Xi'an Jiaotong-Liverpool University
西交利物浦大學

Paper CODE	EXAMINER	DEPARTMENT	TEL
CPT205		Computing	

1st SEMESTER 2024/25 RESIT 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 three types of transformations used in computer graphics. [2 marks]

1.2. List at least 2 output devices used with computer graphics applications. [2 marks]

1.3. What is a framebuffer used in computer graphics? [2 marks]

1.4. What value would normally be assigned to the homogeneous parameter used in homogeneous co-ordinates and why? [2 marks]

1.5. Work out the unit vector of $\mathbf{V_1} = 3\mathbf{i} - 2\mathbf{j} + 6\mathbf{k}$. [2 marks]

1.6. Given two matrices, $\mathbf{A} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ and $\mathbf{B} = \begin{bmatrix} 4 & 5 & 6 \end{bmatrix}$, determine if they can be multiplied as **A*B** and if so, the dimensions of the resultant matrix. [2 marks]

1.7. Given line AB specified by A(8,1) and B(12,4), work out its gradient and length. [2 marks]

1.8. How could a 2D triangle be mirrored about the co-ordinate origin? [2 marks]

1.9. An object in a 2D space is transformed by two translations. Will the result be the same if the order of the two translations is swapped? [2 marks]

1.10. What will the function **glClearColor(1, 1, 1, 1)** in OpenGL do? [2 marks]

Question 2. Transformations and viewing [Total 20 marks]

2.1. Briefly explain the 5 standard transformations. Diagrams can be used to aid your answer. [5 marks]

2.2. Answer the following questions about projection in computer graphics. [5 marks]

(1) What projection is typically used to create lifelike scenes as seen by the human eye?
(2) In engineering drawings, what projection method is used to accurately represent the structure of objects?
(3) What functions in OpenGL are called to construct different projection methods?

2.3. Give examples to explain what planar projection is and what non-planar projection is. [4 marks]

2.4. An object is rotated about an axis (1.0, 0.0, 0.0) by 90° at a fixed point of (3.0, 2.0, 1.0). Find the transformation matrices as a set of matrix multiplications. [6 marks]

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

3.1. A straight line is defined by $P_1(1,10)$ and $P_2(5,2)$. Determine the pixel positions with the DDA (Digital Differential Analyser) algorithm. A diagram can be plotted to demonstrate the result. [8 marks]

3.2. Give an example of a revolved surface. A diagram can be used to aid your answer. [4 marks]

3.3. Explain what a hierarchical model is with an example. Draw a hierarchical tree for the model and discuss how it can be implemented. [8 marks]

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

4.1. Briefly explain flat shading and smooth shading in vertex shading, including their advantages and disadvantages. [8 marks]

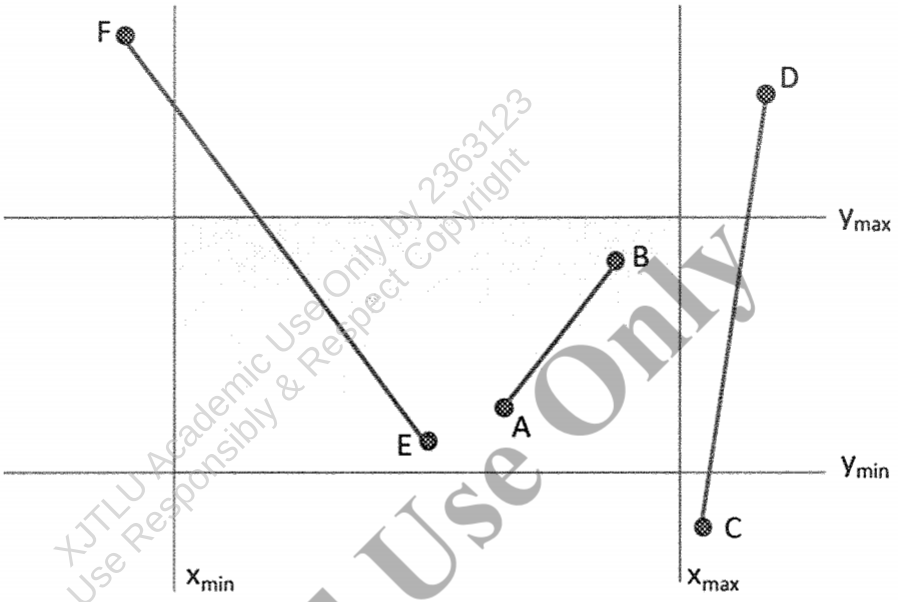
4.2. In what situations is two-sided lighting needed? [2 marks]

4.3. Give an example to explain what two-part mapping is. Diagrams can be used to aid your answer. [6 marks]

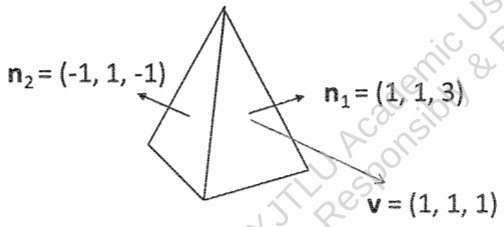
4.4. Why does point sampling of texture lead to aliasing errors? Diagrams can be used to aid your answer. [4 marks]

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

5.1. Given the clipping window defined by the four boundaries and lines AB, CD and EF shown in the figure below, apply the Cohen-Sutherland line clipping algorithm to clip them. For each of the three lines, 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. The following figure shows two polygons with respect to the observer. Determine if any of these two faces would be invisible using vectors for the face normal ($\mathbf{n}_1$ and $\mathbf{n}_2$) and viewing direction ($\mathbf{v}$) shown in the figure. [6 marks]



5.3. Briefly discuss image space algorithms for hidden surface removal and name an example. [4 marks]

THIS IS THE END OF THE EXAM.