

### Math Problem Set 3

#### Fall 2019

Please answer all of these questions. (It's not intended that you answer them on this sheet of paper.)

**Q1.** (10 points) Suppose you have the camera placed at the origin, facing down the negative  $Z$  axis, and the image plane at  $Z = -2$ . What is the projection of the following points:

$$A = (-4, 2, -8)$$

$$B = (4, -2, -8)$$

$$C = (0, 6, -6)$$

**Q2.** (10 points) In the previous problem, suppose the frustum is two units high, extending from top = +1 to bottom = -1. What is the field of view in the  $Y$  direction (FOVY)?

**Q3.** (10 points) Continuing from **Q2**, suppose the frustum extends from left = -1.5 to right = 1.5. What is the aspect ratio of the top of the frustum?

**Q4.** (10 points) In the matrices for orthographic and perspective projection, we projected onto the  $Z = 0$  plane or a plane parallel to it. There's nothing sacrosanct about  $Z$ . Suppose our camera is a weather balloon (high, looking down parallel to the  $Y$  axis), and we want to project onto the  $Y = 0$  plane or a plane parallel to that.

(1) Give a matrix that does an orthographic projection onto  $Y = \text{near}$

(2) Give a matrix that does a perspective projection onto  $Y = \text{near}$