CEN 100

NOTRE DAME UNIVERSITY

Faculty of Engineering

Department of Civil and Environmental Engineering

Fall 2007

Instructor : Dr. Baudewen

Course Code : CEN 100 Section: TTH

EXAM No. 1 Closed Book, Closed Notes **Time:** 1½ Hours

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Problem	Points
1	~~25/25~~ 28/30
2	35/35
3	35/35

TOTAL: 98/100

Grade = 98/100

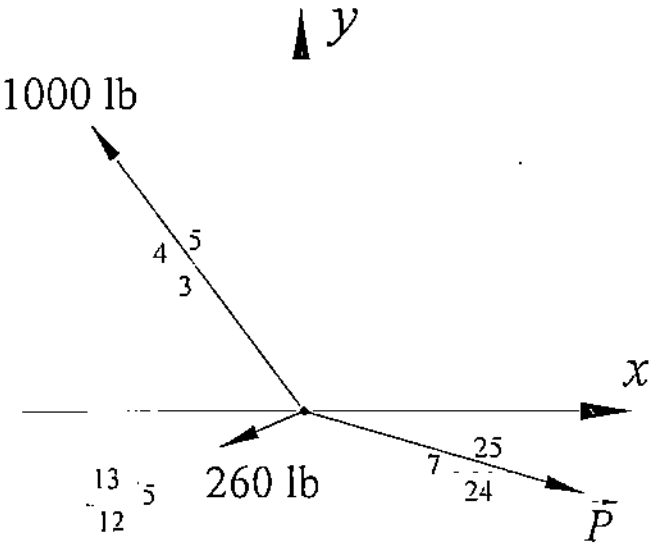
PROBLEM 1: (30 points)

Determine the two possible magnitudes for $\vec{P}$ so that the resultant force $\vec{F}_R$ has a magnitude of 800 lb.

Determine, then the two corresponding directions of $\vec{F}_R$.

N.B.:

All forces are contained in the *x*-*y* plane.



$$\Sigma F_x = P\left(\frac{24}{25}\right) - 1000\left(\frac{3}{5}\right) - 260\left(\frac{12}{13}\right) \quad \text{lb}$$

$$\Sigma F_y = -P\left(\frac{7}{24}\right) + 1000\left(\frac{4}{5}\right) - 260\left(\frac{5}{13}\right) \quad \text{lb}$$

$$\|\vec{F}_R\| = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$$

$$\Rightarrow \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2} = 800 \text{ lb}$$

$$\Rightarrow (0.96P - 840)^2 + (-0.3P + 700)^2 = 640000$$

$$0.9216P^2 - 1612.8P + 705600 + 0.09P^2 - 420P + 490000 = 640000$$

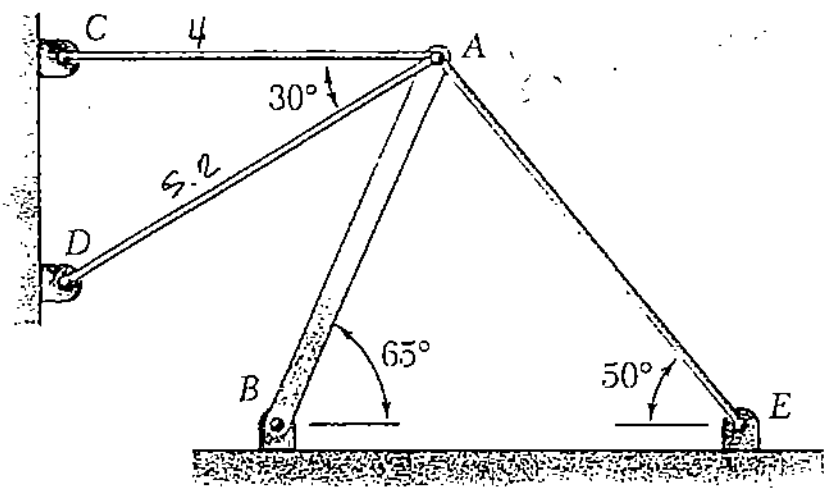
$$1.0116P^2 - 2032.8P + 555600 = 0$$

$P = 1683.18$ lb or $P = 326.3$ lb

PROBLEM 2: (35 points)

Boom AB is held in the position shown by three cables. Knowing that the tensions in cables AC and AD are F_{AC} = 4 kN and F_{AD} = 5.2 kN respectively, determine:

The tension F_{AE} in cable AE, and force F_{BA} in boom AB, when point A is in the equilibrium position shown.



P≠A is in equilibrium, then $\Sigma \vec{F}_x = \vec{0}$ & $\Sigma \vec{F}_y = \vec{0}$

$\Sigma F_x = T_{AE}\cos 50 - F_{AB}\cos 65 - 5.2\cos 30 - 4 = 0$ ✓ (1)

$\Sigma F_y = -T_{AE}\sin 50 - F_{AB}\sin 65 - 5.2\sin 30 = 0$ (2)

(1) $T_{AE}\cos 50 - F_{AB}\cos 65 = 4 + 5.2\cos 30$

(2) $-T_{AE}\sin 50 - F_{AB}\sin 65 = 5.2\sin 30$

Solving (1) & (2) we get:

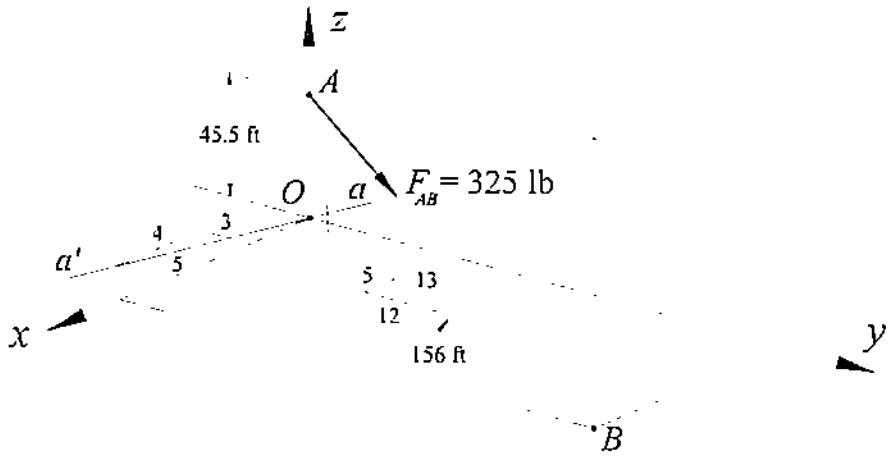
$T_{AE} = 7.3$ kN

$F_{BA} = 9.03$ kN

PROBLEM 3: (35 points)

Determine the moment of the force $\vec{F}_{AB}$, acting along line ***AB*** as shown, about axis ***a'a***.

Express the result as a Cartesian Vector.



N.B.:

Point ***B*** and axis ***a'a*** lie in the *x*-*y* plane.

$A(0,0,45.5)$ $B(60,144,0)$

$\vec{AB}(60,144,-45.5)$ $\vec{u}_{\vec{AB}} = \frac{1}{162.5}\begin{vmatrix} 60\,\vec{i} \\ 144\,\vec{j} \\ -45.5\,\vec{k} \end{vmatrix}$

$\vec{F}_{AB} = \|\vec{F}\| \cdot \vec{u}_{\vec{AB}} = 325\begin{vmatrix} 60\,\vec{i} \\ 144\,\vec{j} \\ -45.5\,\vec{k} \end{vmatrix} = 120\,\vec{i} + 288\,\vec{j} - 91\,\vec{k}$

$\vec{r} = \vec{OA}(0,0,45.5)$

$\vec{u}_{a'a} = \begin{vmatrix} 4/5 & \vec{i} \\ -3/5 & \vec{j} \\ 0 & \vec{k} \end{vmatrix}$

$M_{F_{AB}/a'a} = \vec{u}_{a'a} \cdot (\vec{r} \times \vec{F}_{AB})$

$= \begin{vmatrix} 4/5 & -3/5 & 0 \\ 0 & 0 & 45.5 \\ 120 & 288 & -91 \end{vmatrix}$

$= 4/5(0 - 13104) + 3/5(0 - 5460)$

$= -13759.2$ lb.ft

$\vec{u}_{a'a} \cdot M = (-11007.36\,\vec{i} + 8255.52\,\vec{j})$ lb.ft