Final exam

#1 Solution

F_A : $F_{Ax} = 4\cos 60 = 2$ KN

$F_{Ay} = 4\sin 60 = 3.46410615$ KN

F_B : $F_{Bx} = -6$ KN

$F_{By} = 0$ KN

F_C : $F_{Cx} = -8$ KN

$F_{Cy} = 0$ KN

F_D : $F_{Dx} = 10\cos 45 = 7.071067812$ KN

$F_{Dy} = -10\sin 45 = -7.071067812$ KN

$R_x = \Sigma F_x = 2 - 6 - 8 + 7.07... = -4.928932188$ KN

$R_y = \Sigma F_y = 3.46... + 0 + 0 - 7.07... = -3.606966197$ KN

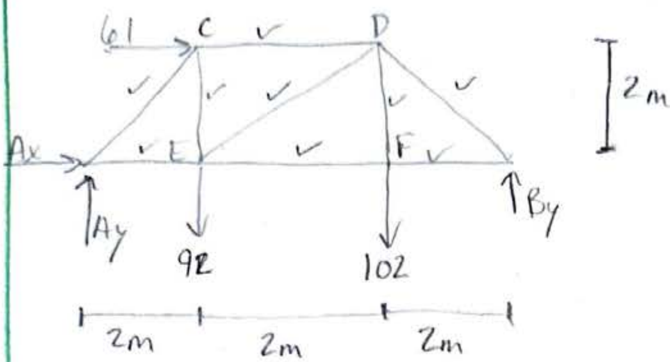
$R = \sqrt{(-3.606...)^2 + (-4.92...)} = 6.107747347$ KN

$\theta = \tan^{-1}\left|\frac{-3.606...}{-4.92...}\right| = 36.19646608°$

$180 + 36.19... = 216.1964661$

$$\boxed{\begin{array}{l} R = 6.11 \text{ KN} \\ \theta = 216° \end{array}}$$

2. Truss FBD



$\Sigma F_x: A_x + 61 = 0 \quad A_x = -61\,KN \quad A_x = 61\,KN \leftarrow$

$\Sigma F_y: A_y + B_y - 92 - 102 = 0$

$\Sigma M_A: -92(2) - 102(4) + B_y(6) = 0$

$-592 + B_y(6) = 0$

$B_y(6) = 592$

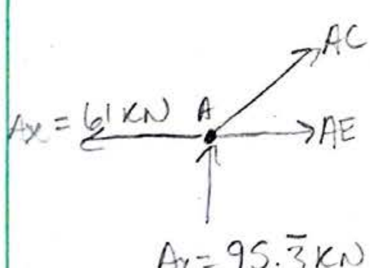
$B_y = \frac{592}{6} = 98.\overline{6}\,KN$

$A_y + 98.\overline{6} - 92 - 102 = 0$

$A_y = 95.\overline{3}\,KN$

FBD of A

$d = \sqrt{2^2 + 2^2} = \sqrt{8}$



$\Sigma F_x: \frac{2}{\sqrt{8}} AC - 61 + AE = 0$

$\Sigma F_y: 95.\overline{3} + \frac{2}{\sqrt{8}} AC = 0$

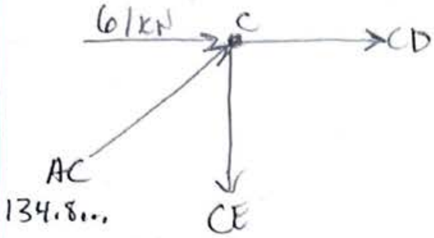
$AC = \frac{-95.\overline{3} \cdot \sqrt{8}}{2} = -134.8216929\,(C)$

$\frac{2}{\sqrt{8}}(-134.8\ldots) - 61 + AE = 0$

$-95.\overline{3} - 61 + AE = 0$

$AE = 156.\overline{3}\ (T)$

FBD of C



$\Sigma F_x: CD + 61 + \frac{2}{\sqrt{8}}(134.8\ldots) = 0$

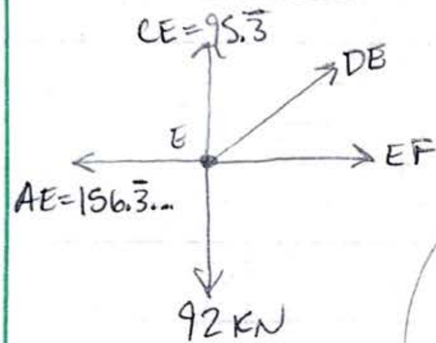
$CD + 95.3\ldots = 0 \quad CD = -95.\overline{3}$ (C)

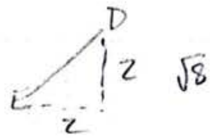
$\Sigma F_y: -CE + \frac{2}{\sqrt{8}}(134.8\ldots) = 0$

$-CE + 95.3\ldots = 0$

$CE = 95.\overline{3}$ (T)

FBD of E





$\Sigma F_x: EF - 156.\overline{3} + \frac{2}{\sqrt{8}} DE = 0$

$\Sigma F_y: 95.\overline{3} - 92 + \frac{2}{\sqrt{8}} DE = 0$

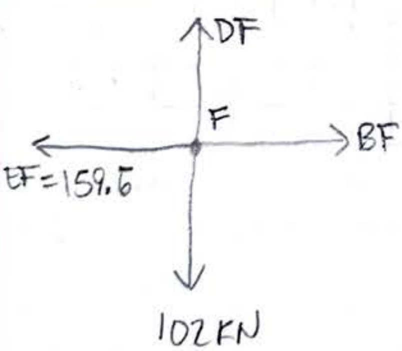
$3.\overline{3} + \frac{2}{\sqrt{8}} DE = 0$

$DE = \frac{-3.\overline{3} \cdot \sqrt{8}}{2} = -4.714045203$ (C)

$EF - 156.\overline{3} + \frac{2}{\sqrt{8}}(-4.7\ldots) = 0$

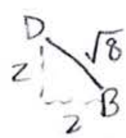
$EF - 159.\overline{6} = 0 \quad EF = 159.\overline{6}$ (T)

FBD of F



$\Sigma F_x: BF - 159.\overline{6} = 0 \quad BF = 159.\overline{6}$ (T)

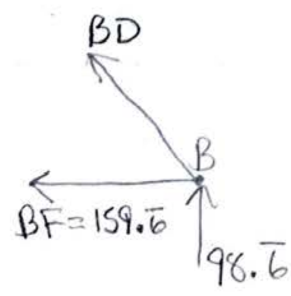
$\Sigma F_y: DF - 102 = 0 \quad DF = 102$ (T)



FBD of B

$\Sigma F_y: 98.\overline{6} + \frac{2}{\sqrt{8}} BD = 0$

$BD = \frac{-98.\overline{6}(\sqrt{8})}{2} = -139.4414572$ (C)



$\Sigma F_x: -\frac{2}{\sqrt{8}} BD - 159.\overline{6} = 0$

AC = 135 KN (C)   CD = 95.3 KN (C)

AE = 156 KN (T)   CE = 95.$\bar{3}$ KN (T)

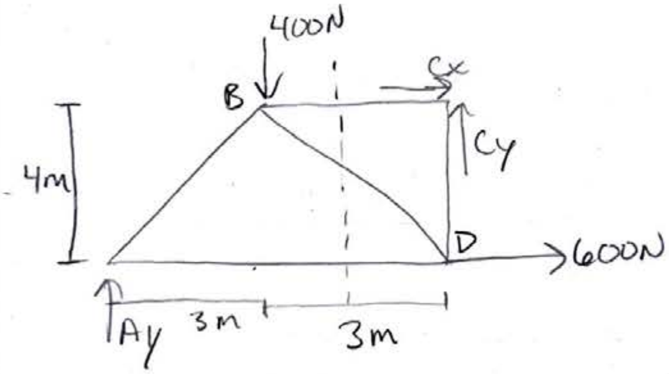
DE = 4.71 KN (C)   EF = 160 KN (T)

BF = 160 KN (T)   DF = 102 KN (T)

BD = 139 KN (C)

3. Solution

Truss FBD



$\Sigma F_x: 600 + C_x = 0 \quad C_x = -600N$ or $600N \leftarrow$

$\Sigma F_y: A_y + C_y - 400 = 0$

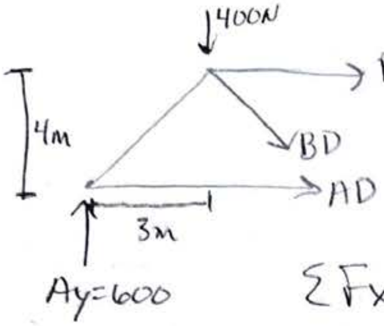
$\Sigma M_c: 600(4) + 400(3) - A_y(6) = 0$

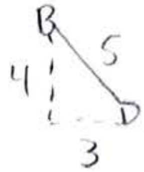
$2400 + 1200 - A_y(6) = 0$

$A_y = \frac{3600}{6} = 600\ N$

$600 + C_y - 400 = 0 \quad C_y = -200$

Partial FBD (Left side)





$\Sigma F_x: AD + \frac{3}{5}BD + BC = 0$

$\Sigma F_y: 600 - 400 - \frac{4}{5}BD = 0$

$BD = \frac{200 \cdot 5}{4} = 250N\ (T)$

$\Sigma M_B: -600(3) + AD(4) = 0$

$-1800 + AD(4) = 0$

$AD = \frac{1800}{4} = 450N\ (T)$

$\Sigma F_x: 450 + \frac{3 \cdot 250}{5} + BC = 0$

$600 + BC = 0$

$BC = -600N\ (C)$

$$\boxed{\begin{aligned} BD &= 250N\ (T) \\ AD &= 450N\ (T) \\ BC &= 600N\ (C) \end{aligned}}$$

4. Point coordinates

A $(0, 0, 8)$ $F_x = -800$ lbs

$F_y = 300$ lbs

B $(5, -4, 0)$ $F_z = 200$ lbs

C $(-4, 3, 0)$ O $(0, 0, 0)$

F_{AC} A to C C - A

$$\begin{array}{rl} C & (-4, 3, 0) \\ -A & (0, 0, 8) \\ \hline & -4, 3, -8 \end{array}$$

$d = \sqrt{(-4) + 3^2 + (-8)^2} = \sqrt{89}$

$F_{ACx}: \frac{-4}{\sqrt{89}} T_{AC}$

$F_{ACy}: \frac{3}{\sqrt{89}} T_{AC}$

$F_{ACz}: \frac{-8}{\sqrt{89}} T_{AC}$

F_{AB} A to B B - A

$$\begin{array}{rl} B & (5, -4, 0) \\ -A & (0, 0, 8) \\ \hline & 5, -4, -8 \end{array}$$

$d = \sqrt{5^2 + (-4)^2 + 8^2} = \sqrt{105}$

$F_{ABx}: \frac{5}{\sqrt{105}} T_{AB}$

$F_{ABy}: \frac{-4}{\sqrt{105}} T_{AB}$

$F_{ABz}: \frac{-8}{\sqrt{105}} T_{AB}$

$$\Sigma F_x: -\frac{4}{\sqrt{89}} T_{AC} + \frac{5}{\sqrt{105}} T_{AB} + O_x - 800 = 0$$

$$\Sigma F_y: \frac{3}{\sqrt{89}} T_{AC} - \frac{4}{\sqrt{105}} T_{AB} + O_y + 300 = 0$$

$$\Sigma F_z: -\frac{8}{\sqrt{89}} T_{AC} - \frac{8}{\sqrt{105}} T_{AB} + O_z + 200 = 0$$

$$\vec{W} = -800\vec{i} + 300\vec{j} + 200\vec{k}$$

$$\vec{T_{AC}} = -\frac{4}{\sqrt{89}} T_{AC}\vec{i} - \frac{3}{\sqrt{89}} T_{AC}\vec{j} - \frac{8}{\sqrt{89}} T_{AC}\vec{k}$$

$$T_{AB} = \frac{5}{\sqrt{105}} T_{AB}\vec{i} - \frac{4}{\sqrt{105}} T_{AB}\vec{j} - \frac{8}{\sqrt{105}} T_{AB}\vec{k}$$

$$R_{OA} = 0\vec{i} + 0\vec{j} + 8\vec{k}$$

$$\vec{M_o} = \vec{R_{OA}} * \vec{W} = \begin{array}{c} \\ R_{OA} \\ \\ \end{array} \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 8 \\ -800 & 300 & 200 \end{vmatrix}$$

$$\vec{M_o} = [0(200) - 8(300)] - [0(200) - 8(-800)] + [0(300) - (-800)0]$$

$$m\vec{o} = -2400\vec{i} - 6400\vec{j} + 0k$$

$$m\vec{o} = R\vec{OA} * T_{AC} = \begin{vmatrix} 0 & 0 & 8 \\ \frac{4}{\sqrt{89}} T_{AC} & \frac{3}{\sqrt{89}} T_{AC} & -\frac{8}{\sqrt{89}} T_{AC} \end{vmatrix}$$

$$M\vec{o} = \left[0\left(\frac{-8}{\sqrt{89}} T_{AC}\right) - 8\left(\frac{3}{\sqrt{89}} T_{AC}\right)\right] - \left[0\left(\frac{-8}{\sqrt{89}} T_{AC}\right) - 8\left(\frac{-4}{\sqrt{89}} T_{AC}\right)\right] + \left[0\left(\frac{3}{\sqrt{89}} T_{AC}\right) - \left(0\left(\frac{-4}{\sqrt{89}} T_{AC}\right)\right)\right]$$

$$M\vec{o} = -\frac{24}{\sqrt{89}} T_{AC}\vec{i} - \frac{32}{\sqrt{89}} T_{AC}\vec{j} + 0k$$

$$\vec{M_O} = \vec{R_{OA}} \times T_{AB} = \begin{vmatrix} 0 & 0 & 8 \\ \frac{5}{\sqrt{105}}T_{AB} & \frac{-4}{\sqrt{105}}T_{AB} & \frac{-8}{\sqrt{105}}T_{AB} \end{vmatrix}$$

$$\vec{M_O} = \left[0\left(\frac{-8}{\sqrt{105}}T_{AB}\right) - 8\left(\frac{-4}{\sqrt{105}}T_{AB}\right)\right] - \left[0\left(\frac{-8}{\sqrt{105}}T_{AB}\right) - 8\left(\frac{5}{\sqrt{105}}T_{AB}\right)\right] + \left[0\left(\frac{-4}{\sqrt{105}}T_{AB}\right) - 0\left(\frac{5}{\sqrt{105}}T_{AB}\right)\right]$$

$$\vec{M_O} = \frac{32}{\sqrt{105}}T_{AB}\vec{i} + \frac{40}{\sqrt{105}}T_{AB}\vec{j} + 0\vec{k}$$

$$\Sigma M_{Ox}: -2400 - \frac{24}{\sqrt{89}}T_{AC} + \frac{32}{\sqrt{105}}T_{AB} + 0 = 0$$

$$\Sigma M_{Oy}: -6400 - \frac{32}{\sqrt{89}}T_{AC} + \frac{40}{\sqrt{105}}T_{AB} + 0 = 0$$

$$\Sigma M_{Oz}: 0 + 0 + 0 + 0 = 0$$

$$\frac{32}{\sqrt{105}}T_{AB} = 2400 + \frac{24}{\sqrt{89}}T_{AC}$$

$$T_{AB} = \frac{\left(2400 + \frac{24}{\sqrt{89}}T_{AC}\right)\sqrt{105}}{32}$$

$$-6400 - \frac{32}{\sqrt{89}}T_{AC} + \frac{40 \cdot \left(2400 + \frac{24}{89}T_{AC}\right)\sqrt{105}}{32 \cdot \sqrt{105}} = 0$$

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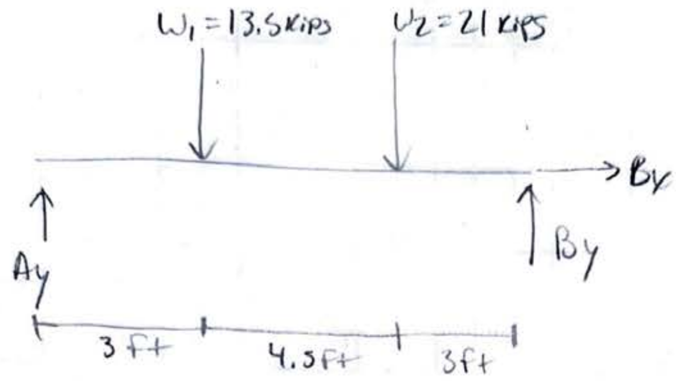
NO Answer

5. FBD



$$W_1 = \frac{4.5 \cdot 6}{2} = 13.5 \text{ Kips}$$

$$\Sigma F_x: \ B_x = 0$$

$$\Sigma F_y: \ A_y + B_y - 13.5 - 21 = 0$$

$$\Sigma M_B: \ 21(3) + 13.5(7.5) - A_y(10.5) = 0$$

$$63 + 101.25 - A_y(10.5) = 0$$

$$A_y = \frac{164.25}{10.5} = 15.64285714 \text{ Kips}$$

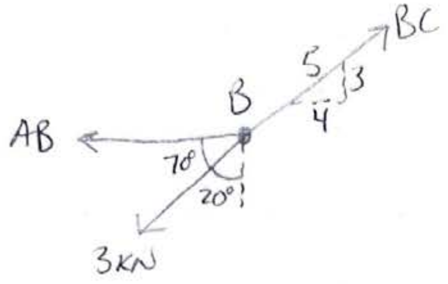
$$15.6\ldots + B_y - 13.5 - 21 = 0$$

$$B_y - 18.85714286 = 0$$

$$B_y = 18.85714286 \text{ Kips}$$

$$\boxed{\begin{aligned} A_y &= 15.6 \text{ Kips} \uparrow \\ B_y &= 18.9 \text{ Kips} \uparrow \\ B_x &= 0 \text{ Kips} \end{aligned}}$$

6. FBD of B



$\Sigma F_x: -AB - 3(\cos 70) + \frac{4}{5} BC = 0$

$\Sigma F_y: -3(\sin 70) + \frac{3}{5} BC = 0$

$BC = \frac{3(\sin 70)\cdot 5}{3} = 4.698463104 \text{ KN}$

$-AB - 3(\cos 70) + \frac{4 \cdot 4.69\ldots}{5} = 0$

$-AB + 2.732710053 = 0$

$AB = 2.732710053$

$$\boxed{\begin{aligned} AB &= 2.73 \text{ KN} \\ BC &= 4.70 \text{ KN} \end{aligned}}$$