EM211
Prof. Burkhardt

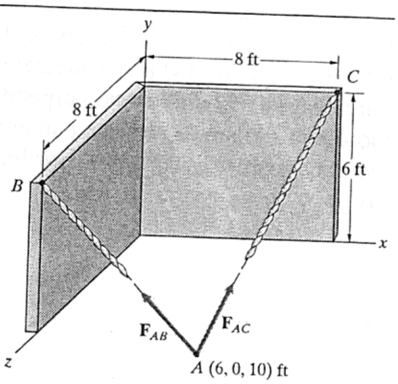
STATICS-EXAM 1
Section 4

Fall AY07
6 September 2006

Name ______________________________

Period 4 5 6

1. (30 pts) Consider the cables and wall shown. Cable AB exerts a 200-lb force $\mathbf{F_{AB}}$ at point A that is directed along the line from A to B. The cable AC exerts a 100-lb force $\mathbf{F_{AC}}$ at point A that is directed along the line from A to C. If $\mathbf{r_{AB}} = -6\mathbf{i} + 6\mathbf{j} - 2\mathbf{k}$ [ft] and $\mathbf{r_{AC}} = 2\mathbf{i} + 6\mathbf{j} - 10\mathbf{k}$ [ft] determine the resultant force, $\mathbf{F_R}$, exerted at point A by the two cables. Calculate and express your answer in terms of vector components using the coordinate system shown.



Given

Find

2

Relationships

$\vec{r}_{AB} = (0,6,8)-(6,0,10) = -6\hat{i}+6\hat{j}-2\hat{k}$ $\hat{e}_{AB} = -0.688\hat{i}+0.688\hat{j}-0.22$

$\vec{r}_{AC} = (8,6,0)-(6,0,10) = 2\hat{i}+6\hat{j}-10\hat{k}$ $\hat{e}_{AC} = 0.169\hat{i}+0.507\hat{j}-0.845\hat{k}$

$\vec{F}_{AB} = 200\,\hat{e}_{AB}$ $\vec{F}_{AB} = -138\hat{i}+138\hat{j}-45.8\hat{k}$

$\vec{F}_{AC} = 100\,\hat{e}_{AC} = 169\hat{i}+50.7\hat{j}-84.5\hat{k} = \vec{F}_{AC}$

5 $\vec{F}_R = \vec{F}_{AB} + \vec{F}_{AC}$

5 $\vec{F}_R = (-138+169)\hat{i} + (138+50.7)\hat{j} + (-45.8-84.5)\hat{k}$

3 $\boxed{\vec{F}_R = -121\hat{i} + 189\hat{j} - 130\hat{k}\ [\text{lb}]}$

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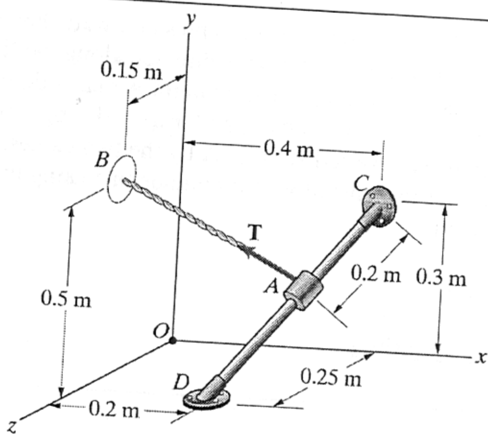
2. (30 pts) The rope AB exerts a 50-N force **T** on collar A located at (0.309,0.163,0.114) [m]. Calculate and express the vector component of **T** parallel and perpendicular to bar CD using the given coordinate system. Calculate and express your answer in terms of vector components using the coordinate system shown.



Given

Find

Relationships

2

$\vec{r}_{AB} = (0, 0.5, 0.15) - (0.309, 0.163, 0.114)$ $\quad \vec{r}_{AB} = -0.309\hat{i} + 0.337\hat{j} + 0.0360\hat{k}$

$r_{AB} = 0.459$ $\quad \hat{e}_{AB} = -0.674\hat{i} + 0.735\hat{j} + 0.0785\hat{k}$

$\vec{r}_{CD} = (0.2, 0, 0.25) - (0.4, 0.3, 0)$ $\quad \vec{r}_{CD} = -0.2\hat{i} - 0.3\hat{i} + 0.25\hat{k}$

$r_{CD} = 0.439$ $\quad \hat{e}_{CD} = -0.456\hat{i} - 0.684\hat{j} + 0.570\hat{k}$

5 $\vec{T} = 50\,\hat{e}_{AB} \longrightarrow \vec{T} = -33.7\hat{i} + 36.8\hat{j} + 3.93\hat{k}$

10 $T_p = \vec{T} \cdot \hat{e}_{CD} = (-33.7)(-0.456) + (36.8)(-0.684) + (3.93)(0.570)$

$T_p = -7.56 \quad \vec{T}_p = T_p\,\hat{e}_{CD} \rightarrow \boxed{\vec{T}_p = 3.45\hat{i} + 5.17\hat{j} - 4.31k\ [1}$

5 $\vec{T}_n = \vec{T} - \vec{T}_p = (-33.7 - 3.45)\hat{i} + (36.8 - 5.17)\hat{j} + (3.93 + 4.31)\hat{k}$

3 $\boxed{\vec{T}_n = -37.2\hat{i} + 31.6\hat{j} + 8.24\hat{k}\ [16]}$

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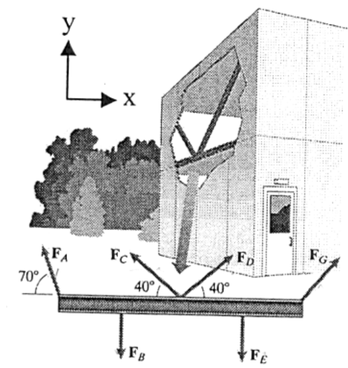
3. (40 pts) Six forces act on a beam that forms part of a building's frame. The vector sum of the forces is zero. The magnitudes $F_B = F_E = 20$ kN, $F_C = 16$ kN, $F_D = 9$ kN and $F_A = 12$ kN, Determine $\mathbf{F_G}$. Calculate and express your answer in terms of vector components using the coordinate system shown.



Given

Find

2

Relationships

$$\vec{F}_A = 12(-\cos 70\,\hat{i} + \sin 70\,\hat{j}) = -4.10\,\hat{i} + 11.3\,\hat{j}$$

$$\vec{F}_B = 20(-\hat{j}) = -20\,\hat{j}$$

0 $$\vec{F}_C = 16(-\cos 40\,\hat{i} + \sin 40\,\hat{j}) = -12.3\,\hat{i} + 10.3\,\hat{j}$$

$$\vec{F}_D = 9(\cos 40\,\hat{i} + \sin 40\,\hat{j}) = 6.89\,\hat{i} + 5.79\,\hat{j}$$

$$\vec{F}_E = 20(-\hat{j}) = -20\,\hat{j}$$

5 $$\vec{F}_G = F_{Gx}\,\hat{i} + F_{Gy}\,\hat{j}$$

5 $$\vec{F}_G + \vec{F}_A + \vec{F}_B + \vec{F}_C + \vec{F}_D + \vec{F}_E = \vec{0}$$

5 $$\hat{i}:\ F_{Gx} - 4.10 + 0 - 12.3 + 6.89 + 0 = 0 \Rightarrow F_{Gx} = -9.51$$

$$\hat{j}:\ F_{Gy} + 11.3 - 20 + 10.3 + 5.79 - 20 = 0 \Rightarrow F_{Gy} = +12.6$$

3 $$\boxed{\vec{F}_G = -9.51\,\hat{i} + 12.6\,\hat{j}\ [\text{kN}]}$$