



Xi'an Jiaotong-Liverpool University

西交利物浦大学

PAPER CODE	EXAMINER	DEPARTMENT	TEL
CPT205		Computing	

1st SEMESTER 2024/25 FINAL EXAMINATION**Undergraduate – Year 3****COMPUTER GRAPHICS****TIME ALLOWED: 2 Hours****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. There is NO penalty for providing a wrong answer.
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. List four application areas of computer graphics. [2 marks]
- 1.2. Give two factors that affect image quality in computer graphics. [2 marks]
- 1.3. Briefly explain the concept of texel in computer graphics. [2 marks]
- 1.4. How is screen resolution defined in computer graphics? [2 marks]
- 1.5. Is there any restriction to the value assigned to the homogeneous parameter used in homogeneous co-ordinates? [2 marks]
- 1.6. What is the inverse of a matrix? [2 marks]
- 1.7. Given two lines AB specified by A(6,1) and B(8,4), and CD specified by C(3,5) and D(6,3), work out the angle between them. [2 marks]
- 1.8. Use an example to explain a parametric representation of a curve. [2 marks]
- 1.9. An object in a 2D space is transformed by a translation followed by a rotation. Will the result be the same if the order of the two transformations is swapped? [2 marks]
- 1.10. What will the function `glColor3f(0.0, 0.0, 1.0)` in OpenGL do? [2 marks]

**Question 2. Transformations and viewing****[Total 20 marks]**

2.1. Briefly answer the following questions about transformations. [6 marks]

- (1) What are the roles of Modelling Transformation, Viewing Transformation, and Projection Transformation?
- (2) What does the OpenGL function `glMatrixMode()` do?

2.2. Briefly answer the following questions about homogeneous co-ordinates. [4 marks]

- (1) What are homogeneous co-ordinates?
- (2) What are the Cartesian co-ordinates corresponding to the homogeneous space point $P(x, y, z, w)$?

2.3. Given a triangle A (-50, 50, 0), B (-50, 0, 0), C (0, 0, 0), rotate it by 90 degrees **anticlockwise** about an axis (0, 0, 1) at point B as a fixed point. [10 marks]

- (1) Write out the transformation process using homogeneous coordinate matrices, without calculating the final result (i.e., as a product of several simpler matrices).
- (2) Provide the OpenGL code snippet for the implementation.

**Question 3. Geometric creation and modelling****[Total 20 marks]**

- 3.1. Give at least four requirements for generating an ideal discrete straight line. [4 marks]
- 3.2. Explain why fitting a single polynomial through a set of interpolation points is unlikely to produce a satisfactory result for computer graphics. [4 marks]
- 3.3. Explain boundary representation (B-Rep), including its main advantages. A diagram can be used to aid your answer. [6 marks]
- 3.4. Briefly explain line by line what the following fragment of code does. [6 marks]

```
void figure() {  
    glPushMatrix();  
    torso();  
    glTranslatef();  
    glRotate3();  
    head();  
    glPopMatrix();  
    glPushMatrix();  
    glTranslatef();  
    glRotate3();  
    left_upper_leg();  
    glTranslatef();  
    glRotate3();  
    left_lower_leg();  
    glPopMatrix();  
    ...;  
}
```

**Question 4. Lighting, materials and texture mapping [Total 20 marks]**

4.1. Answer the following questions about lighting and materials. [8 marks]

- (1) Briefly describe what a lighting model and materials are.
- (2) List and briefly explain 3 common types of light sources.
- (3) List and briefly explain 3 common material properties.

4.2. Briefly explain the steps for texture mapping in OpenGL. [6 marks]

4.3. Answer the following questions about texture mapping. [6 marks]

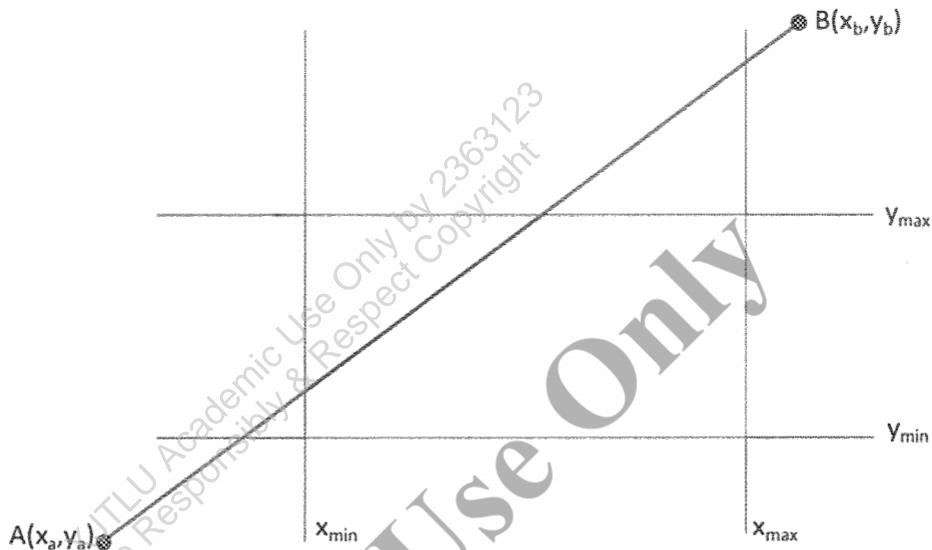
- (1) In the magnification and minification processes, what operation is used to map texels to pixels?
- (2) How can you set texture parameters in OpenGL to map a **2D texture** using **magnification** with the **nearest-neighbor** operation?



Question 5. Clipping and hidden surface removal

[Total 20 marks]

- 5.1. Given the clipping window defined by the four boundaries and line AB defined with A(x_a, y_a) and B(x_b, y_b) shown in the figure below, apply the Cohen-Sutherland line clipping algorithm to clip the line segment. Explain the minimum and maximum numbers of clips needed by carefully showing each clip. Diagrams can be used to aid your answer. [10 marks]



- 5.2. Answer the following questions about *back-face culling* for hidden-surface removal. Diagrams can be used to aid your answer. [10 marks]

- (1) Describe how it works.
- (2) Explain why it is implemented.
- (3) Explain the limitations of back-face culling.
- (4) Explain what will happen if `glEnable(GL_CULL_FACE)` is called to enable face culling without explicitly calling `glCullFace()` in OpenGL.

THIS IS THE END OF THE EXAM.