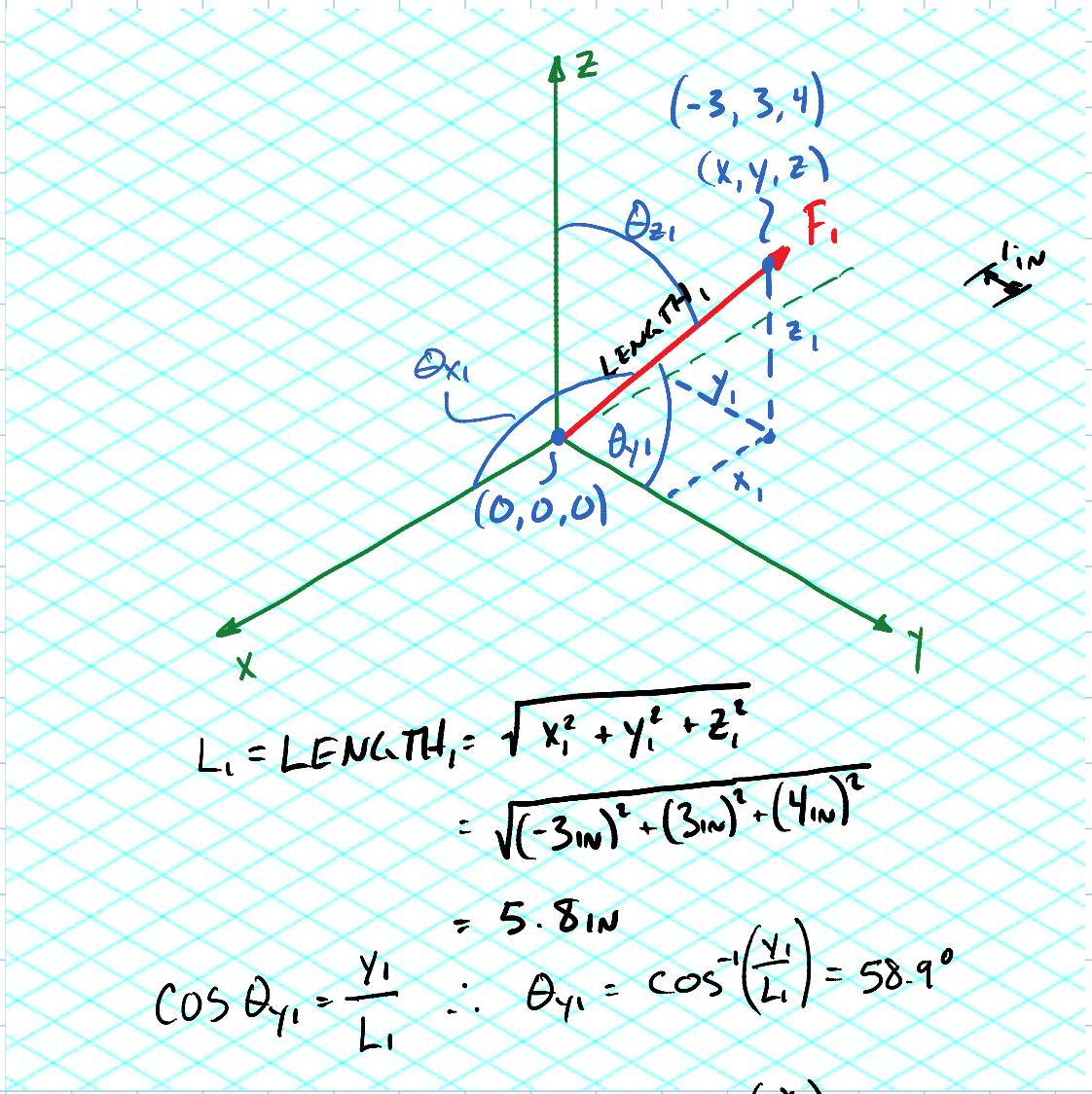
3D CONCURRENT FORCES

Monday, June 04, 2012
2:34 PM



$$L_1 = \text{LENGTH}_1 = \sqrt{x_1^2 + y_1^2 + z_1^2}$$

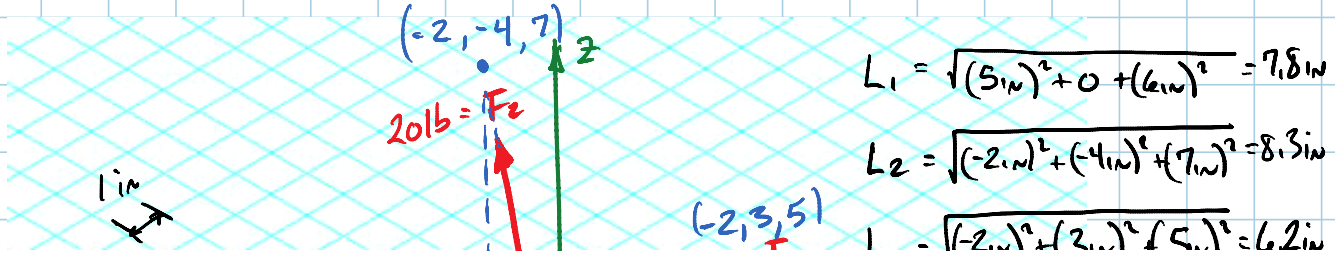
$$= \sqrt{(-3\text{in})^2 + (3\text{in})^2 + (4\text{in})^2}$$

$$= 5.8\text{in}$$

$$\cos\theta_{y1} = \frac{y_1}{L_1} \quad \therefore \quad \theta_{y1} = \cos^{-1}\left(\frac{y_1}{L_1}\right) = 58.9^\circ$$

$$\cos\theta_{x1} = \frac{x_1}{L_1} \quad \therefore \quad \theta_{x1} = \cos^{-1}\left(\frac{x_1}{L_1}\right)$$

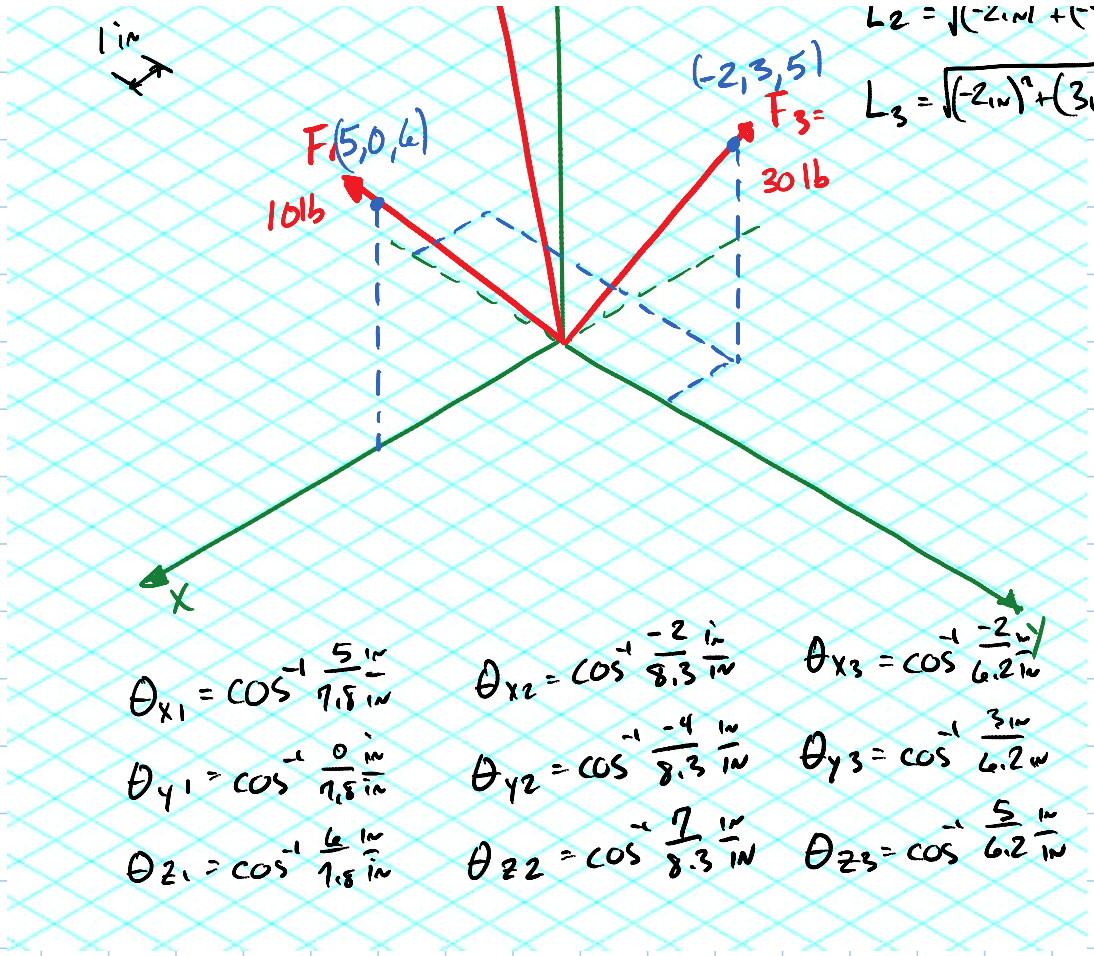
$$\cos\theta_{z1} = \frac{z_1}{L_1} \quad \therefore \quad \theta_{z1} = \cos^{-1}\left(\frac{z_1}{L_1}\right)$$



$$L_1 = \sqrt{(5\text{in})^2 + 0 + (6\text{in})^2} = 7.8\text{in}$$

$$L_2 = \sqrt{(-2\text{in})^2 + (-4\text{in})^2 + (7\text{in})^2} = 8.3\text{in}$$

$$L_3 = \sqrt{(-2\text{in})^2 + (3\text{in})^2 + (5\text{in})^2} = 6.2\text{in}$$



$$\Sigma F_x = F_{1x} + F_{2x} + F_{3x} = R_x$$

$$= 10lb \cdot \cos\theta_{x1} + 20lb \cdot \cos\theta_{x2} + 30lb \cdot \cos\theta_{x3}$$

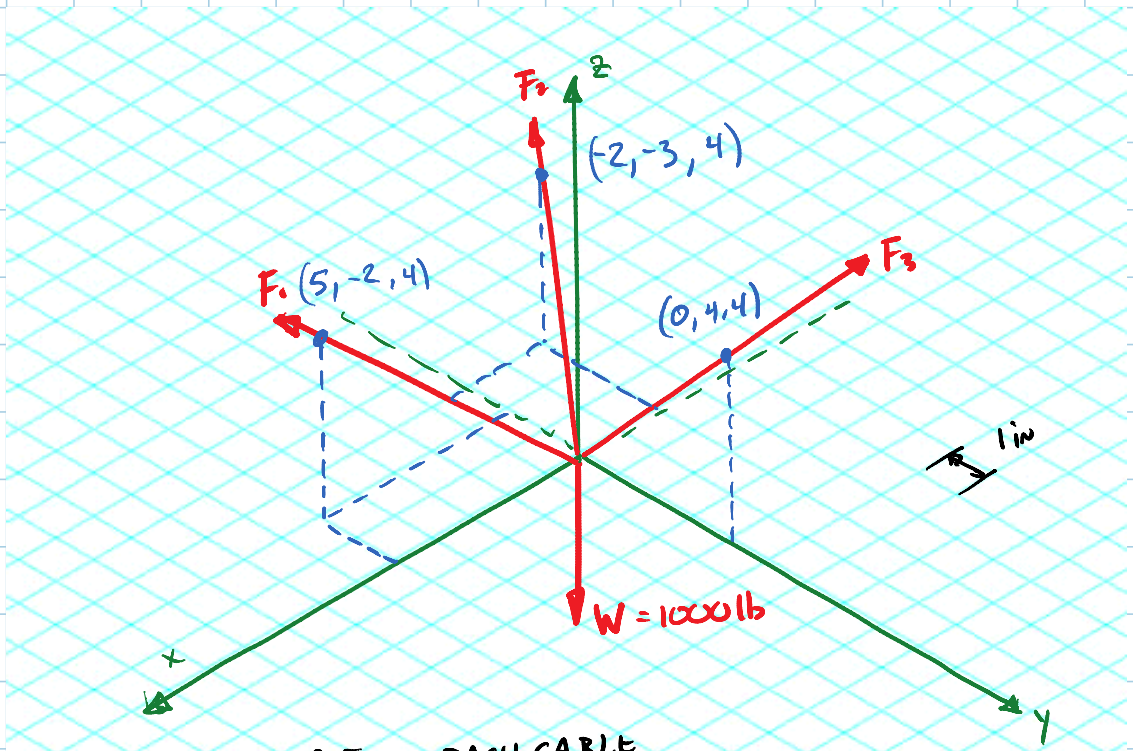
$$= 10lb \cdot \cos\left(\cos^{-1}\frac{5}{7.8}\right) + 20lb \cos\left(\cos^{-1}\frac{-2}{8.3}\right) + 30lb \cdot \cos\left(\cos^{-1}\frac{-2}{6.2}\right)$$

$$= 10lb \cdot \frac{5}{7.8} + 20lb \cdot \frac{-2}{8.3} + 30lb \cdot \frac{-2}{6.2}$$

$$= 6.4\,lb + (-4.8\,lb) + (-9.7\,lb)$$

$$R_x = -8.1\,lb$$

3D EQUILIBRIUM



FIND: THE FORCE IN EACH CABLE.

$$L_1 = \sqrt{(5_{IN})^2 + (-2_{IN})^2 + (4_{IN})^2} = 6.7\ IN$$

$$L_2 = \sqrt{(-2_{IN})^2 + (-3_{IN})^2 + (4_{IN})^2} = 5.4\ IN$$

$$L_3 = \sqrt{0_{IN}^2 + (4_{IN})^2 + (4_{IN})^2} = 5.7\ IN$$

$$\theta_{X1} = \cos^{-1}\frac{5}{6.7} \qquad \theta_{X2} = \cos^{-1}\frac{-2}{5.4} \qquad \theta_{X3} = \cos^{-1}\frac{0}{5.7}$$

$$\theta_{Y1} = \cos^{-1}\frac{-2}{6.7} \qquad \theta_{Y2} = \cos^{-1}\frac{-3}{5.4} \qquad \theta_{Y3} = \cos^{-1}\frac{4}{5.7}$$

$$\theta_{Z1} = \cos^{-1}\frac{4}{6.7} \qquad \theta_{Z2} = \cos^{-1}\frac{4}{5.4} \qquad \theta_{Z3} = \cos^{-1}\frac{4}{5.7}$$

$$\Sigma F_X = R_X = 0 = F_1 \cdot \cos\theta_{X1} + F_2 \cdot \cos\theta_{X2} + F_3 \cdot \cos\theta_{X3}$$
$$= {}^{5}/_{6.7} \cdot F_1 + \left(-{}^{2}/_{5.4}\right) F_2 + {}^{0}/_{5.7} \cdot F_3$$

$$\Sigma F_Y = R_Y = 0 = F_1 \cdot \cos\theta_{Y1} + F_2 \cdot \cos\theta_{Y2} + F_3 \cdot \cos\theta_{Y3}$$
$$= {}^{-2}/_{6.7} \cdot F_1 + \left(-{}^{3}/_{5.4}\right) F_2 + {}^{4}/_{5.7} \cdot F_3$$

$\Sigma F_Z = R_Z = 0 = F_1 \cdot \cos\theta_{Z1} + F_2 \cdot \cos\theta_{Z2} + F_3 \cdot \cos\theta_{Z3}$ = ...

$$\Sigma F_z = R_z = 0 = F_1 \cdot \cos\theta_{z1} + F_2 \cdot \cos\theta_{z2} + F_3 \cdot \cos\theta_{z3} - 1000\,lb$$

$$= {}^{4}/_{6.7} \cdot F_1 + {}^{4}/_{5.4} \cdot F_2 + {}^{4}/_{5.7} \cdot F_3$$

a = COEFFICIENTS =

$$\begin{bmatrix} {}^{5}/_{6.7} & -{}^{2}/_{5.4} & 0 \\ -{}^{2}/_{6.7} & -{}^{3}/_{5.4} & {}^{4}/_{5.7} \\ {}^{4}/_{6.7} & {}^{4}/_{5.4} & {}^{4}/_{5.7} \end{bmatrix} \begin{matrix} \leftarrow \Sigma F_x \\ \leftarrow \Sigma F_y \\ \leftarrow \Sigma F_z \end{matrix}$$

F_1 F_2 F_3

b = residuals =

$$\begin{bmatrix} 0 \\ 0 \\ 1000 \end{bmatrix} \begin{matrix} \leftarrow \Sigma F_x \\ \leftarrow \Sigma F_y \\ \leftarrow \Sigma F_z \end{matrix}$$

lb

to solve: $a^{-1} \cdot b = \begin{bmatrix} F_1 \\ F_2 \\ F_3 \end{bmatrix} = \begin{bmatrix} 285 \\ 575 \\ 576 \end{bmatrix}$ lb