CSE 167 (FA 2022) Exercise 8 — Due 11/16/2022

Exercise 8.1 — 2 pts. In ray tracing, suppose we have a camera

- located at **eye position** = $\begin{bmatrix} -5 \\ 1 \\ 0 \end{bmatrix}$
- looking at **target** = $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$
- with **up vector** = $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$
- with **field of view**$_y$= 90°
- and an image resolution of **width**= 135 pixels and **height**= 90 pixels.

All positions are relative to a common world coordinate. At pixel $(i, j) = (82, 22)$, what is the ray $(\mathbf{p}_0, \mathbf{d})$ shooting through the center of the pixel? (Here, $\mathbf{p}_0 \in \mathbb{R}^3$ is the source point of the ray, and $\mathbf{d} \in \mathbb{R}^3$ is the unit vector for the direction of the ray; both in the world coordinate.)

Hint $\mathbf{p}_0$ *is trivial. For* $\mathbf{d}$*, see slides on "RayTracing," page 20 and page 26.* ∎

Exercise 8.2 — 2 pts. Suppose we have a triangle with its 3 vertex positions given by

$$\mathbf{p}_1 = \begin{bmatrix} 4 \\ 0 \\ 0 \end{bmatrix}, \quad \mathbf{p}_2 = \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix}, \quad \mathbf{p}_3 = \begin{bmatrix} 0 \\ 0 \\ 8 \end{bmatrix}. \tag{1}$$

Now, suppose we have a ray sourced at $\mathbf{p}_0 = \begin{bmatrix} -1 \\ 0 \\ 0 \end{bmatrix}$ with direction $\mathbf{d} = \begin{bmatrix} 2/3 \\ 1/3 \\ 2/3 \end{bmatrix}$. The ray will intersect with the triangle. What is the position $\mathbf{q} \in \mathbb{R}^3$ of this ray-triangle intersection? What is the distance t traveled by the ray (distance between the source and the intersection)? What are the barycentric coordinates $\lambda_1, \lambda_2, \lambda_3$ for $\mathbf{q}$ with respect to the triangle $\mathbf{p}_1\mathbf{p}_2\mathbf{p}_3$?

Hint *Follow page 36 of the slides on "RayTracing." You may use symbolic calculator like Wolfram Alpha for solving equations.* ∎