

Name: \_\_\_\_\_ Student ID: \_\_\_\_\_

You have 2.5 hours to complete the exam. Write your answers in the spaces provided.

No aids (books, notes, calculators, mobile phones, PDAs, telepathic transmitters, music players, other electronic devices, etc.) are permitted.

1) How can you test if a 2D point  $(x, y)$  is inside a triangle with vertices  $(x_0, y_0)$ ,  $(x_1, y_1)$  and  $(x_2, y_2)$ ?

2) Take the barycentric coordinates  $(\alpha, \beta, \gamma)$  of a point  $\vec{x}$  with respect to a triangle with vertices  $\vec{x}_0$ ,  $\vec{x}_1$  and  $\vec{x}_2$ . If  $\gamma < 0$ , what side of the line through  $\vec{x}_0$  and  $\vec{x}_1$  is  $\vec{x}$  on?

3) Give an explicit, parametric formula describing a sphere with centre  $\vec{c}$  and radius  $r$ .

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- 4) Describe the notion of field-of-view in terms of a view volume. (a diagram would help!)
- 5) How do we implement the perspective z-divide using homogenous coordinates?
- 6) Given a point with camera-space coordinates  $(x, y, z)$ , and a perspective view frustum with the usual left, right, bottom, top, near and far bounds, work out where it maps to in an image with dimensions  $M \times N$ .

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7) Construct a model-view matrix for a camera at world-space location  $(-2, 0, -2)$  looking at the world-space origin.

8) How do you map a vertex normal under an affine transformation given by a  $4 \times 4$  matrix  $M$ ?

9) What is back-face culling, and how is it implemented at the rasterization stage of Z-buffer rendering?

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10) Write down a general formula for describing a plane, and then a test to see if a ray with origin  $\vec{x}_0$  and direction  $\vec{d}$  intersects the plane.

11) Say you are given a BVH made of axis-aligned bounding boxes around a collection of spheres. Write efficient recursive pseudocode for checking a point  $\vec{x}$  is inside any of the spheres.

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12) Describe a way that a BVH can be used to accelerate Z-buffer rendering.

13) Give a formula for computing the signed volume of a tetrahedron with vertices  $\vec{x}_0$ ,  $\vec{x}_1$ ,  $\vec{x}_2$  and  $\vec{x}_3$ .

14) Name an effect produced by real physical cameras, and describe how path-tracing can capture it.

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15) How do you compute the gathered light at a point for diffuse (Lambertian) shading in a raytracer?

16) Can shadows be cast on mirror surfaces? Explain.

17) What is the point of specifying surface normals at the vertices of a triangle mesh, where geometrically they are not well-defined?

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18) Name and describe a shading effect that BRDF's cannot describe.

19) How do mipmaps deal with the minification problem?

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20) What is aliasing?

21) What should the colour stored in the  $1 \times 1$  image in a mipmap be, in terms of the original image?

22) Why is biology involved in calibrating two different colour displays?