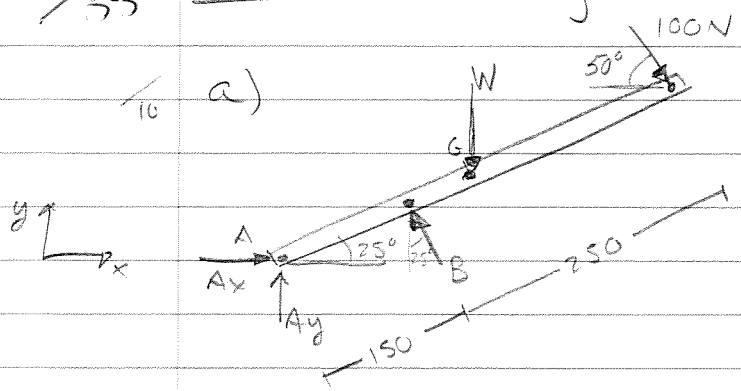
GNG 1105G - ENGINEERING MECHANICS
MIDTERM - SOLUTIONS

/35 **PROB 1** $m = 4\,kg$

/10 a)



(10) -2 per mistake

/25 b) $\circlearrowleft^{+}$ $\sum M_A = 0 = B \cdot 0.15 - mg \cdot 0.2 \cdot \cos 25 - 100 \cdot \cos 50 \cdot 0.4 \cdot \sin 25 - 100 \cdot \sin 50 \cdot 0.4 \cos 25$ (2) (8)

$B = \frac{1}{0.15}(7.113 + 10.866 + 27.771)$ (1)

$\boxed{B = 305\ N \ \angle 65^\circ}$

$\sum F_x = 0$ (2) $\quad A_x - B\sin 25 + 100\cos 50 = 0$ (4)

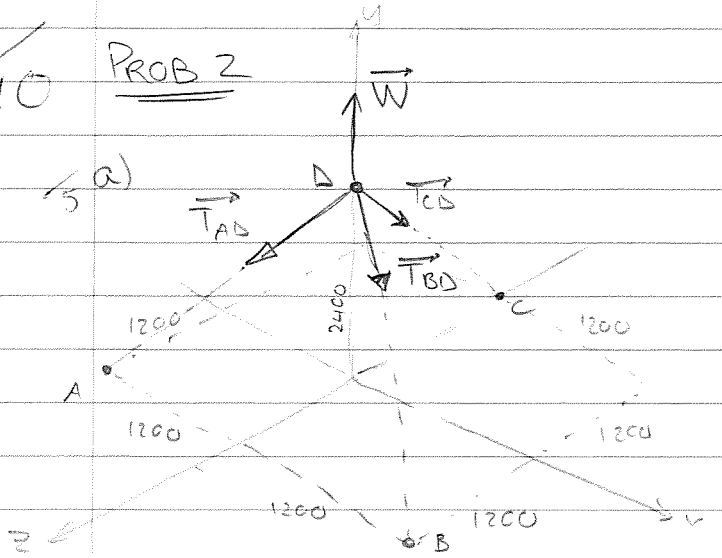
$\boxed{A_x = 64.6\ N \rightarrow}$ (1)

$\sum F_y = 0$ (2) $\quad A_y + B\cos 25 - W - 100\sin 50 = 0$ (4)

$A_y = -160.6\ N$ $\qquad \boxed{A_y = 160.6\ N \downarrow}$ (1)

/40 **PROB 2**

/5 a)



(5) -2 per mistake

/35 b) $\vec{DA} = -1200\vec{i} - 2400\vec{j} + 1200\vec{k}$ (1)

$\|\vec{DA}\| = \sqrt{1200^2 + 2400^2 + 1200^2} = 2939.4\,mm$ (1)

$\vec{T}_{DA}$

$\vec{\lambda} = \frac{\vec{DA}}{\|\vec{DA}\|} = -0.4083\vec{i} - 0.8165\vec{j} + 0.4083\vec{k}$ (1)

$\vec{T}_{DA} = T_{DA}\cdot\vec{\lambda} = -0.4083T_{DA}\vec{i} - 0.8165T_{DA}\vec{j} + 0.4083T_{DA}\vec{k}$ (2)

$\vec{T}_{DB}$ $\vec{DB} = 1200\vec{i} - 2400\vec{j} + 1200\vec{k}$ $\|\vec{DB}\| = 2939.4\,mm$

$\vec{\lambda} = 0.4083\vec{i} - 0.8165\vec{j} + 0.4083\vec{k}$ (5)

$\vec{T}_{BD} = 0.4083T_{BD}\vec{i} - 0.8165T_{BD}\vec{j} + 0.4083T_{BD}\vec{k}$

$\vec{T}_{DC}$ $\vec{DC} = 0\vec{i} - 2400\vec{j} - 1200\vec{k}$ $\|\vec{DC}\| = 2683.3\,mm$

$\vec{\lambda} = 0\vec{i} - 0.8944\vec{j} - 0.4472\vec{k}$ (5)

$\vec{T}_{DC} = 0\vec{i} - 0.8944T_{DC}\vec{j} - 0.4472T_{DC}\vec{k}$

$\vec{W}$ $\vec{W} = mg\vec{j} = 17658\vec{j}$ (2)

Conditions of equilibrium:

[EQ 1]

(1) $\Sigma F_x = 0 \Rightarrow -0.4083T_{DA} + 0.4083T_{DB} = 0$ (3) $\therefore T_{DA} = T_{DB}$

(1) $\Sigma F_z = 0 \Rightarrow 0.4083T_{DA} + 0.4083T_{DB} - 0.4472T_{DC} = 0$ (3)

$0.8165\,T_{DA} = 0.4472\,T_{DC}$ $T_{DC} = 1.8257\,T_{DA}$

[EQ 2]

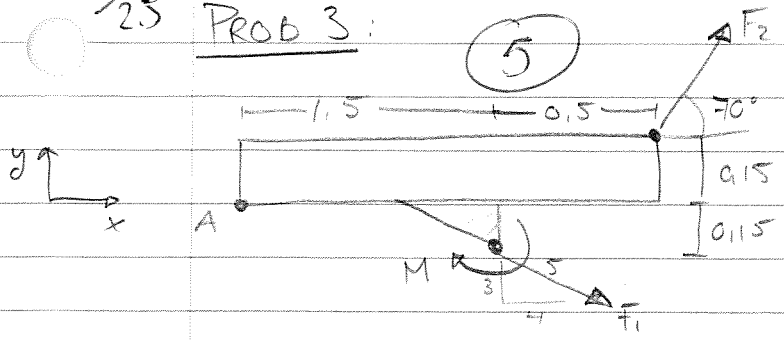
(1) $\Sigma F_y = 0$ $17658 - 0.8165T_{DA} - 0.8165T_{DB} - 0.8944T_{DC} = 0$ (3)

$17658 - 0.8165T_{DA} - 0.8165T_{DA} - 0.8944(1.8257T_{DA}) = 0$

[EQ 3]

SOLVE $\Rightarrow$ $T_{DA} = 5407\,N$ $T_{DB} = 5407\,N$ $T_{DC} = 9871\,N$ (6)

25 PROB 3: (5)



$F_1 = 1{,}2\,kN \qquad F_2 = 2\,kN$

$M = -500\,N\cdot m$ ↻

Equivalent force - couple at A

$\vec{R}_A = \Sigma \vec{F}$

$\vec{M}_A^R = \Sigma \vec{M}_A$

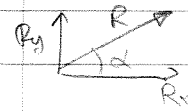
$R_x = \Sigma F_x = \frac{4}{5} F_1 + F_2 \cdot \cos 70$ (1) (3)

$R_x = 1{,}644\,kN \rightarrow$ (1)

$R_y = \Sigma F_y = F_2 \sin 70 - \frac{3}{5} F_1$ (1) (3)

$R_y = 1{,}159\,kN \uparrow$ (1)

$R = \sqrt{R_x^2 + R_y^2} = 2{,}011\,kN$ (2)



$\alpha = \tan^{-1}\left(\frac{R_y}{R_x}\right) \Rightarrow \alpha = 35{,}2°$

$\boxed{R = 2{,}011\,kN \;\angle\; 35{,}2°}$

$M_A^R = \Sigma M_A = F_{1x} \cdot 0{,}15 - F_{1y} \cdot 1{,}5 + F_{2y} \cdot 2 - F_{2x} \cdot 0{,}15 + M$ (1) (a) (6)

$= \frac{4}{5} F_1 \cdot 0{,}15 - \frac{3}{5} F_1 \cdot 1{,}5 + F_2 \sin 70 \cdot 2 - F_2 \cos 70 \cdot 0{,}15 + M$

$M_A^R = 2{,}7202 + M$

$\uparrow -0{,}5\,kN\cdot m$

$\boxed{M_A^R = 2{,}22\,kN\cdot m}$ ↻

(1)