

Problem 1

page 1

$$(a) \quad \underline{n}_F = (9, 0, 12) \frac{1}{\sqrt{9^2 + 12^2}} = (0.6, 0, 0.8)$$

$$\underline{F} = 1000 (0.6, 0, 0.8)$$

$$(b) \quad \underline{M}_B = \underline{r} \times \underline{F}$$

$$\underline{r} = \underline{BA} = (0, 0, 12)$$

$$\underline{M}_B = 1000 \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ 0 & 0 & 12 \\ 0.6 & 0 & 0.8 \end{vmatrix} = 12000 (0.6 \underline{j})$$

$$|\underline{M}_B| = 7200 \text{ lb}\cdot\text{in.}$$

$$(c) \quad \underline{BC} = (-9, 15, 0) \quad , \quad \underline{n}_{BC} = \frac{(-3, 5, 0)}{\sqrt{3^2 + 5^2}} = (-0.515, 0.858, 0)$$

$$|M_{BC}| = |\underline{M}_B \cdot \underline{n}_{BC}| = 7200 \times 0.858 = 6177.6 \text{ lb}\cdot\text{in.}$$

Problem 2.

page 2

(a). $C_A = -75 \times 0.3 = -22.5 \text{ N}\cdot\text{m}$ (反时针为正)

$$C_B = -90 \times 0.25 = -22.5$$

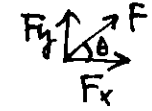
$$C_C = -60 \times 0.25 = -15$$

$$C_D = -50 \times 0.3 = -15$$

(b) $\Sigma F_x = 90 - 60 = 30 \text{ N}$

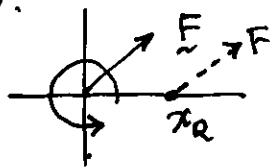
$$\Sigma F_y = 75 - 50 = 25 \text{ N}$$

$$\text{magnitude} = \sqrt{30^2 + 25^2} = 39.1 \text{ N} \quad (\text{Note: magnitude 是正的})$$

direction: θ  $\tan \theta = \frac{25}{30} = \frac{5}{6}$, $\theta = 39.8^\circ$

$$\Sigma C = -22.5 - 22.5 - 15 - 15 + 10 = -65 \text{ N}\cdot\text{m}$$

(c).

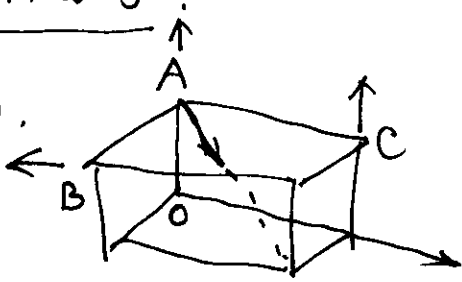


把 F 移动到过 $x_R \Rightarrow$ 对 O 的 moment 要等于 ΣC .

$$F_y \cdot x_R = -65 \Rightarrow 25 x_R = -65 \Rightarrow x_R = -2.6 \text{ m}$$

problem 3

(a).



$$\vec{F}_A = 150 \cdot \frac{(2, 2, -1)}{\sqrt{2^2 + 2^2 + 1}} = (100, 100, -50) \text{ N}$$

$$\vec{F}_B = (0, 0, 25) \text{ N}$$

$$\vec{F}_C = (0, -50, 0) \text{ N}$$

$$(b) \quad \vec{C}_A = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 100 & 100 & -50 \end{vmatrix} = (-100, 100, 0) \text{ N}\cdot\text{m}$$

$$\vec{C}_B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 0 & 1 \\ 0 & -50 & 0 \end{vmatrix} = (50, 0, -100) \text{ N}\cdot\text{m}$$

$$\vec{C}_C = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 2 & 1 \\ 0 & 0 & 25 \end{vmatrix} = (50, 0, 0) \text{ N}\cdot\text{m}$$

$$(c) \quad \vec{R} = \vec{F}_A + \vec{F}_B + \vec{F}_C = (100, 50, -25) \text{ N}$$

$$\vec{C} = (0, 100, -100) \text{ N}\cdot\text{m}$$

$$(d) \quad \vec{n}_R = \frac{(100, 50, -25)}{114.56} = (0.8729, 0.4365, -0.2182)$$

$$(e) \quad \vec{C}_{||} = \vec{C} \cdot \vec{n}_R = (50, 0, -100) \cdot (0.8729, 0.4365, -0.2182) = 65.465 \text{ N}\cdot\text{m}$$

$$\vec{C}_{||} = 65.465 \vec{n}_R = (57.14, 28.58, -14.28)$$

$$\vec{C}_{\perp} = \vec{C} - \vec{C}_{||} = (-57.14, 71.42, -85.72)$$

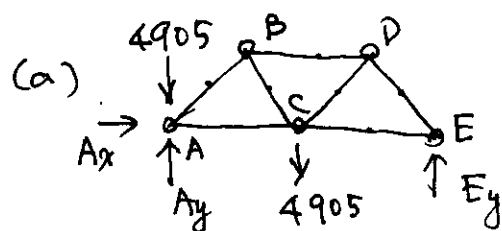
$$(f) \quad \vec{r} = (0, 0, 0) - (x_R, y_R, 0) = (-x_R, -y_R, 0)$$

$$\vec{r} \times \vec{R} = -\vec{C}_{\perp} \Rightarrow \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -x_R & -y_R & 0 \\ 100 & 50 & -25 \end{vmatrix} = \begin{pmatrix} 25y_R \\ -25x_R \\ -50x_R - 100y_R \end{pmatrix} = \begin{pmatrix} 57.14 \\ -71.42 \\ 85.72 \end{pmatrix}$$

$$\Rightarrow x_R = 2.86 \text{ m} \quad y_R = 2.29 \text{ m}$$

Problem 4 :

page 4



car weight = $2000 \times 9.81 = 19620$.

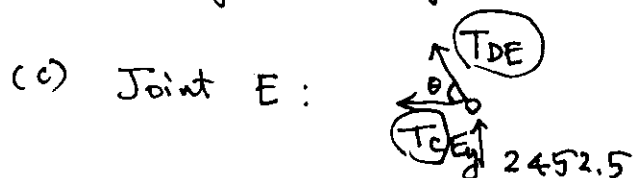
取一半 = 9810 N . (前後各半) 可提醒同學

分在 joint A 和 C 各半, 4905 N

(b) $\Sigma M_A = 0 \Rightarrow E_y \cdot 20 = 4905 \cdot 10 \Rightarrow E_y = 2452.5 \text{ N}$

$\Sigma F_x = 0 \Rightarrow A_x = 0$

$\Sigma F_y = 0 \Rightarrow A_y + 2452.5 = 9810 \Rightarrow A_y = 7357.5 \text{ N}$

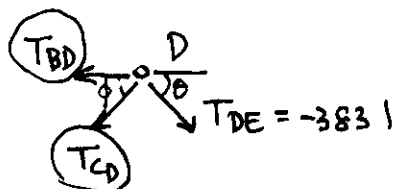


$\theta = \tan^{-1} \frac{5}{6} = 39.8^\circ$ $\begin{cases} \cos 39.8^\circ = 0.7683 \\ \sin 39.8^\circ = 0.6401 \end{cases}$

$T_{DE} \sin \theta + 2452.5 = 0 \Rightarrow T_{DE} = -\frac{2452.5}{0.64} = -3831 \text{ N}$

$T_{CE} + T_{DE} \cos 39.8^\circ = 0 \Rightarrow T_{CE} = 2943 \text{ N}$

Joint D:



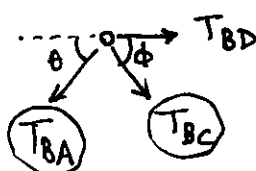
$\phi = \tan^{-1} \frac{5}{4} = 51.3^\circ$ $\begin{cases} \cos 51.3^\circ = 0.6252 \\ \sin 51.3^\circ = 0.7804 \end{cases}$

$\Sigma F_y = T_{CD} \sin \phi + T_{DE} \sin \theta = 0$
 $\Rightarrow T_{CD} = -\frac{(-3831) \sin 39.8^\circ}{\sin 51.3^\circ} = 3142 \text{ N}$

$\Sigma F_x = -T_{BD} - T_{CD} \cos \phi + T_{DE} \cos \theta = 0$

$\Rightarrow T_{BD} = -(3142) \cdot \cos 51.3^\circ + (-3831) \cdot \cos 39.8^\circ = -4908 \text{ N}$

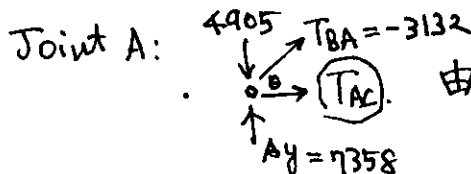
Joint B:



$\begin{cases} \Sigma F_x = -T_{BA} \cos 39.8^\circ + T_{BC} \cos 51.3^\circ + (-4908) = 0 \\ \Sigma F_y = T_{BA} \sin 39.8^\circ + T_{BC} \sin 51.3^\circ = 0 \end{cases}$

$\Rightarrow \begin{cases} -T_{BA} \cdot 0.7683 + T_{BC} \cdot 0.6252 - 4908 = 0 \quad (1) \\ T_{BA} \cdot 0.6401 + T_{BC} \cdot 0.7804 = 0 \quad (2) \end{cases}$

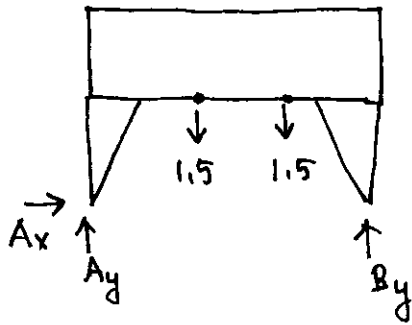
(2) $\Rightarrow T_{BA} = -1.2192 T_{BC}$. 代入 (1) $\Rightarrow T_{BC} = 3142 \text{ N}$ 故 $T_{BA} = -3831 \text{ N}$



由 $\Sigma F_x = 0 \Rightarrow T_{AC} = -T_{BA} \cos \theta = 3831 \cdot 0.7683 = 2943 \text{ N}$
 $= T_{AC}$

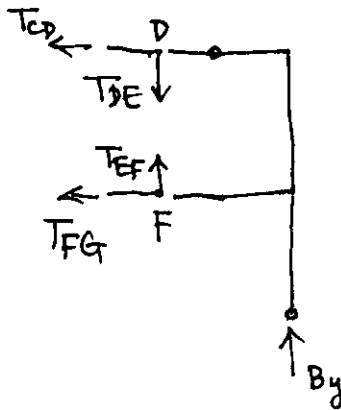
problem 5. symmetric problem

(a)



$$\sum M_A = 0 \Rightarrow B_y \cdot 18 = 3 \cdot 9 \Rightarrow B_y = 1.5 \text{ kN}$$

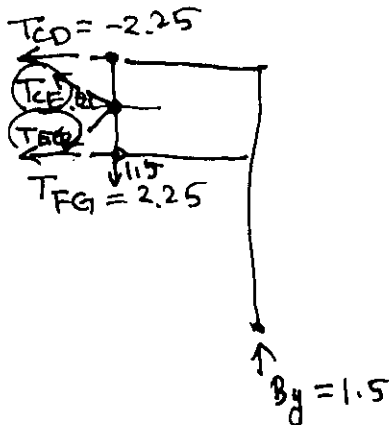
(b)



$$\sum M_D = 0 \Rightarrow T_{FG} \cdot 4 = 1.5 \times 6 \Rightarrow T_{FG} = 2.25 \text{ kN}$$

$$\sum M_F = 0 \Rightarrow T_{CD} \cdot 4 = 1.5 \times 6 \Rightarrow T_{CD} = -2.25 \text{ kN}$$

(c)



$$\theta = \tan^{-1} \frac{2}{3} = 33.7^\circ \cdot \cos \theta = 0.832, \sin \theta = 0.555$$

$$\sum F_x = 0 \Rightarrow T_{CE} \cos \theta + T_{EG} \cos \theta + T_{CD} + T_{FG} = 0$$

$$\Rightarrow T_{CE} \cdot 0.832 + T_{EG} \cdot 0.832 - 2.25 + 2.25 = 0$$

$$\Rightarrow T_{CE} = -T_{EG}$$

$$\sum F_y = 0 \Rightarrow T_{CE} \sin \theta - T_{EG} \sin \theta + 1.5 - 1.5 = 0$$

$$\Rightarrow T_{CE} = T_{EG} = 0$$

FG	2.25 kN	Tension
CD	2.25 kN	compression
CE	0 kN	zero-force
EG	0 kN	zero-force

注意: magnitude 只有正的。
可提醒同学!