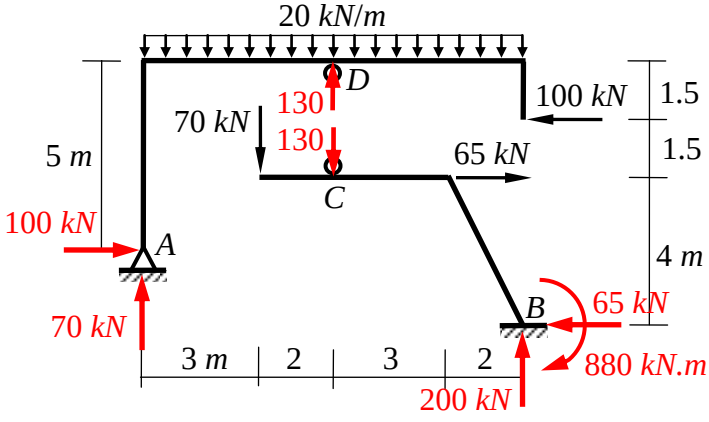
$\therefore\ B_x = +65 \leftarrow$ $\quad$ $B_x = 65\ kN \leftarrow$

$+\uparrow \sum F_y = 0:\quad B_y - 70 - 130 = 0$

$\therefore\ B_y = +200 \uparrow$ $\quad$ $B_y = 200\ kN \uparrow$

$+\circlearrowright \sum M_B = 0:\quad -70(7) - 130(5) + 65(4) - M_B = 0$

$\therefore\ M_B = +880 \circlearrowright$ $\quad$ $M_B = 880\ kN.m \circlearrowright$




***Final Reactions***

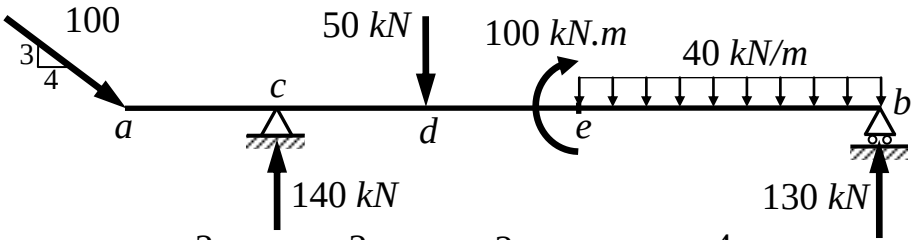
*With my best wishes*
***Dr. M. Abdel-Kader***

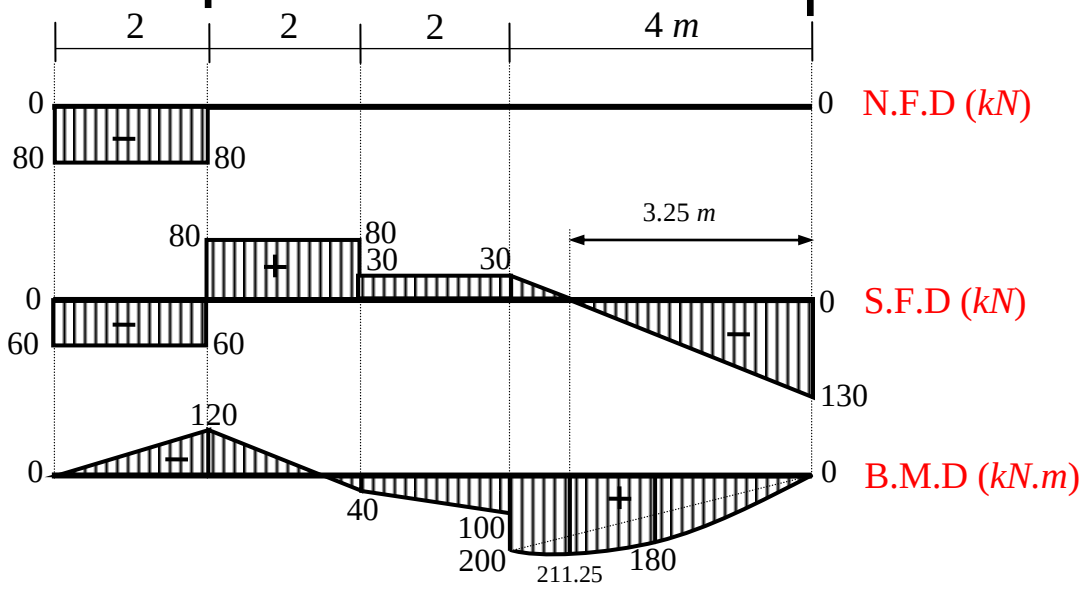
## Question (2): (20 Marks)

For the beam and frame shown in **Fig. 2a and 2b**, draw the normal force, shear force and bending moment diagrams.

***Note***: *All the reactions (except $C_x$ in beam) are given.*

**Solution:**

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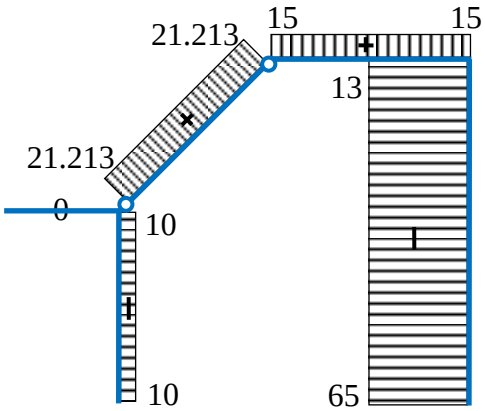


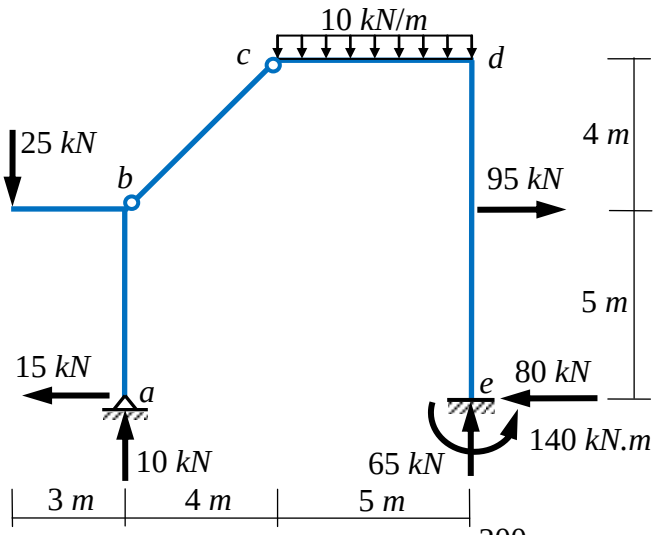


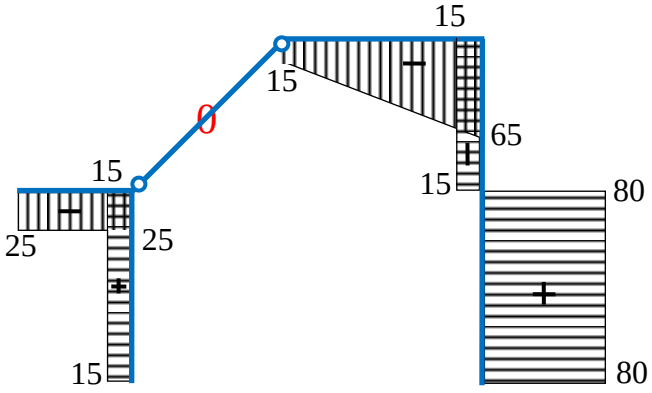


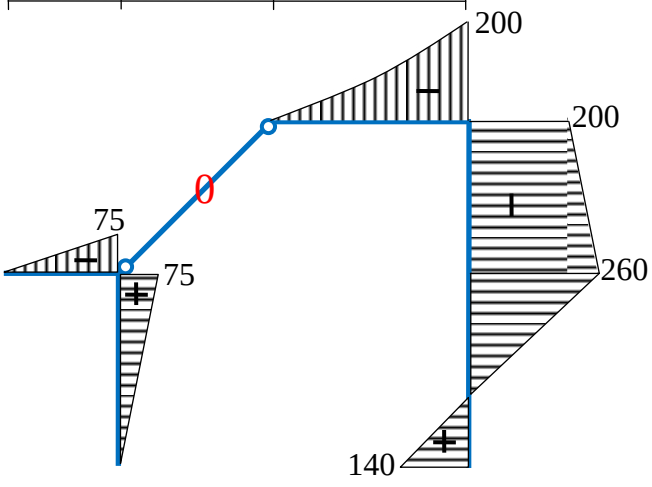


*With my best wishes*

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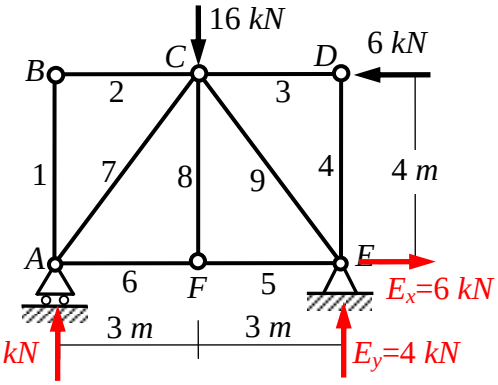
## Question (3): (20 Marks)

**(a)** For the truss shown above in **Fig. 3**:

(i) Determine the reactions at the supports *A* and *E*.
(ii) Using the **method of joints**, determine the forces in all truss members.
(iii) Using the **method of sections**, determine the forces in members *FE and CE* (members 5 and 9).

**Solution:**




### (i) Reactions:

$+\rightarrow \sum F_x = -6 + E_x = 0 \quad \therefore E_x = +6 \rightarrow$ **$E_x = 6\ kN \rightarrow$**

$+\circlearrowleft \sum M_E = A_y(6) - 16(3) - 6(4) = 0 \quad \therefore A_y = 12 \uparrow$ **$A_y = 12\ kN \uparrow$**

$+\uparrow \sum F_y = A_y + E_y - 16 = 0 \quad \therefore E_y = 4 \uparrow$ **$E_y = 4\ kN \uparrow$**

### (ii) Forces in members:

**Joint *B*:** $+\rightarrow \sum F_x = F_{BC} = 0 \quad \therefore F_2 = F_{BC} = 0$ C

$+\uparrow \sum F_y = F_{BA} = 0 \quad \therefore F_1 = F_{BA} = 0$

**Joint *D*:** $+\rightarrow \sum F_x = -F_{DC} - 6 = 0 \quad \therefore F_3 = F_{DC} = 6$ C

$+\uparrow \sum F_y = -F_{DE} = 0 \quad \therefore F_4 = F_{DE} = 0$

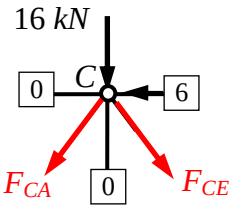
**Joint *F*:** $+\uparrow \sum F_y = F_{FC} = 0 \quad \therefore F_8 = F_{FC} = 0$

**Joint *C*:** $+\rightarrow \sum F_x = F_{CE}(0.6) - F_{CA}(0.6) - 6 = 0 \quad \therefore F_{CE} - F_{CA} = 10$ ..... (1)

$+\uparrow \sum F_y = -16 - F_{CE}(0.8) - F_{CA}(0.8) = 0 \quad \therefore F_{CE} + F_{CA} = -20$ ..... (2)

From (1) in (2) $F_{CA} = -15$ and $F_{CE} = -5$

$\therefore$ $F_7 = F_{CA} = 15$ C and $F_9 = F_{CE} = 5$ C



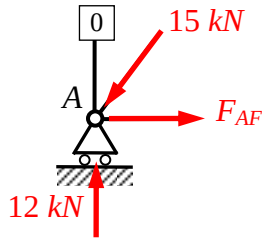

**FBD of Joint C**

**Joint *A*:**

$+\rightarrow \sum F_x = F_{AF} - 15(0.6) = 0 \quad \therefore F_6 = F_{AF} = 9$ T

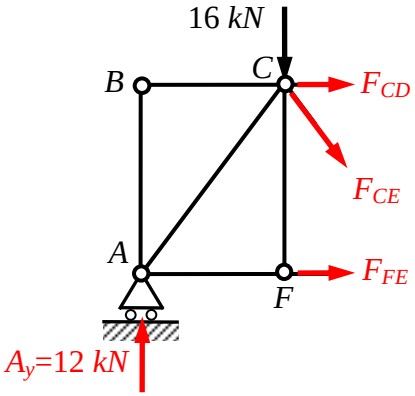
**Joint *F*:**

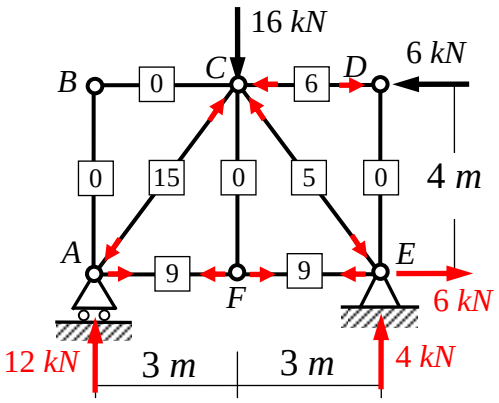
$+\rightarrow \sum F_x = 0: \quad F_{FE} = F_{FA} = 9 \quad \therefore F_5 = F_{FE} = 9$ T




**FBD of Joint A**

### (iii) Forces in members *FE* and *CE*:



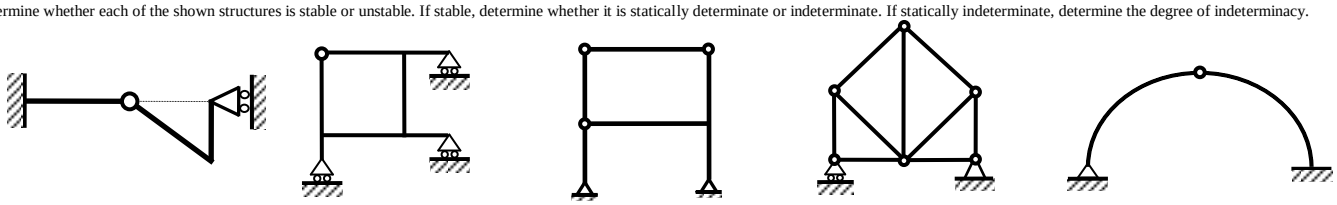

**Forces in Members**

| Member | Force (*kN*) | T or C |
|---|---|---|
| 1 | 0 | |
| 2 | 0 | |
| 3 | 6 | C |
| 4 | 0 | |
| 5 | 9 | T |
| 6 | 9 | T |
| 7 | 15 | C |
| 8 | 0 | |
| 9 | 5 | C |

$+\circlearrowleft \sum M_C = 0: \quad 12(3) - F_{FE}(4) = 0 \quad F_{FE} = +9 \quad \therefore F_5 = F_{FE} = 9$ T

$+\uparrow \sum F_y = 0: \quad 12 - 16 - F_{CE}(0.8) = 0 \quad F_{CE} = -5 \quad \therefore F_9 = F_{CE} = 5$ C

**(b)** 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 + Det. **(4)** Stable + Det. **(5)** Stable + Indet. to the 1st degree.

*With my best wishes*
***Dr. M. Abdel-Kader***