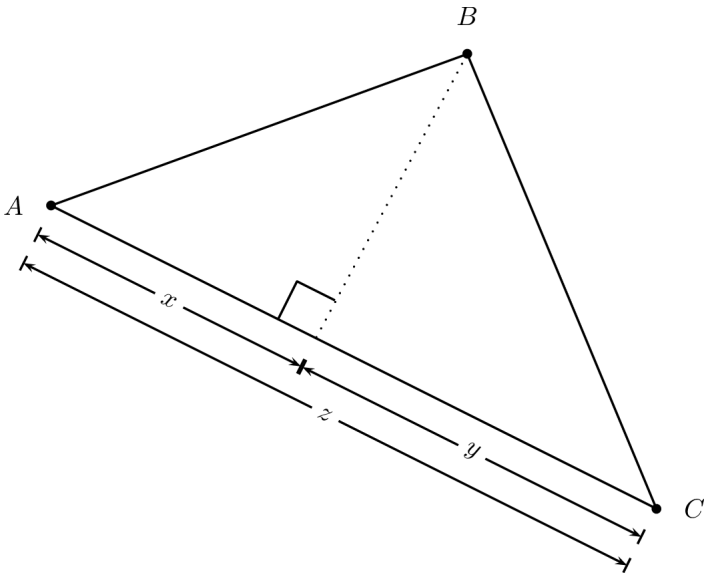
CSCI 480, Fall 2015, Math Homework # 2

Name_____ Number _____

Typeset your homework using LaTeX.

1. In the picture below, A, B, and C are arbitrary points, and the dotted line is perpendicular to the line from A to C. Give pseudocode for an algorithm to find the distances x, y, and z as a function of the points A, B, and C. Use point subtraction and dot products.



2. For each of the following implicitly defined quadric surfaces, find a formula to determine the value of t where a ray defined by $p + tv$ intersects the surface.

   (a) Elliptic paraboloid

   $$\frac{x^2}{a^2} + \frac{y^2}{b^2} - z = 0$$

   (b) Hyperbolic paraboloid

   $$\frac{x^2}{a^2} - \frac{y^2}{b^2} - z = 0$$

   (c) Elliptic hyperboloid of one sheet

   $$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{z^2}{c^2} = 1$$

   (d) Elliptic hyperboloid of two sheets

   $$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{z^2}{c^2} = -1$$

3. Find a formula for a vector normal to each of the following surfaces.

   (a) Elliptic paraboloid

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - z = 0$$

   (b) Hyperbolic paraboloid

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} - z = 0$$

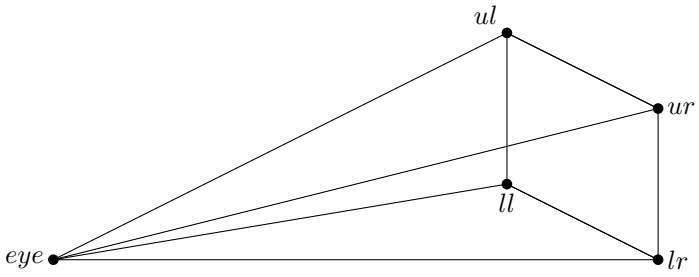
   (c) Elliptic hyperboloid of one sheet

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{z^2}{c^2} = 1$$

   (d) Elliptic hyperboloid of two sheets

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{z^2}{c^2} = -1$$

4. Suppose we specify a camera by five points: the eye point and the four corners of the image plane (upper left, upper right, lower left, lower right), as in the figure below (the left side of the image plane is deeper into the picture than the right side).



Given a position in the image plane defined by x and y, each scaled to $[0, 1]$, and with the origin of the image plane understood as the lower left corner, write an expression giving the vector for a ray from the eye to that point in the image plane. You do not need to normalize the vector.

5. Given a camera specified as in the lecture notes, with an eye point, normalized right, up, and foward vectors, and scalars depth, width and height, $\langle p, r, u, f, d, w, h\rangle$, write expressions for each of the five points in the camera representation from the previous problem.

   (a) $eye =$

   (b) $ul =$

   (c) $ur =$

   (d) $ll =$

   (e) $lr =$