- What are the two main high-level algorithms for rendering in graphics? Describe each algorithms approach in terms of pseudocode at a high level. How do they differ?

- Is a pixel a little square? If not, what is it? What implications does this have? Give at least 2.

- Explain the difference between an LED and OLED display.

- What is the lerp function? How do you perform bilinear interpolation? Express bilinear interpolation in terms of the linear interpolation function lerp().

- What is aliasing? Give an example of spatial aliasing in an image. Give an example of temporal aliasing.

- What are the two main strategies used to address aliasing?

- What is gamma correction and why do you need to perform gamma correction on an image?

- How is transparency handled in images?

- How do you compute the image gradient magnitude? What does it tell you about an image? How can you get smooth image gradients?

- Provide a concise formula for computing the Gaussian blur of 1D image.

- What is luma? How do you compute it?

- What is tone mapping? Why is it needed?

- Describe an algorithm for computing HDR bloom.

- What are the 3 main classes of color receptors in our eyes? How do they differ?

- How do you compute the area of a 3D triangle specified by vertices A, B, and C?

- Given a point p on the same plane of a triangle specified by 3D vertices a, b, and c. Describe in detail how you would test if p is within the triangle or not. Explain what the key insight of this test is.

- What does a vertex shader do? Describe in detail.

- What does a fragment shader do? Describe in detail.

- What is a scene graph? Given a scene graph, describe the transformations needed to move an object in the leaf.

- Provide the pseudo-code for drawing from a scene graph. Assume the graph is specified using vertices and children node pointers.

- Give an algorithm to convert a polygonal mesh to triangle mesh.

- Give an example of a 2-manifold triangle mesh. Give an example a triangle mesh that is not 2-manifold.

- Give an example of a mesh that cannot be consistently oriented. Explain why it can't be consistently oriented.

- How are vertex normals interpolated along the face of a triangle mesh?

- Given a face-vertex mesh, write a detailed algorithm (pseudocode only) for computing vertex normals.
- What are the main components of Phong shading?

- In a drawing, illustrate all of the main vectors needed for phong shading.

- Given a vector pointing in the direction s. Explain in detail how the reflection direction can be derived.

- How is Phong shading computed at a single point on a triangle?

- Give an algorithm to compute the geodesic distance on a triangle mesh.

- What is needed to apply a 2D texture on an image? How is the color of a pixel in the middle of a triangle computed using a texture map?

- Give 3 approaches to determining the UV coordinates of a texture on a mesh.

- What parts of phong shading can be modified by a texture?

- Give a rotation matrix for rotation about the y-axis.

- How can we represent translation using a matrix vector multiplication (in 2D and 3D)?

- How do you compute an orthonormal basis from two vectors a and b?

- Express rotation about an arbitrary vector in terms of 3 matrix multiplications.

- Why is the normal matrix needed? How is it computed?

- Why is it better to expression rotations in terms of quaternions?

- What rotation does the conjugate quaternion represent?

- Express the euler rotations, thetax, thetay, and thetaz, in terms of quaternions.

- What does a quaternion q multiplied by it's conjugate equal?

- What does SLERP allow you to do?

- What is the model matrix used for?

- How does perspective projection differ from orthographic projection?

- What is a view frustum?

- What is the view transformation do?

- Describe in a diagram how a camera coordinate system can be built using a look center, a look up direction, and a camera position.

- What direction is the camera pointing in view space and where is it positioned?

- How do you construct a view transformation using the camera coordinate system?

- What space is Phong shading performed in?

- What are the main parameters of perspective transformation? What do they do?
- Derive how the distance to the view plane is computed using field of view.

- Given a point \((x, y, z)\), how do we compute its projected position on the view plane?

- What is the viewport transformation?

- Draw a diagram that shows what the model, view, and projection transformation do.

- Give a simple algorithm for drawing a triangle on an image.

- What is the painter's algorithm? Give an example of geometry where the painter's algorithm would fail.

- Sketch the z-buffer algorithm.

- How does the z-buffer fail to detail with transparency. Give an algorithm that fixes this limitation.

- Draw a diagram that describes how the shadow mapping algorithm works.

- Describe via a diagram how inter-reflections can be obtained from cube mapping.

- What is refraction? How can it be used with cube mapping?

- What is the conversion formula from an image coordinate \((x_i, y_i)\) to a normalized device coordinate on the OpenGL viewport \((x_v, y_v)\)?

- How do you cast a ray from perspective camera specified by a y-field of view, a camera quaternion, and aspect ratio?

- Derive ray-sphere intersection.

- Describe 2 different algorithms to perform ray-triangle intersection. Explain how they differ conceptually.

- How is instancing performed in ray-tracing?

- Construct a bounding volume hierarchy over a given set of 2D geometry.

- What is the surface area heuristic?

- How do \(kd\)-trees differ from bounding volume hierarchies? Give an example of where one method might perform better than the other?

- Give the pseudo-code for intersecting a ray and a set of triangles using a constructed BVH.

- How can you avoid self-intersections in ray-tracing?

- How can soft shadows and glossy surfaces be generated in ray-tracing?

- Give an algorithm for anti-aliasing by ray-traced images?

- Give 3 examples of lighting effects possible using a global illumination rendering algorithm.

- What is radiance and irradiance?

- Describe the high-level Monte-Carlo path-tracing algorithm.
- What are the main limitations of triangle meshes? How do parametric surface patches address these limitations? How do subdivision surfaces address these limitations?

- What are the main types of continuity for splines?

- What additional features do NURBS have over standard B-splines?

- What types of meshes does Loop Subdivision and Catmull-Clark subdivision operate on?

- What must happen to parametric surfaces before they're displayed? How can you use a GPU to handle this?