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**Semester I exam Examination - 2021/2022**

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**School of Computer Science**

**COMP 3033J Computer Graphics**

Assoc Prof Chris Bleakley

Asst Prof Abraham Campbell

**Time Allowed: 120 minutes**

**Instructions for Candidates**

All questions carry equal marks. The distribution of marks in the right margin shown as a percentage gives an approximate indication of the relative importance of each part of the question.

**Answer the 4 Mandatory Questions and 4 Optional Questions**

**BJUT Student ID: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ UCD Student ID: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

I have read and clearly understand the Examination Rules of both Beijing University of Technology and University College Dublin. I am aware of the Punishment for Violating the Rules of Beijing University of Technology and/or University College Dublin. I hereby promise to abide by the relevant rules and regulations by not giving or receiving any help during the exam. If caught violating the rules, I accept the punishment thereof.

**Honesty Pledge：\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Signature)**

**Instructions for Invigilators**

Non-programmable calculators are permitted.

No rough-work paper is to be provided for candidates.

**Part 1: Mandatory Questions: Answer all questions**

**Question 1:**

1. What is the **Painter’s Algorithm** and what does it do? When does it break down?

**(4 marks)**

1. Describe the concept of **Alberti’s Window**

**(4 marks)**

1. Discuss how you would define a **View Frustum** and sketch an example

**(4.5 marks)**

**Question 2:**

1. What is the difference between **Modal** and **Non-Modal** interfaces?

**(5 marks)**

1. Describe with the use of diagram the **visual hierarchy** of a widget for example that is acting as a printer dialog window?

**(4 marks)**

1. How does an **event loop** aid in creating **a Non-Modal** interface? Give an example of an event loop for a computer game to illustrate your point.

**(3.5 marks)**

**Question 3:**

1. What is **inverse kinematics** and how can simulation support animation in general?

**(4 marks)**

1. How do **glPush()** and **glPop()** methods support animation in OpenGL?

**(3.5 marks)**

1. Sketch a suitable **animation hierarchy** for a Horse .

**(5 marks)**

**Question 4:**

1. What is the difference between **C0** and **C1** **continuous line** , and sketch an example of a curve that is continuous but not smooth

**(5.5 marks)**

1. Sketch an example of a curve that is **C∞**

**(2 marks)**

1. Describe and write pseudocode for the **de Castljau** algorithm

**(5 marks)**

**Part 2: Optional Questions / Choose 4 out of 6**

**Question 5:**

1. What is **CMYK Colour Space**?

**(3 marks)**

1. What is the **Phong model** of Lighting?

**(7 marks)**

1. How and why is surface normal as well as the eye position used to compute **specular reflections**?

**(2.5 marks)**

**Question 6:**

1. Please write out a **4x4 Homogeneous Matrix**, marking where in the matrix, the following operations would act upon
   1. Perspective operations
   2. Translational operations
   3. Rotational operations

**(4 marks)**

1. Explain what the follow **transformation operations** would do in as much detail as you can

**(4.5 marks)**

1. **Homogeneous coordinates** are defined as (x,y,z,w) , if you had a point P at (24,12,7,3) and changed the “w” component from 3 to 10, what would be the corresponding change to other points if we wanted the point P to still refer to the same point in 3D space

**(4 marks)**

**Question 7:**

1. Describe and write pseudocode for the generating a **Tetrahedron** in **OpenGL**

**(6 marks)**

1. What **geometric objects** would you use to model a rocket ship

**(3 marks)**

1. How would you calculate the **normal** for each face of a **Tetrahedron**?

**(3.5 marks)**

**Question 8:**

1. Give pseudocode for the **Bresenham’s Algorithm** to draw a line

**(3 marks)**

1. What is the **half-plane test**, give a diagram , and explain how it can be used for rendering a triangle

**(3.5 marks)**

1. Give pseudocode for a **Line-Circle Intersection**

**(6 marks)**

**Question 9:**

1. Describe **Ray Tracing** as a technique to generate computer graphics.

**(5 marks)**

1. What is **Hybrid Rendering**?

**(4 marks)**

1. Can Ray Tracing be used in **real time graphics engines** and if not why?

**(3.5 marks)**

**Question 10:**

1. Describe the **six standard coordinate systems** that are commonly used in projective rendering and name **three of the matrices** involved.

**(6 marks)**

1. Answer the following **linear algebra** **questions**.
2. Given Vector u=[3,2,1] and Vector v = [1,4,5], compute a vector perpendicular to both u and v.
3. Given Vector u=[3,4] and Vector v = [-8,6], compute the angle between these two vectors.
4. What is the Normalized Vector of Vector w = [1,2,2] ?

**(4.5 marks)**

1. What is an **Orthonormal Basis**?

**(2 marks)**