**Xi'an Jiaotong-Liverpool University**

西交利物浦大學

| Paper CODE | EXAMINER | DEPARTMENT | TEL |
|---|---|---|---|
| CPT205 | | Computing | |

**1st SEMESTER 2022/23 RESIT EXAMINATION**

**Undergraduate – Year 3**

# COMPUTER GRAPHICS

**TIME ALLOWED: 2 Hours**

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## INSTRUCTIONS TO CANDIDATES

1. **This is a closed-book examination, which is to be written without books or notes.**
2. **Total marks available are 100.**
3. **Answer ALL questions in this examination. It is not necessary to copy the questions into the answer booklet.**
4. **Answers should be written in the answer booklet(s) provided.**
5. **Only solutions in English are accepted.**
6. **All materials must be returned to the exam invigilator upon completion of the exam. Failure to do so will be deemed academic misconduct and will be dealt with accordingly.**

## Question 1. Fundamentals [Total 20 marks]

1.1. Give a brief definition of computer graphics. [2 marks]

1.2. What is a framebuffer used for computer graphics? [2 marks]

1.3. List four output devices for a graphics system? [2 marks]

1.4. Graphics packages use a fourth 'colour co-ordinate', A or alpha (in addition to Red, Green and Blue). What does it do? [2 marks]

1.5. List at least four key areas of computer graphics? [2 marks]

1.6. A straight line is represented as $ax + by + c = 0$. Work out its slope. [2 marks]

1.7. Calculate the magnitude of vector $3\mathbf{i} - 4\mathbf{j}$. [2 marks]

1.8. What value would normally be assigned to the homogeneous parameter in computer graphics, and why? [2 marks]

1.9. How can an object in 2D space be mirrored about the x-axis? [2 marks]

1.10. What would the following fragment of code do? [2 marks]

```
int x = x0, y = y0;
while (x <= x1)
do {
    DrawPoint(x,y);
    x = x + 1;
}
```

## Question 2. Generation of geometry and transformations

**[Total 20 marks]**

2.1. Show that you understand the DDA (Digital Differential Analyser) algorithm for drawing straight-lines by using it to calculate the pixel positions for a line in 2D with end-points $p_1(6,5)$ and $p_2(16,1)$. Alternatively, a diagram can be plotted to demonstrate the result. [8 marks]

2.2. Describe the three main types of transformation. 2D space and diagrams can be used in your answer. [9 marks]

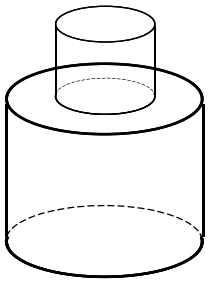
2.3. Transformation products are not always commutative (e.g. given two transformations **A** and **B**, $\mathbf{A}\cdot\mathbf{B} \neq \mathbf{B}\cdot\mathbf{A}$). For each of following two cases, decide if it is true or false (write your answer in the answer book provided). [3 marks]

| | **A** | **B** |
|---|---|---|
| 1 | Translation in 2D | Rotation in 2D about the origin |
| 2 | Rotation in 2D about the origin | Rotation in 2D about the origin |

## Question 3. 3D Modelling and viewing [Total 20 marks]

3.1. Describe Constructive Solid Geometry (CSG) modelling, including its advantages and disadvantages. Diagrams can be used in your answer. [7 marks]

3.2. Identify if the following object is a manifold object using Euler's law. [5 marks]



3.3. Briefly describe and compare orthogonal and perspective projections. [8 marks]

## Question 4. Lighting and texture mapping [Total 20 marks]

4.1. The following OpenGL code defines a light source: [6 marks]

```
GLfloat light_position[] = {20.0, 20.0, 1.0, 1.0};
glLightfv(GL_LIGHT0, GL_POSITION, light_position);
```

a) What kind of light source is specified?
b) What does **glLightfv()** do?
c) If transformations are applied to the light source, will the model-view matrix or projection matrix mode be used and why?

4.2. Show the combined effect of two light sources (1.0, 0.5, 0.1) and (0.3, 0.5, 0.2), that are applied to a scene. [4 marks]

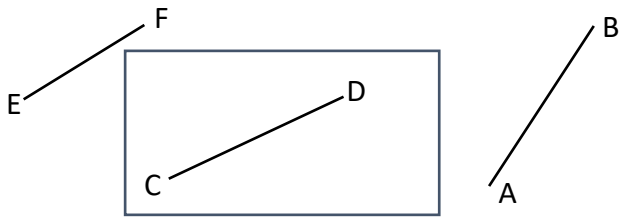
4.3. Answer the following questions related to texture mapping. [10 marks]

a) Briefly describe the concept of texture mapping.
b) An image of 400*600 pixels is to be mapped onto a display screen of 800*600 pixels. Explain how the mapping could be implemented, and whether this case is magnification or minification.

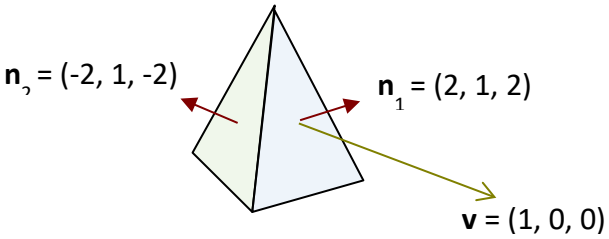
## Question 5. Texture mapping and clipping [Total 20 marks]

5.1. Provide your answer to the following three questions about the Cohen-Sutherland line clipping algorithm. Diagrams can be used in your answer. [10 marks]

a) Taking 2D space as an example, explain how the space is divided with outcodes.
b) Explain how the Cohen-Sutherland algorithm could be extended from 2D to 3D space.
c) The following figure shows three lines and a rectangular clipping window. Describe the steps of clip that the Cohen-Sutherland algorithm would perform for each of these lines.




5.2. The following figure shows two polygons with respect to the observer. Determine if any of these two faces would be visible using vectors for the face normal and viewing direction shown in the figure. [6 marks]




5.3. Using OpenGL, what will happen when **glEnable(GL_CULL_FACE)** is called but not **glCullFace()**, and why? [4 marks]

**THIS IS THE END OF THE EXAM.**