

Sample Test 2: Coordinates, 3D Transformations and Light

August 24, 2024

- State any simple, reasonable assumption used to arrive at your answer.
- A ‘yes’ or ‘no’ answer without reasoning is worth 0 points.
- Zero points if the writing is hard to decipher. Use a black pen if in doubt.
- Indicate with arrow if you use the back of the previous page (last page for page 1).

1 Basic Math

(a) Compute the reflection of $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$, across $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$.

(b) Compute the normal to the ellipsoid $\{x, y, z : x^2 + y^2 + 2z^2 = 4\}$ at the point $\begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$ on the ellipsoid.

2 Transformations

b. (2 points) Give a simple(st) 4×4 matrix that maps the line segment $\overline{\begin{bmatrix} 1 \\ 0 \end{bmatrix} \begin{bmatrix} 2 \\ 0 \end{bmatrix}}$ to the line segment $\overline{\begin{bmatrix} 1 \\ 0 \end{bmatrix} \begin{bmatrix} q \\ 0 \end{bmatrix}}$ of the same length. Clearly indicate your reasoning! What is q ?

c. (1 points) Give the quaternion operation for rotating the point $[x,y,z,2]$ by $\pi/2$ about the x -axis.

d. (1 points)
What is a 'vanishing point'?

3 Quaternion rotation and perspective

a. (2 points)

Give the quaternion operation for rotating the point $[x,y,z,2]$ by an angle $\alpha = 2\pi/6$ about the x -axis.

b. (1 points)

What is a 'vanishing point'?

4 Lighting

(4 points) Given is a white diffuse light source at $(0, 20, 0, 1)$, and a unit cube $(\pm 1, \pm 1, \pm 1)$ with vertex normals computed as the average of the surrounding face normals. The scene contains no ambient light (neither from the lighting model nor from the light) and there is no attenuation. Use Gouraud shading. Determine the rgb light intensity at the point $(0, 1, 0)$ of the cube. Why is this lighting model unsatisfactory?