

Question 1. Fundamentals

[Total 20 marks]

- 1.1. How is screen resolution defined in computer graphics? [2 marks]
- 1.2. Briefly explain gl, glu and glut functions in OpenGL. [2 marks]
- 1.3. List at least four input devices used with computer graphics applications. [2 marks]
- 1.4. Calculate the unit vector of $\mathbf{V} = 3\mathbf{i} - 4\mathbf{j}$. [2 marks]
- 1.5. Explain why 4x4 matrices are used to process 3D transformations in computer graphics. [2 marks]
- 1.6. Explain any restriction to the value of the homogeneous parameter used in homogeneous co-ordinates. [2 marks]
- 1.7. How can an object in 2D be mirrored about the co-ordinate system origin? [2 marks]
- 1.8. What does the `glClearColor(1.0, 1.0, 1.0, 1.0)` do in OpenGL do? [2 marks]
- 1.9. Explain the concept of texture mapping in computer graphics. [2 marks]
- 1.10. Decide which of the following processes are involved in hidden surface removal; write down your answer in the answer book provided. [2 marks]
- a) Culling
 - b) Depth buffering
 - c) Double buffering
 - d) Z-buffering

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Question 2. Transformation and viewing

[Total 20 marks]

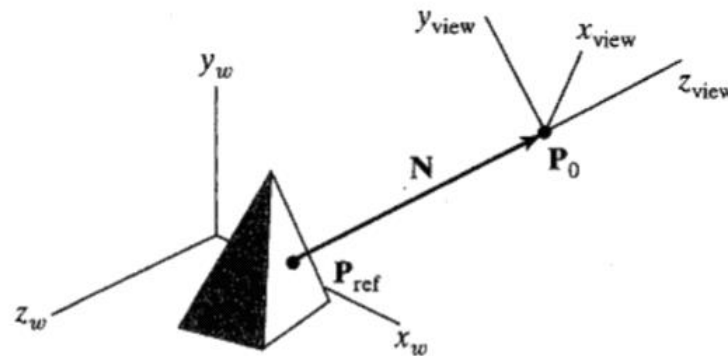
2.1. An object is rotated about an axis $(0.0, 0.0, 1.0)$ by 30° at a fixed point of $(3.0, -2.0, 1.0)$.

[8 marks]

- Find the transformation matrices as a set of matrix multiplications,
- Write OpenGL code for the transformations.

2.2. There are several co-ordinate parameters for 3D viewing such as viewing origin (or camera position) P_0 , reference point (or look-at point) P_{ref} , viewing direction N , and viewing co-ordinate system (as shown below). Describe how the viewing co-ordinate system can be defined. Diagrams can be used in your answer where necessary.

[6 marks]



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2.3. There are concerns about the placement of the viewing plane for a frustum perspective projection. Explain

- If there is any restriction on the placement of the viewing plane, and
- effect of the placement of the viewing plane on the on object display.

Diagrams can be used in your answer where necessary.

[6 marks]

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Question 3. Creation and representation of geometry [Total 20 marks]

3.1. Briefly explain the types of continuity that can be enforced at the joint of a Spline curve.

[4 marks]

3.2. Briefly describe and compare wireframe, surface and solid models including their strengths, drawbacks and applications.

[8 marks]

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3.3. Explain what the following OpenGL code does, referring to lines of the code where necessary.

[8 marks]

```
01      glBegin(GL_QUADS);
02      for (A = 0; A < 2pi; A = +DA) {
03          glVertex3f(R*cos(A), R*sin(A), 0);
04          glVertex3f(R*cos(A+DA), R*sin(A+DA), 0);
05          glVertex3f(R*cos(A+DA), R*sin(A+DA), H);
06          glVertex3f(R*cos(A), R*sin(A), H);
07      }
08      glEnd();
09
10      glBegin(GL_POLYGON);
11      for (A = 0; A < 2pi; A = +DA)
12          glVertex3f(R*cos(A), R*sin(A), 0);
13      glEnd();
14
15      glBegin(GL_POLYGON);
16      for (A = 0; A < 2pi; A = +DA)
17          glVertex3f(R*cos(A), R*sin(A), H);
18      glEnd();
```

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Question 4. Lighting and texture mapping

[Total 20 marks]

- 4.1. Explain the point and directional light sources. Which of these light sources would benefit from having attenuation of light strength applied and why? [8 marks]
- 4.2. Given a light source (0.8, 0.6, 0.2) and a material (0.0, 1.0, 0.5), work out the combined effect. [2 marks]
- 4.3. Briefly explain the concepts of magnification and minification. Diagrams can be used in your answer where necessary. [5 marks]
- 4.4. Explain second mapping in texture mapping and provide an example of the methods for implementation. [5 marks]

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Question 5. Clipping and hidden surface removal

[Total 20 marks]

- 5.1. Provide your answer to the following two questions about the Cohen-Sutherland line clipping algorithm. Diagrams can be used in your answer where necessary. [8 marks]
- a) Explain how the Cohen-Sutherland algorithm could be extended from 2D to 3D space.
- b) The following figure shows two lines and a rectangular clipping window. Describe the steps of clips that the Cohen-Sutherland algorithm would perform for each of these lines.



- 5.2. Explain the painter's method for hidden surface removal and the main problems with this method. Diagrams can be used in your answer where necessary. [6 marks]
- 5.3. Describe the z-buffer method for hidden surface removal. [6 marks]

