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CS174A – Introduction to Computer Graphics
MIDTERM EXAM SPRING 2021
APRIL 29, 2021

1. Displays & Framebuffers

a. (4 points) What is meant by rasterization (or scan conversion) of a polygon?

b. (4 points) What are the 2 factors to consider while determining an algorithm for scan converting lines or polygons in CG?

c. (7 points) What is the role of Framebuffer in a CG system? What is the purpose of double-buffering?

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2. Vectors & Matrices

a. (8 points) Given a line by its 2 endpoints P_1P_2 and a point P, find the shortest distance between P and P_1P_2 using the method discussed in class.
$P_1 = (0,0,0)$; $P_2 = (1,1,1)$; $P = (0,0,1)$

b. (7 points) A plane passes through the following 3 points; find the equation of this plane by first finding its normal. What is the shortest distance of this plane from the origin?
$P_1 = (0,1,0)$; $P_2 = (0,0,1)$; $P_3 = (1,0,0)$

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3. Interpolations & Extrapolations

(12 points) Calculate the location of the 3D point based on the following interpolation; for each case, mention if the interpolation is linear, affine, or convex, and why.

$P_1 = (3,2,1)$; $P_2 = (4,1,0)$; $P = a_1 * P_1 + a_2 * P_2$

- **a.** $a_1 = -1$, $a_2 = 3$
- **b.** $a_1 = 1.3$, $a_2 = -0.3$
- **c.** $a_1 = 0.2$, $a_2 = 0.8$

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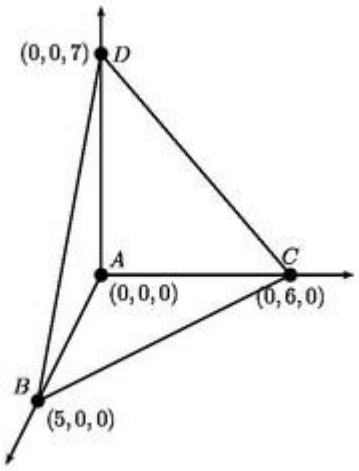
4. Polygons & Polyhedrons

a. (5 points) Explain one issue with using concave polygons in CG

b. (10 points) Given the following tetrahedron, write out an indexed data structure to list out the vertices and polygons (use right-hand coordinate system)



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5. Homogeneous Representation

- **a.** (4 points) Why do we need homogeneous representation of points and vectors?
- **b.** (2 points) Given the following vector in 3D, convert it into its homogeneous representation
  V = (2,3,1)
- **c.** (2 points) Given the following homogeneous point, convert it to Cartesian representation
  P = (6,2,1,0.5)

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6. Viewing

(15 points) Using the following camera parameters in WS (world space), derive the 4x4 homogeneous components of the Eye Matrix needed to transform points from WS to ES (eye space), using the change-of-basis discussed in class. Do not multiply the matrices.

Eye location = (1,1,1); COI = (0,0,0); Top Point = (0,1,0)

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7. Viewing

a. (5 points) What parameters are needed to form non-square perspective projection matrix?

b. (5 points) Prove (with the help of a diagram) that the pers projection of a 3D point (x,y,z) onto the plane z=d is given by $(\frac{x}{z}d, \frac{y}{z}d, d)$

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8. Projections and Viewing

a. (5 points) What is canonical view volume? What are its dimensions (as discussed in class) and why do we need it?

b. (5 points) What is the canonical parallel projection matrix used for mapping a point in eye space to a point in projection space, for a view volume (in eye space) given by $-W/2 \leq X \leq W/2$, $-H/2 \leq Y \leq H/2$, $N \leq Z \leq F$

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