UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

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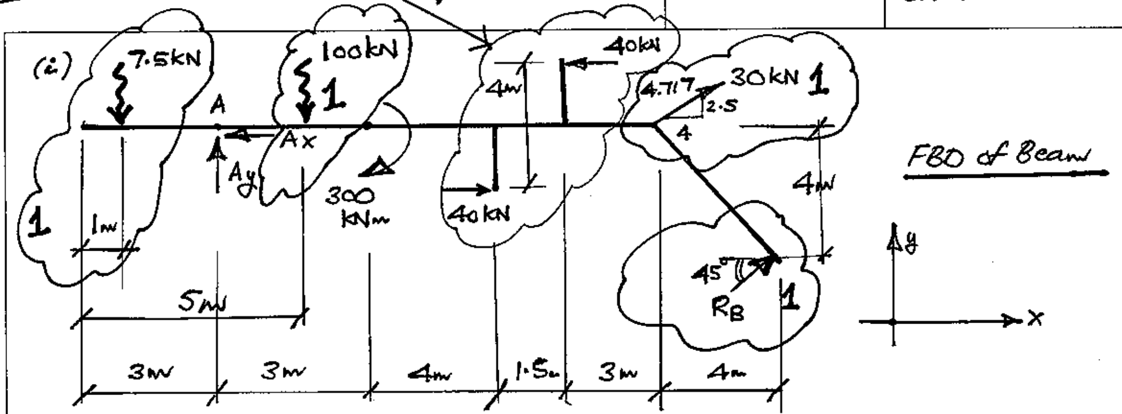
COURSE NO. | COURSE NAME CIV100F: Mechanics | 2 MIDTERM.

Q1.

Can also be shown as 160kNm

4.



FBD of Beam

2. (ii) $\Sigma M_A = 0 \Rightarrow -7.5(2) + 100(2) + 300 - 40(4) - \left(\frac{2.5}{4.717}\right)(30)(11.5) - R_B\cos 45°(4) - R_B \cos 45° (15.5)$

$\therefore\ 325 - 182.85 - 19.5 \cos 45° \cdot R_B = 0$

1. $\therefore\ R_B = \frac{7.2897}{\cos 45°} = 10.31\ kN$ ½ , 45° ½ = Reaction @ B.

1. $\Sigma F_x = 0 \Rightarrow -A_x + \left(\frac{4}{4.717}\right)(30) + (10.31)\cos 45° = 0 \quad \therefore\ A_x = 32.7\ kN \leftarrow$

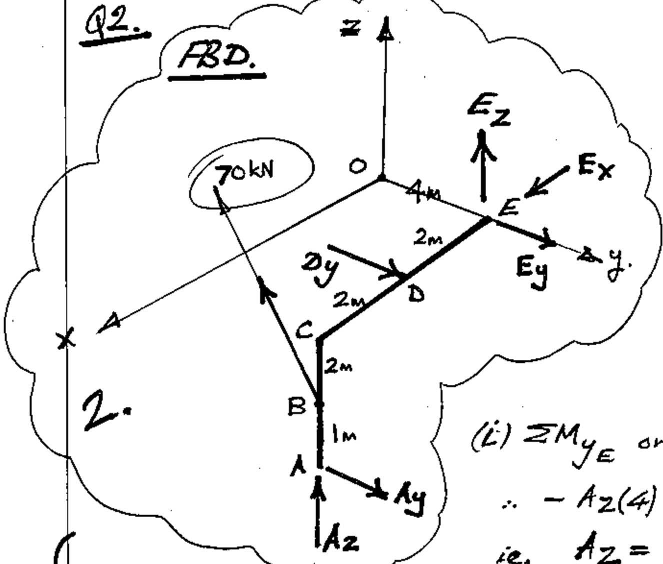
1. $\Sigma F_y = 0 \Rightarrow -7.5 + A_y - 100 + \left(\frac{2.5}{4.717}\right)(30) + R_B \cos 45° = 0 \quad \therefore\ A_y = 84.3\ kN \uparrow$

1. $\therefore$ Reaction @ A $= \sqrt{32.7^2 + 84.3^2} = 90.4\ kN$ ½ ; R_A 68.8° ½

$\Sigma = 10$.

Q2.

FBD.



Length of BF $= \sqrt{(+2)^2 + (-4)^2 + (6)^2}$
$= \underline{7.4833\,m}$

$\therefore F_{BF_x} = \left(\frac{2}{7.4833}\right)(70) = 18.708\,kN$

& $F_{BF_y} = \left(\frac{-4}{7.4833}\right)(70) = -37.417\,kN$

& $F_{BF_z} = \left(\frac{6}{7.4833}\right)(70) = 56.125\,kN$

2.

(i) ΣM_{y_E} or line OE $= 0$

$\therefore -A_Z(4) - 18.708(2) - 56.125(4) = 0 \quad \therefore A_Z = -65.48\,kN$

i.e. $\underline{A_Z = 65.5\,kN} \downarrow$

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(ii) ΣM_{x_E} or line ~~EC~~ $= 0 \Rightarrow A_y(3) - 37.417(2) = 0 \quad \therefore A_y = 24.945\,kN$

i.e. $\underline{A_y = 24.9\ kN}$ ↘

(iii) $\Sigma M_{Z_E} = 0 \Rightarrow D_y(2) + 24.945(4) \cancel{-18.708(4)} - 37.417(4) = 0$

$\therefore D_y = 24.944\,kN$ i.e. $\underline{D_y = 24.9\,kN}$ ↘

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(iv) $\Sigma F_x = 0 \Rightarrow E_x + 18.708\,kN = 0 \quad \therefore \underline{E_x = 18.71\,kN}$ ↗

(V) $\Sigma F_y = 0 \Rightarrow E_y + 24.944 + 24.9 - 37.417 = 0 \quad \therefore E_y = -12.427$ i.e. $\underline{E_y = 12.43\,kN}$ ↖

(Vi) $\Sigma F_Z = 0 \Rightarrow E_Z - 65.5 + 56.125 = 0 \quad \therefore E_Z = 9.38$, i.e. $\underline{E_Z = 9.38\,kN}$ ↑

$$\boxed{\begin{aligned} &\therefore \text{Reaction @ } A = (24.9\vec{j} - 65.5\vec{k})\ kN \\ &\text{Reaction @ } D = 24.9\vec{j}\ kN \\ &\text{Reaction @ } E = (-18.71\vec{i} - 12.43\vec{j} + 9.38\vec{k})\ kN \end{aligned}}$$

OR

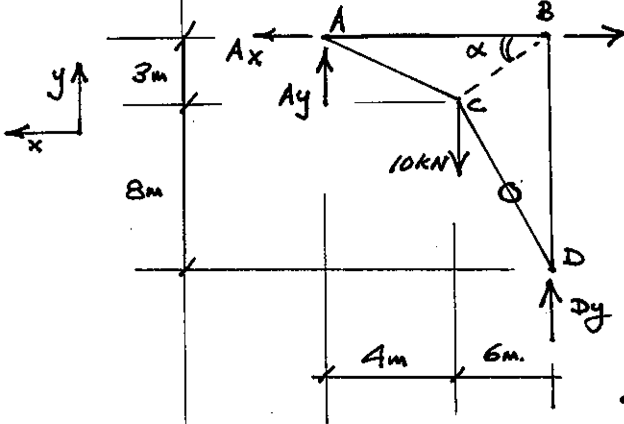
• Alternatively, for steps (i), (ii) & (iii) above, $\Sigma M_E = 0$ and vector cross products can be used ($\vec{r} \times \vec{F}$)

i.e.
$$\underbrace{\begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 0 & -2 \\ 18.71 & -37.42 & 56.13 \end{vmatrix}}_{\text{to 70kN}} + \underbrace{\begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 0 & 0 \\ 0 & D_y & 0 \end{vmatrix}}_{\text{to } D_y} + \underbrace{\begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 0 & -3 \\ 0 & A_y & A_z \end{vmatrix}}_{\text{to A.}} = 0$$

i.e. $(-\cancel{74.84}\vec{i} - \cancel{261.94}\vec{j} - \cancel{149.68}\vec{k}) + (2D_y\vec{k}) + (\cancel{3A_y\vec{i}} - \cancel{4A_z\vec{j}} + 4A_y\vec{k}) = 0$

i.e. $\underbrace{(-74.84 + 3A_y)}_{=0}\vec{i} + \underbrace{(-261.94\vec{j} - 4A_z)}_{=0}\vec{j} + \underbrace{(-149.68 + \cancel{4}A_y)}_{=0}\vec{k} = 0$

Q3. (a) FBD of Whole Truss



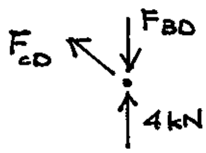
$\Sigma M_A = 0 \Rightarrow 10(4) - D_y(10) = 0 \quad \therefore D_y = 4\,kN \uparrow$ ½+½

$\Sigma F_y = 0 \Rightarrow A_y + 4 - 10 = 0 \quad \therefore A_y = 6\,kN \uparrow$ ½+½

$\Sigma F_x = 0 \Rightarrow A_x - 10 = 0 \quad \therefore A_x = 10\,kN \leftarrow$ ½+½

$\alpha = 26.565°$

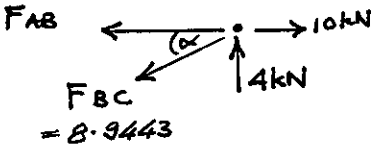
- FBD of Joint D:



$\Sigma F_x = 0 \Rightarrow F_{CD} = 0$ ½+½

$\Sigma F_y = 0 \Rightarrow F_{BD} = 4kN\ C.$ ½+½

- FBD of Joint B



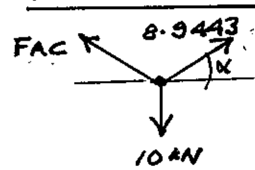
$\Sigma F_y = 0 \Rightarrow F_{BC} \sin\alpha - 4 = 0$

$\therefore F_{BC} = 8.94\,kN\ T.$ ½+½

$\Sigma F_x = 0 \Rightarrow F_{AB} + 8.94\cos\alpha - 10 = 0$

$\therefore F_{AB} = 2.00\,kN\ T.$ ½+½

- FBD of Joint C



$\Sigma F_x = 0 \Rightarrow 8.000 - F_{AC}\left(\frac{4}{5}\right) = 0$

$\therefore F_{AC} = 10.000\,kN\ T.$ ½+½

½ for Magnitude
½ for Direction or Sense.

Not necessary but a good check

- check @ Joint A:

$\Sigma F_x = 10 - 2 - 10\left(\frac{4}{5}\right) = 0$ ✓

$\Sigma F_y = 6 - 10(3/5) = 0$ ✓ $\therefore$ Solution Correct. ✓

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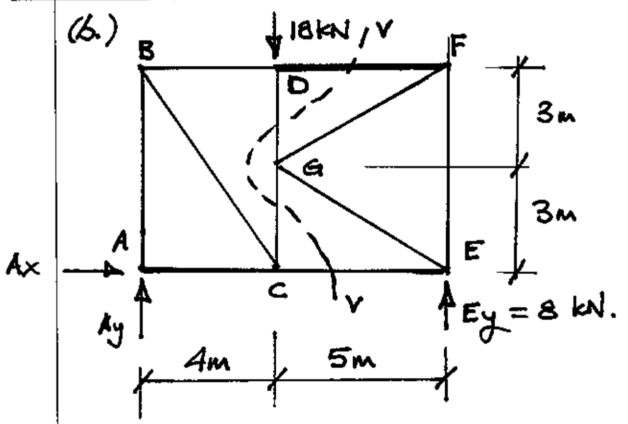
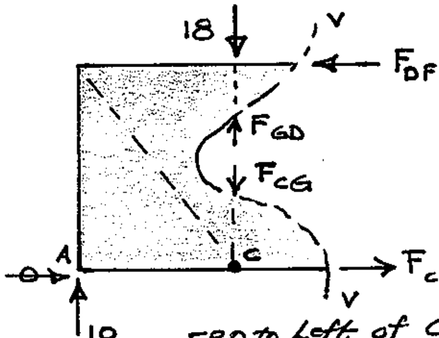
(b.)





FBD to Left of Cut V-V

1½

FBD of Whole Truss

$\Sigma M_A = 0 \Rightarrow 18(4) - E_y(9) = 0$
$\therefore E_y = 8\,kN$
$\therefore A_y = 10\,kN$ & $A_x = 0.$ ½

Section V-V actually produces 4 unknown forces, but 3 unknown forces have lines of action that pass through point C !

$\therefore \Sigma M_C = 0 \Rightarrow 10(4) - F_{DF}(6) = 0$

$\therefore F_{DF} = 6.67\,kN\ C.$

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