



THE UNIVERSITY OF
**WESTERN
AUSTRALIA**

SEMESTER 1, 2020 EXAMINATIONS

CITS 3003
Graphics and Animation

Physics, Mathematics & Computing
EMS

This paper contains: 5 Pages **(including title page)**

Time Allowed: **2:00** hours

INSTRUCTIONS

Solve the questions on your own papers. For each answer, clearly specify the Question Number. For MCQs and True/False questions, write the correct choice as 'A', 'B', 'C', 'D', and 'True', 'False'.

THIS IS A CLOSED BOOK EXAMINATION

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1. What does 'field of view' of a camera mean? [2 points].

Is it advisable to use a pinhole camera if you need a camera with adjustable field of view? Justify your answer with a reason [2 points].

(Total 4 points)

2. Both `glUniform3f` and `glUniform2i` perform the same logical function but use different parameter types. What does this indicate about the 'object orientation' of OpenGL [2 points].

Based on the format of OpenGL functions, what three properties of `glUniform2i` can you state? [3 points].

(Total 5 points)

3. OpenGL adopts a 'pipeline' architecture. Consider 'vertex processor' as the first component of this pipeline. What are the next three components in the correct order? [1.5 marks]. State two major functions of vertex processor [2 points]. What is the major benefit of pipeline architecture? Explain with an example [2.5 points].

(Total 6 points)

4. Transformations to vertices can be applied in both application program (using C++ code) and shaders (using GLSL). What is more preferred between these two options and why? [3 points].

(Total 3 points)

5. What do you understand by the terms 'simple', 'convex' and 'flat' as properties of polygons? [3 points].

Indicate which of the following polygons do not possess at least one of these properties, and which property is that: right-angle triangle, equilateral triangle, perfect square, perfect pentagon, regular star shape [2 points].

(Total 5 points)

6. Assume that you are introducing two qualifiers Alpha and Omega in GLSL. You want to use Alpha to mark a parameter as read-only when a function is declared. Similarly, you want Omega to mark a parameter as write-only when a function is declared. Which original GLSL qualifiers can you replace with Alpha and Omega in the vertex shader? [2 points].

Describe 'uniform' qualifier by discussing its purpose, scope and the ability of parameters to change their values [5 points].

(Total 7 points)

7. You have encountered a vertex shader code written in GLSL. What do you understand with each of the following statements in the code: (i) `#version 150` (ii) `in vec4 vPos;` (iii) `out vec4 color;` (iv) `gl_Position = vPos` [4 points].

For this vertex shader you are not able to find an explicit statement declaring `gl_Position`, but the execution does not return any error. What is the reason for that? [2 points].

In the application program that uses this vertex shader, you have encountered the following statement `'alpha = glGetAttribLocation(program, "vPosition")'` in the function `init()`. Based only on the provided information, do you think that this statement is correct? If yes, why? If no, what is the problem and what will be the correct statement? [3 points].

(Total 9 points)

8. Consider a three-dimensional vector space. Your friend says that he has found four linearly independent vectors in that space and is confused which three of those he can use as a basis to define coordinates? Write the definitions of 'dimension' [2 points] and 'basis' [2 points].

Considering those definitions, mention what is wrong with your friend's statement [2 points].

(Total 6 points)

9. Let R be a standard 4×4 rotation matrix defined for homogeneous coordinates. Using it to rotate a point about z-axis will require it to have two rows having only '0' and '1' in them, which rows will they be? [2 points].

(Total 2 points)

10. You have written a function that expects as input the value of 'theta' (angle of rotation) and returns the 4×4 rotation matrix R for the homogeneous coordinate frame. How can you use the same function to compute inverse of the computed rotation matrix? [2 points].

(Total 2 points)

11. What is event mode programming and callback? [8 points].

(Total 8 points)

12. Give three examples of different events in event mode programming. That is, state the event name and the condition that makes the event occur [3 points].

(Total 3 points)

13. What is a viewport? [3 points]. For what purpose can it be used? [4 points].

(Total 7 points)

14. What is the difference between orthographic projection and perspective projection in terms of camera focal length? [2 points].

To adjust your camera, you decided to first rotate it along y-axis with R_y , then rotate it along x-axis with R_x and then translate it with T . How can you construct your model view matrix C using R_x , R_y and T ? write the equation [2 points].

(Total 4 points)

15. Surface normals are essential for shading models. Assume that you have a perfect sphere, with implicit representation $f(x,y,z) = 0$ and you must compute a normal vector over its surface at point 'p'. Describe in plain text (no equations) how can you achieve this? [2 points].

Assume that the same sphere has a parametric representation $x = \cos(u)\sin(v)$, $y = \cos(u)\cos(v)$, $z = \sin(u)$. How can you compute the normal at 'p' using the parameters 'u' and 'v'? State in plain text (no equation) [2 points].

(Total 4 points)

16. What are quaternions? [3 points]. What advantages they have over transformation matrices? [7 points], and which functionalities of transformation matrices cannot be performed by quaternions? [3 points].

(Total 13 points)

17. What is gimbal lock problem? [2 points].

(Total 2 points)

18. To get good triangles for rendering we should try to maximize the largest interior angle of the triangles.

(Total 1 point)

- A. True
- B. False

19. Both 'rigid' and 'similarity' transform can preserve angles and lengths.

(Total 1 point)

- A. True
- B. False

20. Skinning will be required to correctly animate a body made of rigid cylinders only.

(Total 1 point)

- A. True
- B. False

21. Select two correct statements

(Total 1 point)

- A. Similarity transformation has 6 degrees of freedom.
- B. Rigid transformation has 6 degrees of freedom.
- C. Affine transformation has 7 degrees of freedom.
- D. Affine transformation has 12 degrees of freedom.

22. Select the correct statement

(Total 1 point)

- A. Flat shading is more suitable when viewer is close to the polygon being shaded.
- B. Gouraud shading is also known as per-vertex shading.
- C. Gouraud shading is computationally more expensive than Phong Shading.
- D. Phong shading interpolates vertex intensities to get the polygon intensity.

23. You would like to use Gouraud shading, select the best choice for that

(Total 1 point)

- A. The code should be implemented in vertex shader.
- B. The code should be implemented in fragment shader.
- C. The code must be implemented in both vertex and fragment shaders.
- D. The code should be implemented in the application program.

24. Due to the same pipeline for geometry and images in OpenGL, it is preferred to use simpler textures to avoid making geometry more complex.

(Total 1 point)

- A. True
- B. False

25. Select all the correct statements

(Total 1 point)

- A. For mapping texture to geometry, resolution of both must match.
- B. For texture sampling, linear filtering uses the value of the texel that is closest to the texture coordinates output by rasterizer.
- C. Mipmapping can help in reducing interpolation error for small textured objects.
- D. Textures are applied during fragment shading.

26. For a subdivision surface technique in 3D modelling, which property is desirable in generating smooth surfaces from a control mesh?

(Total 1 point)

- A. An original point should affect a large part of the surface.
- B. The surface normal never changes suddenly.
- C. The second derivative is never continuous.
- D. The first derivative is always discontinuous.

27. Select the correct statement in the context of hierarchical modelling.

(Total 1 point)

- A. Symbol-instance table is a good way to show relationship between the parts of a model.
- B. In 'trees', each node can have at most one parent.
- C. It is not possible to specify an instance appearance of an articulated model by giving all joint angles.
- D. For tree traversal, visiting each node multiple times in each traversal is preferred.