



Xi'an Jiaotong-Liverpool University

西交利物浦大學

**Department of Computer Science and Software Engineering**

**Semester 1  
2018-19**

**CSE209 Computer Graphics**

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**for Year 3 students**

**Examiner:**

**Instructions to Candidates:**

- 1) Total time allowed: Two hours.**
- 2) Total marks available: 100 (worth 70% of the overall module assessment).**
- 3) Answer ALL questions in the booklet provided.**

**THIS PAPER IS NOT TO BE REMOVED FROM THE EXAM ROOM.**

**Question 1. Fundamentals**

**[Total 20 marks]**

- 1.1. List 4 main topics of computer graphics. [2 marks]
- 1.2. Why is a framebuffer used for computer graphics? [2 marks]
- 1.3. How many colours can a pixel have in a PseudoColour (i.e. 8-bit) framebuffer? [2 marks]
- 1.4. 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]
- 1.5. List 2 factors that affect image quality. [2 marks]
- 1.6. What is the inverse of a matrix? [2 marks]
- 1.7. Use an example to explain a parametric representation of a curve. [2 marks]
- 1.8. Which of the following statements about polygons is false? [2 marks]
- (a) a polygon can have one face;
  - (b) a polygon can be filled;
  - (c) a polygon must be convex;
  - (d) a polygon must have at least 3 vertices.
- 1.9. What OpenGL function defines black colour for the display background? [2 marks]
- 1.10. When a viewing plane is behind the projection reference, what will happen with the objects in the scene? [2 marks]

## Question 2. Generation of geometry and modelling

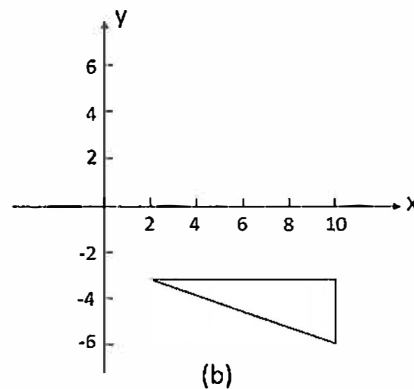
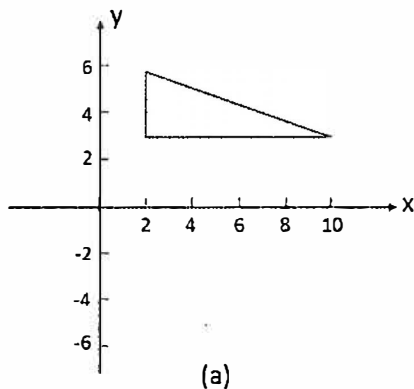
[Total 20 marks]

- 2.1. Discuss how symmetry of a circle can be used to reduce the amount of computation for generating the full circle, using diagrams where necessary. [8 marks]
- 2.2. Explain briefly the concept of a spline. [4 marks]
- 2.3. Briefly describe the boundary representation (B-Rep) model and the two types of B-Rep model. Diagrams can be used to aid your explanation. [8 marks]

## Question 3. Transformations and viewing

[Total 20 marks]

- 3.1. Briefly explain the transformation pipeline including each of the stages. A diagram can be used to aid your explanation. [6 marks]
- 3.2. The 2D object in Figure (a) below is to be transformed to the position shown in Figure (b). Describe the steps needed and show the transformation matrices for each step; work out the combined transformation matrix. [8 marks]



- 3.3. Briefly explain what the following fragment of code would do. [6 marks]

```
void init(void) {  
    glClearColor(0.0, 1.0, 0.0, 1.0);  
  
    glMatrixMode(GL_MODELVIEW);  
    gluLookAt(100, 50, 50, 50, 50, 0, 0, 1, 0);  
  
    glMatrixMode(GL_PROJECTION);  
    glFrustum(-40, 40, -60, 60, -40, 60);  
}
```

#### Question 4. Lighting and texture mapping

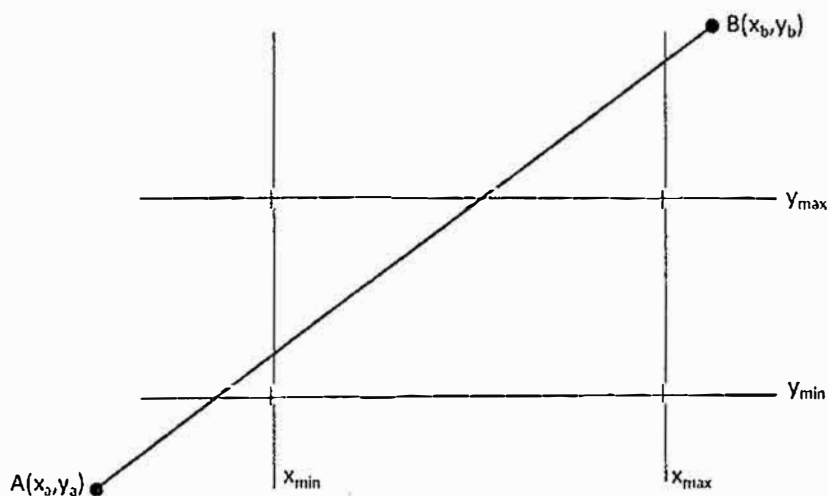
[Total 20 marks]

- 4.1. Briefly discuss the concepts of lighting, lighting model and Phong model in computer graphics. [6 marks]
- 4.2. Work out the combined lighting effect of two light sources, L1 (0.4, 0.6, 0.0) and L2 (0.5, 0.5, 0.0), that are applied to a scene. [4 marks]
- 4.3. What is texture mapping and why is it needed? A photograph of 1600\*1200 pixels is to be mapped onto a display screen of 800\*600. Explain how the mapping could be implemented, and what term would this case be called. [10 marks]

#### Question 5. Clipping and hidden-surface removal

[Total 20 marks]

- 5.1. Answer the following questions about **back-face culling** for hidden-surface removal. Diagrams can be used to aid your explanation. [10 marks]
- a) Describe how and why it is implemented.
  - b) Explain the limitations of back-face culling.
  - c) What will happen if `glEnable(GL_CULL_FACE)` is called to enable face culling without explicitly calling `glCullFace()` in OpenGL.
- 5.2. Given the clipping window defined by the four boundaries shown in the figure below, apply the Cohen-Sutherland line clipping algorithm to the line segment with endpoints  $A(x_a, y_a)$  and  $B(x_b, y_b)$ . Show carefully each step in applying the algorithm. [10 marks]



THIS IS THE END OF THE EXAM.