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

Paper CODE	EXAMINER	DEPARTMENT	TEL
CPT205		Computing	

1st SEMESTER 2023/24 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 at least 4 main topics for computer graphics. [2 marks]

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

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

1.4. A straight line is represented as $x - 2y + 10 = 0$. Work out its y-intercept. [2 marks]

1.5. For the vectors $\mathbf{V_1} = 3\mathbf{i} - 5\mathbf{j}$ and $\mathbf{V_2} = 5\mathbf{i} + 3\mathbf{j}$, work out their dot product. [2 marks]

1.6. Given two matrices, **A** = $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ and **B** = $\begin{bmatrix} -8 \\ 5 \\ 1 \end{bmatrix}$, determine if they can be multiplied as **A*B** and why? [2 marks]

1.7. 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;
}
```

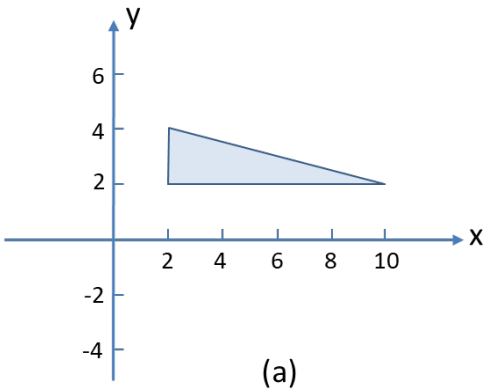
1.8. How could a 2D rectangle be scaled by a factor of 3 while its top-right corner remains unchanged? [2 marks]

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

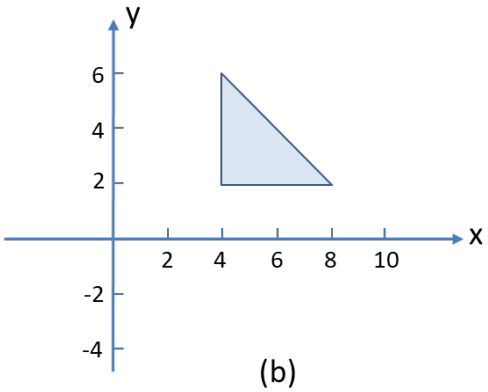
1.10. There are different matrix modes in OpenGL. Which one of **GL_MODELVIEW** and **GL_PROJECTION** should be used in conjunction with a **glOrtho()** function call and why? [2 marks]

Question 2. Transformations and viewing [Total 20 marks]

2.1. For the 2D object shown in the figures below, work out the 2D homogeneous transformation matrix M which transforms the 2D object in Figure (a) into the 2D object in Figure (b). You can write the transformation matrix as a product of several simpler matrices (i.e., you do not have to multiply the matrices). A diagram can be used to aid your answer. [8 marks]



(a)



(b)

2.2. Briefly explain line by line what the following fragment of code does. [8 marks]

```
void init(void) {
    glClearColor(0.0, 1.0, 0.0, 1.0);

    glMatrixMode(GL_MODELVIEW);
    glLoadIdentity();
    gluLookAt(100, 50, 50, 50, 50, 0, 0, 1, 0);

    glMatrixMode(GL_PROJECTION);
    glLoadIdentity();
    glFrustum(-40, 40, -60, 60, -40, 60);
}
```

2.3. Explain the orthogonal projection and its implementation with OpenGL **glOrtho()**. A diagram can be used to aid your answer. [4 marks]

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

3.1. Briefly explain line by line what the following fragment of code does. [8 marks]

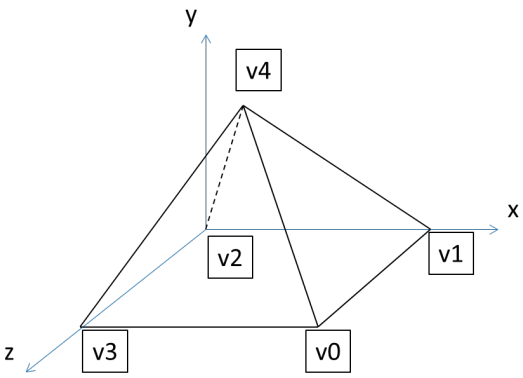
```
void display()
{
    glClearColor(1, 1, 1, 1);
    glClear(GL_COLOR_BUFFER_BIT);

    glShadeModel(GL_SMOOTH);
    glBegin(GL_TRIANGLES);
    glColor3f(1, 0, 0);
    glVertex2f(-50, 50);
    glColor3f(0, 1, 0);
    glVertex2f(-50, 0);
    glColor3f(0, 0, 1);
    glVertex2f(0, 0);
    glEnd();

    glFlush();
}
```

3.2. Given the B-Rep (Boundary Representation) model for the pyramid with 4 vertices ([v0] to [v4]) shown below, its base is a square of side length 10 units; the tip of the pyramid is 10 units above the base. [12 marks]

a) Draw the diagram in your answer book and label the edges and faces (e.g. with e0, e1, … and f0, f1, …).
b) Annotate your diagram with the (x,y,z) values of the vertices.
c) Produce a table or graph to show the B-Rep of the model.



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

4.1. Describe what specular reflectance is and how it is affected with material properties. A diagram can be used to aid your answer. [8 marks]

4.2. Given the following two scenarios, work out their combined effect. [6 marks]

a) two light sources L1 (0.5, 0.6, 0.7) and L2 (0.2, 0.3, 0.4).
b) a light source L (1.0, 0. 8, 0.6) and a material M (0.0, 0.2, 0.4).

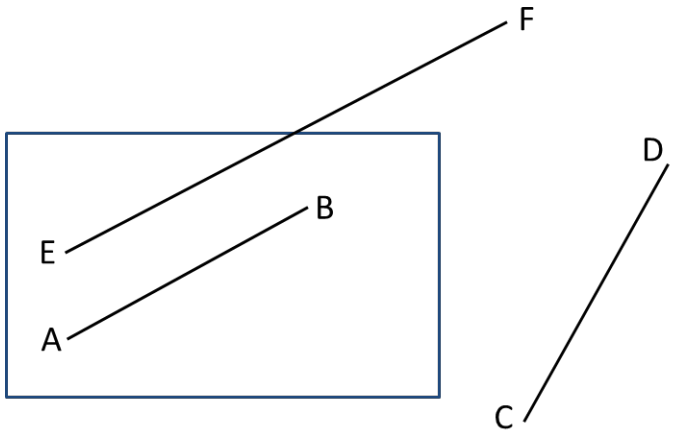
4.3. Explain what filtering is and how it works in texture mapping. [6 marks]

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

5.1. Describe and compare clipping and hidden-surface removal. [6 marks]

5.2. The following figure shows three lines and a rectangular clipping window. [8 marks]

a) Divide the 2D space with outcodes shown for the Cohen-Sutherland clipping algorithm.
b) Explain the operations that the Cohen-Sutherland clipping algorithm would perform, and the minimum number of clips for each of these lines.



5.3. Briefly explain the z-buffer method for hidden surface removal. [6 marks]

THIS IS THE END OF THE EXAM.