Homework 5

1 B:(58, 5, 28) C:(34, 15, 28) G:(34, 15, 16)

$r_{BC} = (-24, 10, 0)$ $\hat{u}_{BC} = (-.9231, .3846, 0)$

$M_{F_T} = -Fd = -F(23)$

$M_C = r_{CG} \times W$

$W = (0, -86, 0)$ $r_{CG} = (0, 0, -12)$

$M_C = -1032\uparrow$

about BCD $M_C \cdot \hat{u}_{BC} = 952.6154$

$M_R = M_C + M_F$

$-60 = 952.6154 - 23F$

$F = 44.0268$

2 $M_{OB} = (\vec{r}_{OA} \times \vec{F}) \cdot \hat{u}_{OB}$

$\vec{r}_{OA} = -.06\,m\,\hat{j} + .08\,m\,\hat{k} \rightarrow (0, -.06, .08)$

$\vec{F} = (130, -50, 0)$

$\hat{u}_{OB} = \frac{r_{OB}}{|r_{OB}|} = (.1818, .8182, .5455)$

$r_{OA} \times \vec{F} = (4, 10.4, 7.8)$

$M_{OB} = 13.4914\ Nm$

3 $\vec{F}_B = F_B(\frac{6}{11}, \frac{-9}{11}, \frac{2}{11}) \rightarrow (\frac{6}{11}F_B, \frac{-9}{11}F_B, \frac{2}{11}F_B)$

$\vec{r}_{AB} = (1.8 - 1.8\cos 15, 1.8\sin 15, 0) = (-3.5387, .4659, 0)$

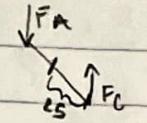
($\hat{i}$ difference btwn F_A & F_B; $\hat{j}$ diff between F_A & F_B)

$M = r_{AB} \times F_B = .08470\,F_B\,\uparrow + .6434\,F_B\,\hat{j} + 2.6412\,F_B\,\hat{k}$

$-3.5387 \quad \frac{6}{11}F_B$

$.4659 \quad \frac{-9}{11}F_B$ moment about z axis = 52 in lb so

$0 \quad \frac{2}{11}F_B$ $2.6412\,F_B = 52 \rightarrow F_B = 19.6883$

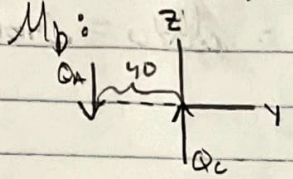
4 

$F_A = F_C = Q_A = Q_C$ since ABCD are couples

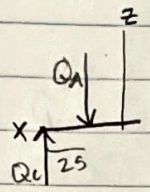
$F_A = Q_A = 125\ N$

$M_{(a)} = (F_A)(d) = (125\ N)(25 \cdot 2) = 6250\uparrow$

M_b:



$\uparrow = (40)(Q_C) = (40)(125) = 5000\uparrow$



$\hat{j} = (25)(Q_A)(-1) = -3125\,\hat{j}$

↑ right hand

$M_b = 5000\uparrow - 3125\hat{j}$

5 M_x (moment about x axis) $= 8200\ N\,mm$

(a) $F_A = F_C$

$M = F_C \cdot d \Rightarrow \quad 8200 = (50)(F) \quad F = 164\ N$

(b) $Q_A = Q_C$

$M = F_C \cdot d_x \Rightarrow \quad 8200 = 40(F) \quad F = 205\ N$

6 $P = 270$ ← +x ↓ +y ↻ positive M

$F_{Rx} = 2(P + 200\sin 20 + 400\cos 20) = 1428.5625$

$F_{Ry} = 2(200\cos 20 - 400\sin 20) = 102.2609$

M_R → only vertical forces affect M_R

2x $200\cos 20$ → positive M, $d = 50$

$400\sin 20$ → negative M

$M_R = 2(50)(200\cos 20 - 400\sin 20) = 5113.0467$

7 $P = 8751\text{b}$ ↓ +z direction

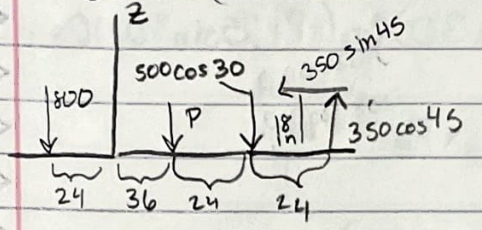
$F_{Rx} = 0$

$F_{RY} = 500\sin 30 - 350\sin 45 = 2.5126$

$F_{RZ} = 400+400+300+300+P+500\cos 30 - 350\cos 45 = 2460.5253$

$M_{OY} = M_{OZ} = 0$

$M_{OX} = (800)(24) - P(36) - (500\cos 30)(24+36) + (350\cos 45)(36+24+24)$
$+ 18(350\sin 45)$
$= -13037.0500$ ↺
$= 13037.0500$ ↻



8 $F_{RZ} = 2460.5253$ (from 7) $\vec{F} = (0, 2.5126, 2460.5253)$

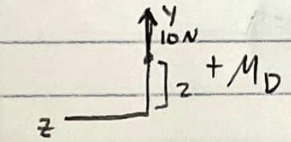
$\vec{M} = (13037.0500, 0, 0)$

$\vec{r} \times F = \vec{M}$

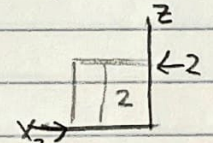
r_x	0	$2460.5253\, r_y - 2.5126 r_z = 13037.0500$
r_y	2.5126	$r_z = 0$ (on xy plane)
r_z	2460.5253	$r_y = 5.2985$

$(r_x)(2460.5253) = 0 \quad r_x = 0$

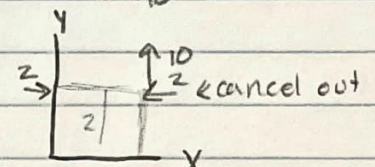
9 $F_R = (2-2)\hat{i} + (10)\hat{j} + 0\hat{k} = 10\hat{j}$ $\quad M_D = 10$



$\hat{i} = (2)(10) + M_D$
$= 30$



$\hat{j} = 2 \cdot 2 = 4$



$\hat{k} = 10 \cdot 2 = 20$

$M_{RA} = \sqrt{30^2 + 4^2 + 20^2} = 36.2767$

10 $F_{Rx} = 2-2 = 0$ $\quad M_{Ax} = 30$
$F_{RY} = 10$ $\quad M_{AY} = 4$ } from 9
$F_{RZ} = 0$ $\quad M_{AZ} = 20$

11 $F_R = (10, 0, 10) = 10\hat{i}$

$\vec{M}_R$ in $\hat{k} = M_2$

LOA $M_1 = Fd$ $\quad d_x = \frac{M_1}{F}$

$d_y = 0 \rightarrow M_1$ & F are on same x coord

12 $\vec{F}_R = (-30)\hat{i} + (-90 - 25\cos 30 - 10\cos 30)\hat{j} + (-P + 25\sin 30 + 10\sin 30)\hat{k}$

$= (-30, -120.311, -18.5)$

$\vec{M}_{RO} = \vec{r}_{OB} \times \vec{F}_B + \vec{r}_{OC} \times F_C + \vec{r}_{OD} \times \vec{F}_D + \vec{r}_{OE} \times F_E$

$(30)(36)\hat{k} - P(44)\hat{i}$

$r_{OD} \times F_D = (-8, 18, 15) \times (0, 25\cos 30, 25\sin 30)$

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