MidTerm

Statics

ENCE 232

الصيفي الاول

2015/2014

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Statics ENCE 232

Mid-Term Exam **Wednesday, June 24, 2015**

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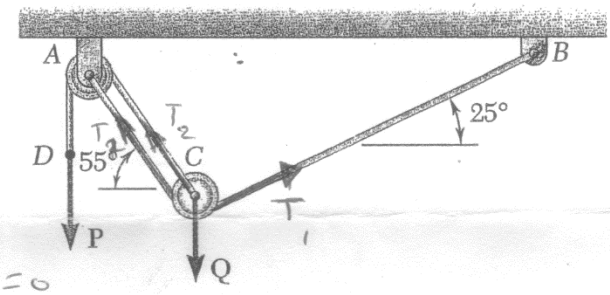
3	22
4	35
	97

1. a (10 points) Determine the tension in cable ACB.
   b. (10 points) Determine the magnitude of force P.

20

$T_{CA} = T_{CB}$

$P = T_2$



ΣF_x at C $= T_1 \cos 25 - T_1 \cos 55 - T_2 \cos 55 = 0$

$0.3327\,T_1 - 0.5736\,T_2 = 0$

$T_1 = 1.724\,T_2$

15 kN

ΣF_y at C $= T_1 \sin 25 + T_1 \sin 55 + T_2 \sin 55 - 15 = 0$

$1.242\,T_1 + 0.8192\,T_2 = 15$

$\Rightarrow (1.242)(1.724)\,T_2 + 0.8192\,T_2 = 15$

$2.960\,T_2 = 15$ KN

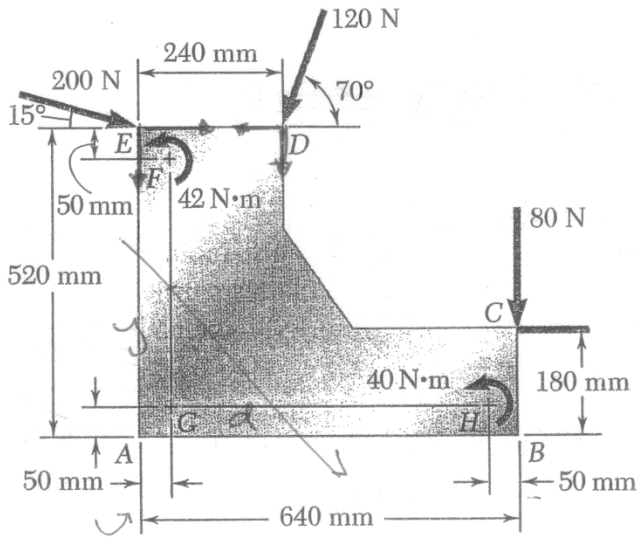
$T_2 = P = 5.067\,(-j)$ KN $\leftarrow$ $T_2 = 5.067$ KN

$T_1 = 1.724 \times 5.067$

T_{ACB} $T_1 = 8.735$ KN

2. a. (10 points) Replace the forces and couples shown by a single force and a single couple at point G.

b. (10 points) Replace the force-couple system at G with a single force and determine its point of application on line FG or GH.



$F_{200} = 200\cos 15\, i + 200\sin 15\, j$

$F_{200} = 193.2\, i - 51.76\, j$ N

$F_{120} = -120\cos 70\, i - 120\sin 70\, j$

$F_{120} = -41.04\, i - 112.8\, j$ N

$F_{80} = 0\, i - 80\, j$ N

$M_1 = 42$ N.m ↻

$M_2 = 40$ N.m ↺

(a)

$\Sigma M_G =$ ↻ (+)

$= (\vec{F}_{200} \times \vec{r}_{200}) + (\vec{F}_{120} \times \vec{r}_{120}) + (\vec{F}_{80} \times \vec{r}_{80}) + M_1 + M_2$

$= \frac{(193.2 \times 470)}{1000} + \frac{(50)(51.76)}{1000} + \frac{(470)(41.04)}{1000} - \frac{(190)}{1000}(112.8) + 42 + 40 - (80)\frac{540}{1000}$

$= -90.80 + 2.588 + 19.29 - 21.43 + 42 + 40 - 47.2$

$\Sigma M_G = -55.55$ ↺ N.m

ΣF_x at G $= 193.2 - 41.04 = 152.2$ $(+i)$ N

ΣF_y at G $= -51.76 - 112.8 - 80 = 244.6$ $(-j)$ N

R at G $= \sqrt{(152.2)^2 + (244.6)^2} = 288.1$ N

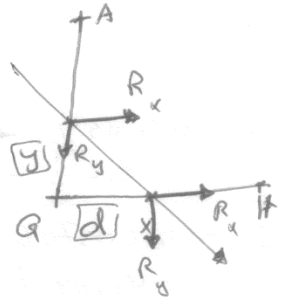
$\theta = 58.1$

$\tan\theta = \frac{-244.6}{152.2} \Rightarrow \theta = -58°$

(B)

$R = 152.2\,i - 244.6\,j$ N

$\Sigma M_G = 55.55$ ↻

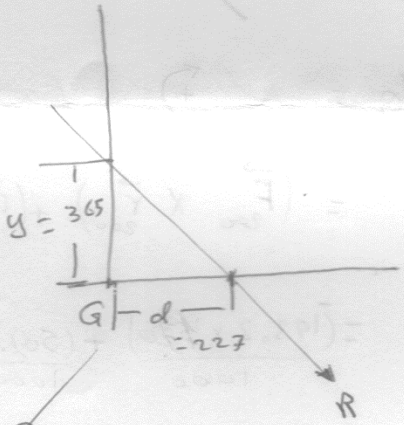


$M_G = (y) \times (152.2\,R_x)$

$55.55 = y \times 152.2$

$y = 0.365$ m $= 365$ mm

Perpendicular distance above G, on line G A



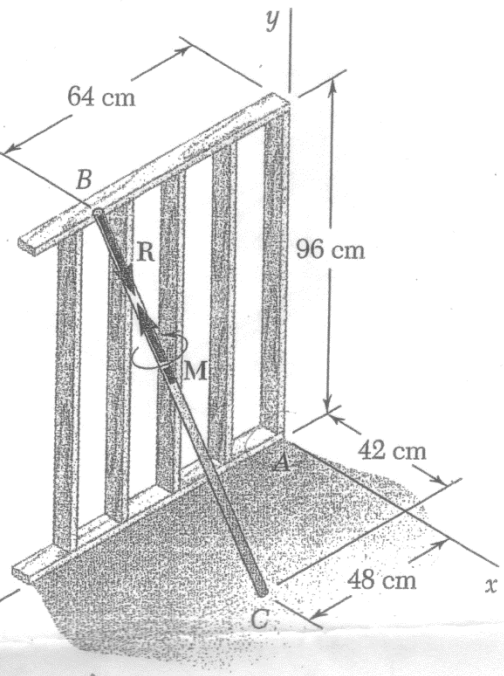
$M_G = (d) \times (R_y)$

$55.55 = d \times 244.6$

$d = 0.227$ m $= 227$ mm

to the right from G, on Line G H.

3. (25 points) Replace the force-couple system (R and M) with an equivalent system applied at point A. Given R = 50 N and M = 10 N.m.



$\vec{BC} = 42i - 96j - 16K$ cm

$BC = 106$ cm

$\vec{\lambda}_{BC} = 0.3962\,i - 0.9056\,j - 0.1509K$

$\vec{R} = 19.81\,i - 45.28\,j - 7.545K$ N

$\vec{CB} = -42i + 96j + 16K$ cm

$CB = 106$ cm

$\vec{\lambda}_{CB} = -0.3962\,i + 0.9056\,j + 0.1509K$

$M = -3.962\,i + 9.056\,j + 1.509K$ N.m

A (0, 0, 0)

B (0, 96, 64)

C (42, 0, 48)

$\sum M_A = M + M_A^R$

$M_A^R \Rightarrow \vec{r}_{AC} = 42i + 0j + 48K$

$$M_A^R = \begin{vmatrix} i & j & K \\ 4.2 & 0 & 4.8 \\ 19.81 & -45.28 & -7.545 \end{vmatrix} = i(217.3) + j(126.8) + K(-190.2)$$

$= 217.3\,i + 126.8\,j - 190.2K$ N.m

$\sum M_A = (217.3 - 3.962)\,i + (126.8 + 9.056)\,j + (-190.2 + 1.509)K$ N.m

$= 213.3\,i + 135.8\,j - 188.7K$ N.m

$\sum R_A = R = 19.81\,i - 45.28\,j - 7.545K =$

4. (35 points) Determine the tension in the cable. A and E are ball-and-socket joints.

$\vec{DF} = -16\,i + 11\,j - 8\,K$ cm

$DF = 21$ cm

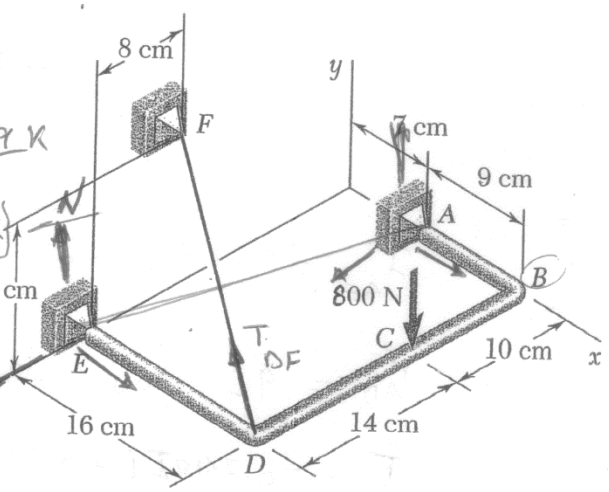
$\vec{\lambda}_{DF} = -0.7619\,i + 0.5238\,j - 0.3809\,K$

$\vec{F}_{DF} = -0.7619T\,i + 0.5238T\,j - 0.3809T\,K$

$F_C = 0\,i - 800N\,j + 0\,K$ N

$R_A = A_x\,i + A_y\,j + A_z\,K$

$R_E = E_x\,i + E_y\,j + E_z\,K$



A (7 , 0 , 0)
B (16 , 0 , 0)
C (16 , 0 , 10)
D (16 , 0 , 24)
E (0 , 0 , 24)
F (0 , 11 , 16)

To find the tension in the cable DF, I will ~~Find~~ ~~Calculate~~ take the same of Cuple ~~on~~ about Line AE, $\sum M_{AE} = 0$

$M_{AE} = M^{T}_{AE} + M^{F_C}_{AE}$

① $M^{F_C}_{AE}$: $\vec{AE} = -7\,i + 0\,j + 24\,K$ cm ; $AE = 25$

$\vec{\lambda}_{AE} = -0.28\,i + 0\,j + 0.96\,K$ —(1)

$\vec{r}_{AC} = 9\,i + 0\,j + 10\,K$ cm

$\vec{F}_C = 0\,i - 800N + 0\,K$ N

$$M_{AE}^{F_c} = \begin{vmatrix} -0.28 & 0 & 0.96 \\ 9 & 0 & 10 \\ 0 & -800 & 0 \end{vmatrix} = (+0.28)(+8000) + 0 + 0.96(-7200)$$

$$-2240 - 6912 = -9152 \ N.cm$$

② M_{AE}^{T}

$$\vec{i}_{AE} = -0.28\,i + 0\,j + 0.96\,K$$

$$\vec{r}_{AD} = 9i + 0j + 24K$$

$$\vec{F}_{AD} = -0.7619T\,i + 0.5238T\,j - 0.3809T\,K$$

$$M_{AE}^{T} = \begin{vmatrix} -0.28 & 0 & 0.96 \\ 9 & 0 & 24 \\ -0.7619T & 0.5238T & -0.3809T \end{vmatrix} = (-0.28)(-24 \times 0.5238T) + 0 + 0.96(0.5238T \times 9)$$

$$= 3.520T + 4.526T$$

$$= 8.046T \ N.cm$$

$$\Sigma M_{AE} = 0 = 8.046T - 9152 = 0$$

$$T = \frac{9152}{8.046} = 1137 \ N$$

بالتوفيق