MTE 203 – Advanced Calculus
Homework 1 (Questions)

Vector Operations Review

As mentioned during our first lecture, the shortest distance between two points (or the length of the line segment joining two points) $P_1\left(x_1, y_1, z_1\right)$ and $P_2\left(x_2, y_2, z_2\right)$ in 3-D space is given by,

$$\left\|P_1P_2\right\| = \sqrt{\left(x_2 - x_1\right)^2 + \left(y_2 - y_1\right)^2 + \left(z_2 - z_1\right)^2}$$

Using your previous knowledge in vector operations (MTE 119) and the concept of distance between points and lines in the 2-D space (MATH 118), solve the following problems in the 3-D space.

Problem 1 [S. 11.1, Prob. 5]:

Show that the (unidirected, prependicular) distances from a point (x, y, z) to the $x-, y-$, and $z-$ axes are, respectively, $\sqrt{y^2 + z^2}, \sqrt{x^2 + z^2}, \sqrt{y^2 + x^2}$.

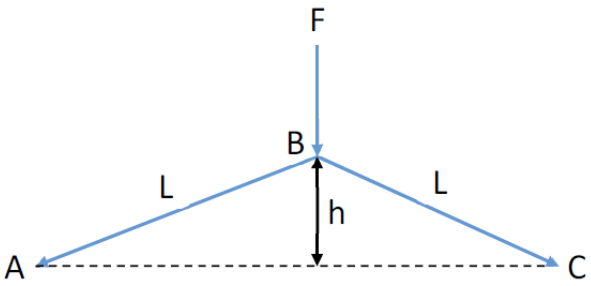
Problem 2 [S. 11.1, Prob. 13]:

a. If $\left(\sqrt{3} - 3, 2 + 2\sqrt{3}, 2\sqrt{3} - 1\right)$ and $\left(2\sqrt{3}, 4, \sqrt{3} - 2\right)$ are two vertices of an equilateral triangle, and if the third vertex lies on the $z-$axis, find the third vertex coordinates.
b. Can you find a third vertex on the $x-$axis?

Problem 3 [11.3, Prob. 41] – Application Problem:

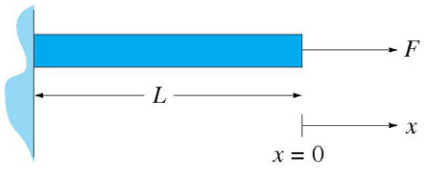
Two bars, ***AB*** and ***BC***, are pinned at ***B*** as well as at each of the ends ***A*** and ***C*** (see figure). Initially each bar is of length ***L***; and point ***B*** is at a distance ***h*** above the line ***AC***. The bars are identical, each having cross sectional area ***A*** and Young's modulus **E**. A vertical force with magnitude **F** is applied at ***B***. Show that the displacement **y** of ***B*** is related to **F** by the equation:

$$F = \frac{2\,A\,E}{L}\,(h - y)\left[\frac{L}{\sqrt{y^2 - 2\,hy + L^2}} - 1\right]$$



Hint: To solve this problem you will need to use the following concept that you learned from strength of materials:

FIGURE 7.74 Stretch in rod when force is applied to one end



$$x = \frac{FL}{AE}$$

Extra Practice Problems

Solutions to these problems are in the Trim's Student Solution Manual

1. S. 11.1, Probs. 4, 14, 20
2. 2. 11.3, Probs. 8, 20, 30