Ministry of Higher Education
Giza Higher Institute of Engineering & Technology
Civil Engineering Department
Course Name: **Theory of Structures (1)A**
Course Code : **CIV 111** Date : **23 / 12 / 2017**

Academic Year : **2017/2018**
Semester : **First**
Level : **1st Civil**
Time : **3 Hours**
Examiner: ***Dr. M. Abdel-Kader***

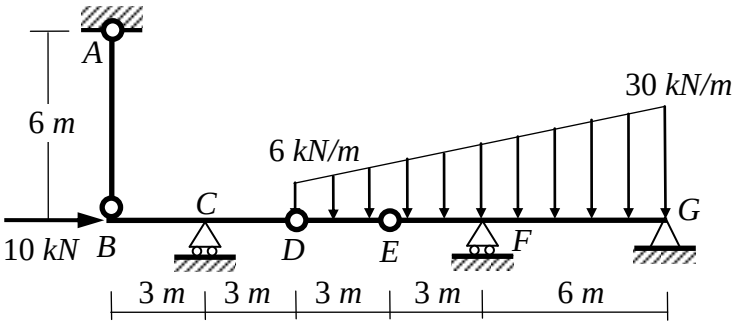
Answer of Final Exam

Total Marks: **90** No. of Questions:**3** (Attempt all questions)

Question (1.a): (15 Marks)

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

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

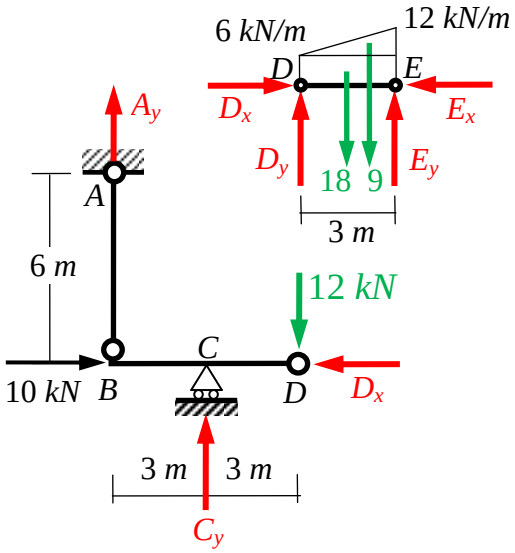


Solution:

Part *DE*:

$+\circlearrowleft \sum M_D = 0:\quad 18(1.5) + 9(2) - E_y(3) = 0 \rightarrow E_y = +15 \uparrow$

$+\uparrow \sum F_y = 0:\quad D_y + E_y - 18 - 9 = 0 \rightarrow D_y = +12 \uparrow$



Part *ABCD*:

$+\circlearrowleft \sum M_C = 0:\ A_y(6) + 12(3) = 0 \rightarrow A_y = -12 \uparrow$ → $A_y = 12\ kN \downarrow$

$+\uparrow \sum F_y = 0:\ A_y + C_y - 12 = 0 \rightarrow C_y = +24 \uparrow$ → $C_y = 24\ kN \uparrow$

$+\rightarrow \sum F_x = 0:\ 10 - D_x = 0 \rightarrow D_x = +10 \leftarrow$

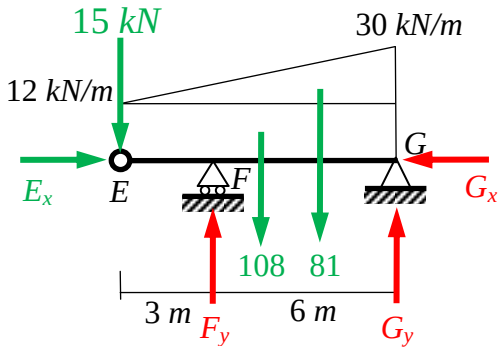
Part *EFG*:

$+\circlearrowleft \sum M_G = 0:\quad -15(9) + F_y(6) - 108(4.5) - 81(3) = 0$

$\rightarrow F_y = +144 \uparrow$ → $F_y = 144\ kN \uparrow$

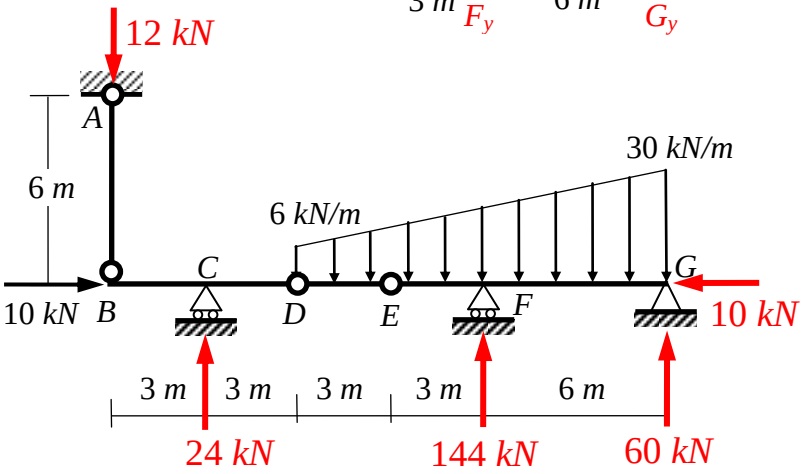
$+\uparrow \sum F_y = 0:\quad F_y + G_y - 15 - 108 - 81 = 0$

$\rightarrow G_y = +60 \uparrow$ → $G_y = 60\ kN \uparrow$



For the entire frame:

$+\rightarrow \sum F_x = 0:\ 10 - G_x = 0 \ \therefore G_x = +10 \leftarrow$ → $G_x = 10\ kN \leftarrow$



Chech:

$+\uparrow \sum F_y = A_y + C_y + F_y + G_y - 0.5(6+30)(12)$

$= -12 + 24 + 144 + 60 - 216 = 0$ ***O.K***

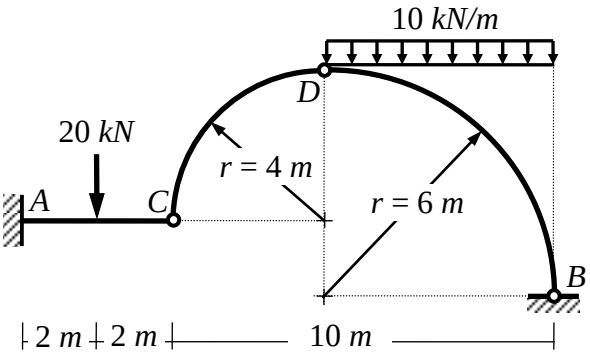
Final Reactions

With my best wishes
Dr. M. Abdel-Kader

Question (1.b): (15 Marks)

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

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



Solution:

$+\circlearrowleft \Sigma M_D = 0$ **for Part *DB*:**

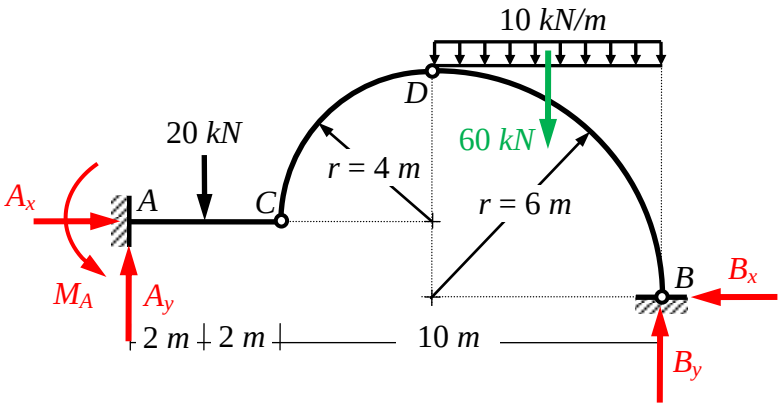
$60(3) + B_x(6) - B_y(6) = 0$

$\rightarrow \quad B_x - B_y = -30 \quad \ldots\ldots (1)$

$+\circlearrowleft \Sigma M_C = 0$ **for Part *CB*:**

$60(7) + B_x(2) - B_y(10) = 0$

$\rightarrow \quad B_x - 5B_y = -210 \quad \ldots\ldots (2)$



From (1) and (2)

$\rightarrow \quad B_y = +45\ kN \uparrow$ and $B_x = +15\ kN \leftarrow$ $\boxed{B_y = 45\ kN \uparrow}$ and $\boxed{B_x = 15\ kN \leftarrow}$

$+\rightarrow \sum F_x = 0$ **for the entire frame**: $A_x - B_x = 0 \ \therefore A_x = +15\ kN \rightarrow$ $\boxed{A_x = 15\ kN \rightarrow}$

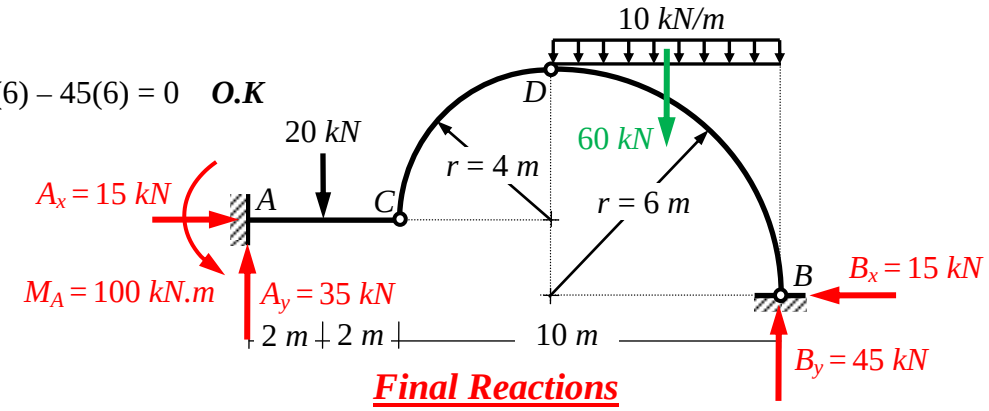
$+\uparrow \sum F_y = 0$ **for Part *CA***: $A_y + B_y - 20 - 60 = 0 \ \therefore A_y = +35\ kN \uparrow$ $\boxed{A_y = 35\ kN \uparrow}$

$+\circlearrowleft \Sigma M_C = 0$ **for Part *CA***: $A_y(4) - 20(2) - M_A = 0 \rightarrow M_A = +100\ kN.m \circlearrowleft$ $\boxed{M_A = 100\ kN.m \circlearrowleft}$

Chech:

$+\circlearrowleft \Sigma M_D =$

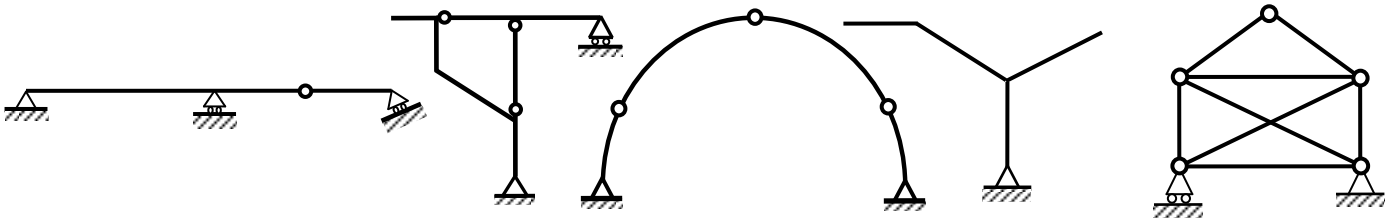
$35(8) - 15(4) - 100 - 20(6) + 60(3) + 15(6) - 45(6) = 0$ ***O.K***



Final Reactions

Question (3.b): (10 Marks)

(3.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)	(2)	(3)	(4)	(5)
4 = 4	**6 = 6**	**4 < 6**	**2 < 3**	**11 > 10**
Stable + Det.	**Stable + Det.**	**Unstable**	**Unstable**	**Stable + Ind. (1st degree)**

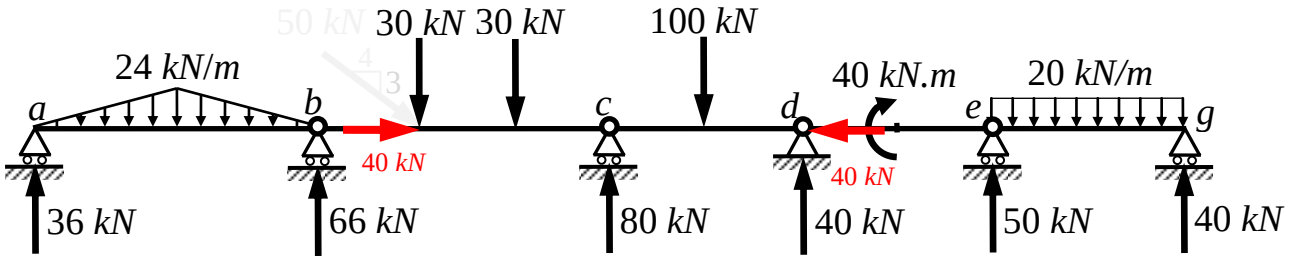
With my best wishes

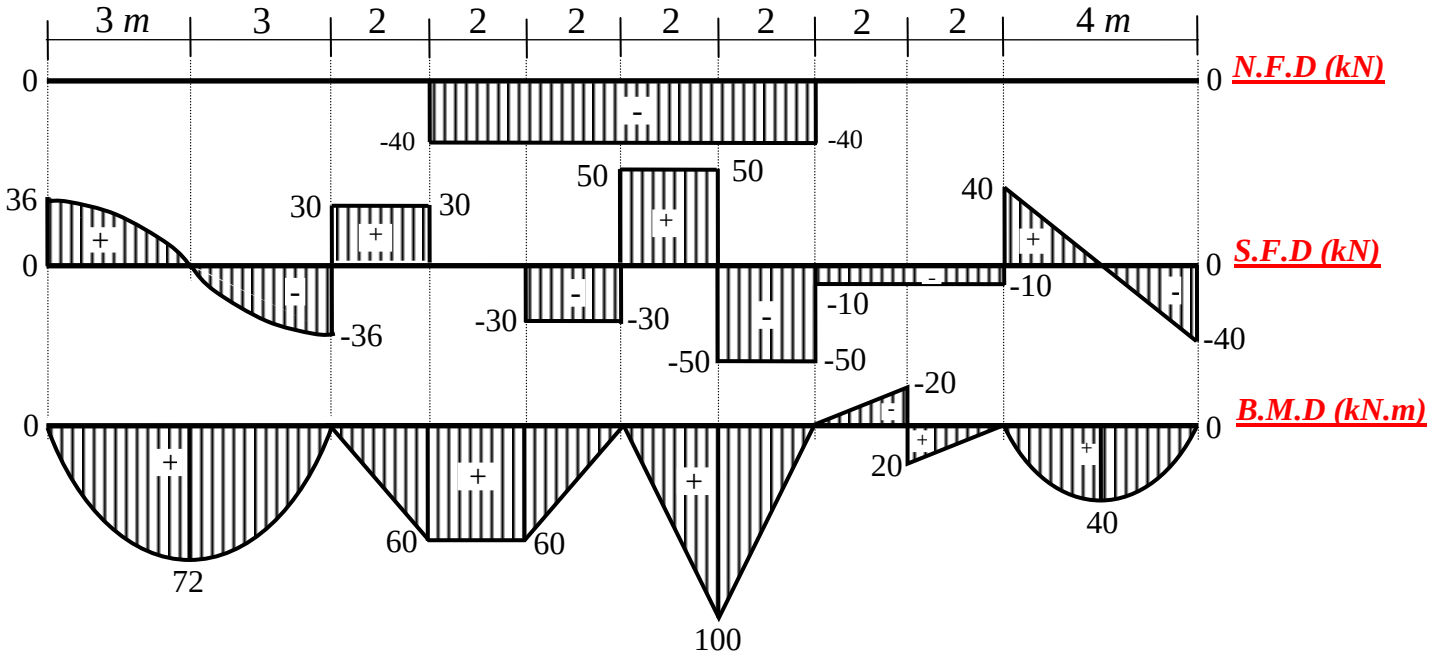
Dr. M. Abdel-Kader

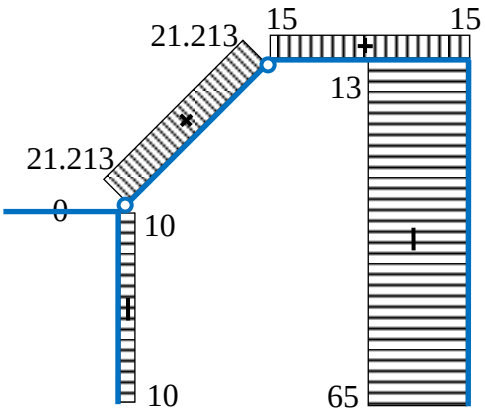
Question (2): (30 Marks)

For the beam and frame shown in **Fig. 2**, draw the normal force, shear force and bending moment diagrams. ***Note***: *All the reactions (except d, in the beam) are given.*

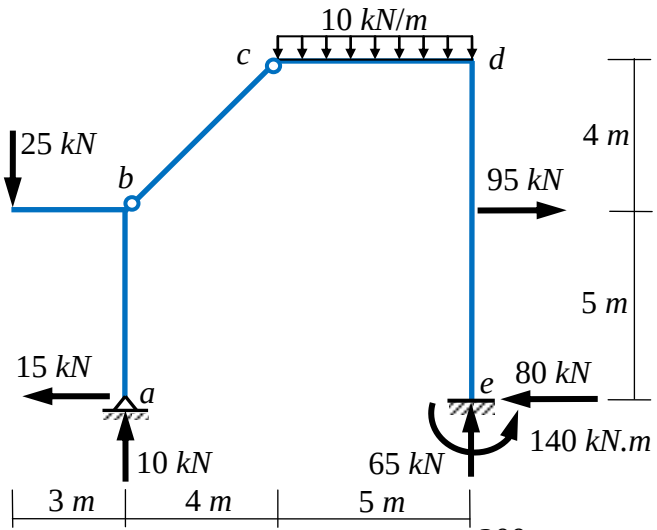
Solution:

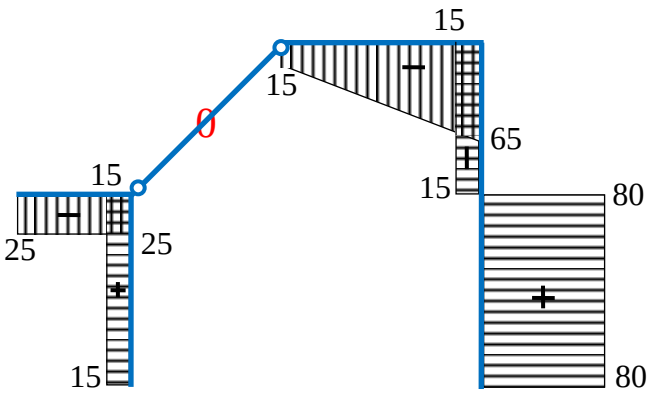




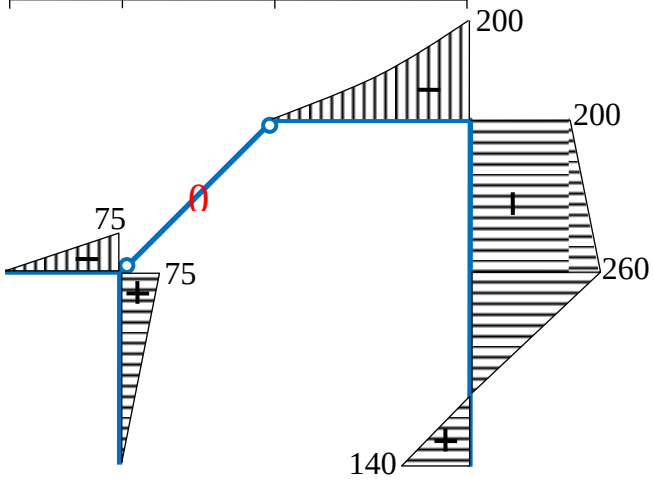


N.F.D (kN)





S.F.D (kN)



B.M.D (kN.m)

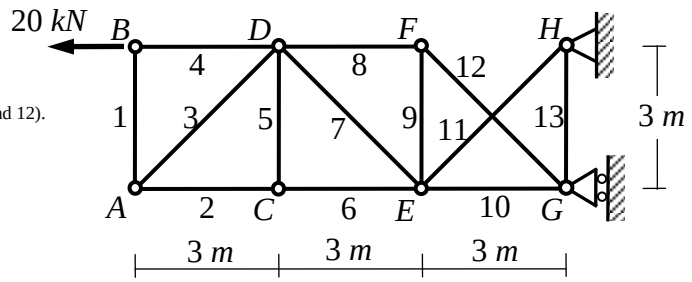
With my best wishes

Dr. M. Abdel-Kader

Question (3.a): (20 Marks)

(a) For the loaded truss shown above in **Fig. 3**:
(i) Determine the reactions at the supports.
(ii) Using the **method of joints**, determine the forces in all truss members.
(iii) Using the **method of sections**, determine the forces in members *DE and FG* (members 7 and 12).

Note: *In your answer sheet, draw the truss and put the force magnitude and the indication (T or C) on each member.*



Solution:

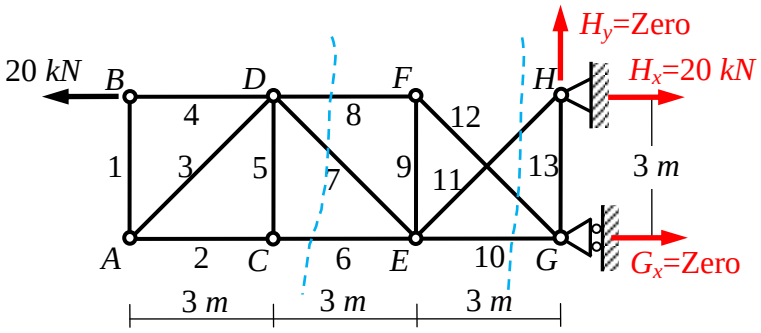
(i) Reactions:

$+\uparrow \sum F_y = H_y = 0 \quad \therefore H_y = 4 \uparrow$ $\boxed{H_y = 0}$

$+\circlearrowleft \Sigma M_G = H_x(3) - 20(3) = 0 \quad \therefore H_x = +20 \leftarrow$

$\boxed{H_x = 20\ kN \leftarrow}$

$+\rightarrow \sum F_x = H_x + G_x - 20 = 0 \quad \therefore G_x = 0$ $\boxed{G_x = 0}$



(ii) Forces in members:

Joint *B*: $+\rightarrow \Sigma F_x = F_{BD} - 20 = 0$ $\boxed{F_4 = F_{BD} = 20\ T}$ and $+\uparrow \sum F_y = F_{BA} = 0$ $\boxed{F_1 = F_{BA} = 0}$

Joint *A*: $\boxed{F_2 = F_{AC} = 0}$ and $\boxed{F_3 = F_{AD} = 0}$

Joint *C*: $\boxed{F_5 = F_{CD} = 0}$ and $\boxed{F_6 = F_{CE} = 0}$

Joint *D*: $+\uparrow \sum F_y = 0$ $\boxed{F_7 = F_{DE} = 0}$ and $+\rightarrow \sum F_x = 0$ $\boxed{F_8 = F_{DF} = 20\ T}$

Joint *F*: $+\rightarrow \sum F_x = F_{FG}(1/\sqrt{2}) - F_{FD} = 0 \quad \therefore F_{FG} = 20\sqrt{2}$ $\boxed{F_{12} = F_{FG} = 20\sqrt{2}\ T}$

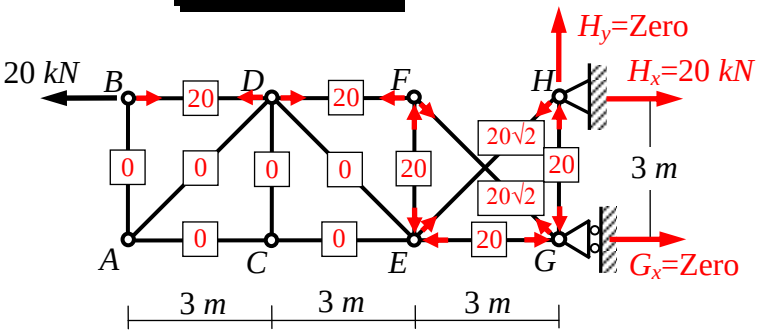
$+\uparrow \sum F_y = -F_{FE} - F_{FG}(1/\sqrt{2}) = 0 \quad \therefore F_{FE} = -20$ $\boxed{F_9 = F_{FE} = 20\ C}$

Joint *H*: $+\rightarrow \sum F_x = 20 - F_{HE}(1/\sqrt{2}) = 0 \quad \therefore F_{HE}(1/\sqrt{2}) = 0$ $\boxed{F_{11} = F_{HE} = 20\sqrt{2}\ T}$

$+\uparrow \sum F_y = -F_{HG} - F_{HE}(1/\sqrt{2}) = 0 \quad \therefore F_{HG} = -20$ $\boxed{F_{13} = F_{HG} = 20\ C}$

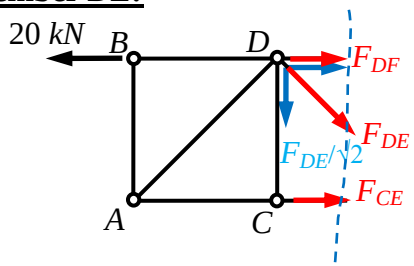
Joint *G*: $+\rightarrow \sum F_x = -F_{GE} - F_{GF}(1/\sqrt{2}) = 0 \quad \therefore F_{GE} = -20$ $\boxed{F_{10} = F_{GE} = 20\ C}$

(iii) Forces in members *DE* and *FG*:



Forces in Members (kN)

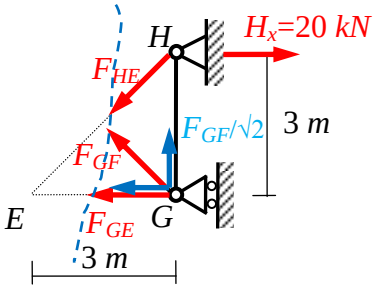
Forces in member *DE*:



$+\uparrow \Sigma F_y = 0$: $-F_{DE}/\sqrt{2} = 0$

$\boxed{F_7 = F_{DE} = 0}$

Forces in member *FG*:



$+\circlearrowleft \Sigma M_E = 0$: $20(3) - (F_{GF}/\sqrt{2})(3) = 0 \quad \therefore F_{GF} = +20$

$\boxed{F_{12} = F_{GF} = F_{FG} = 20\sqrt{2}\ kN\ T}$

With my best wishes

Dr. M. Abdel-Kader