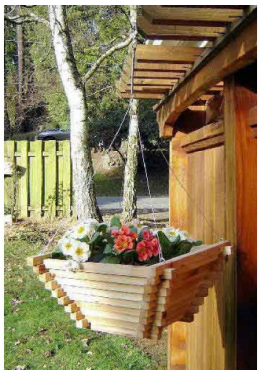
AEM 2011 Exam #1 Friday, March 7

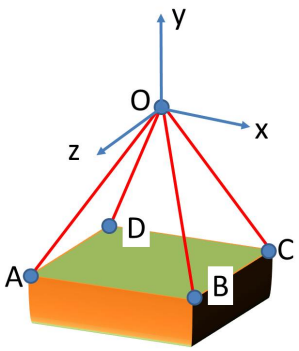
You may only use a simple calculator that does not communicate in any wireless manner. Pagers, cell phones, and all other communications devices must be turned off during the quiz. All work (free body diagrams, algebra, etc) is required to receive full credit.

1. (30 points) A flower basket with mass $m = 3kg$ hangs from four cables. The basket is shown below (left figure) along with a simplified geometry (right figure). The cables connect to the point O and attach to the basket at the following four points:

$$\mathbf{r_A} = -0.2\mathbf{i} - \mathbf{j} + 0.2\mathbf{k}$$
$$\mathbf{r_B} = 0.2\mathbf{i} - \mathbf{j} + 0.2\mathbf{k}$$
$$\mathbf{r_C} = 0.2\mathbf{i} - \mathbf{j} - 0.2\mathbf{k}$$
$$\mathbf{r_D} = -0.2\mathbf{i} - \mathbf{j} - 0.2\mathbf{k}$$

All vectors are in meters. Determine the tension (magnitude only) of each cable required to support the basket in static equilbrium.





2. (35 points) A helicopter can transport a suspended load as shown in the left figure below. A simplified geometry of the cables and load is shown in right picture below with:

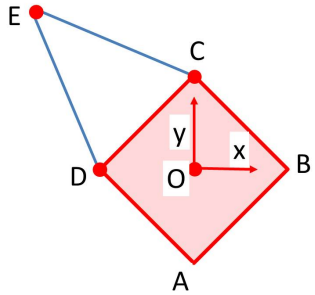
$$\mathbf{r_A} = -\mathbf{j}m,\ \mathbf{r_B} = \mathbf{i}m,\ \mathbf{r_C} = \mathbf{j}m,\ \mathbf{r_D} = -\mathbf{i}m,\ \mathbf{r_E} = -10\mathbf{i}m + 10\mathbf{j}m.$$

Note: The diagram is not drawn to scale. The wind creates a drag force on the load that acts in the positive x direction on the load at point D. The load has a mass $m = 100$kg and the gravitational force acts in the negative y direction on the load at point O.

(a) Draw a free-body diagram showing all forces acting on the load.

(b) Determine the unit vector from C to E. Also determine the unit vector from D to E.

(c) Determine the drag force and tension forces in both cables.



3. (35points) A garage storage shelf is shown in the left figure below. A simplified version of the shelf geometry is shown in the right figure below. The shelf is attached to the garage wall at points O, A, B, and C.

   (a) A box of mass $m = 10kg$ is placed at $\mathbf{r_D} = -\mathbf{i} + 0.5\mathbf{k}$ m. The box generates a force $\mathbf{F_D} = -mg\mathbf{j}$ on the storage shelf. What is the moment about point $\mathbf{O}$ generated by the force $\mathbf{F_D}$?

   (b) What is the moment generated by the force $\mathbf{F_D}$ about the x-axis?

   (c) Assume the wall only applies forces to the shelf at points O, A, B, and C. Let $\mathbf{F_B}$ and $\mathbf{F_C}$ denote the forces by the wall acting on the storage shelf at points B and C. Assume that these two forces are equal. Will the z-component of $\mathbf{F_B}$ be positive or negative? Briefly justify your answer.