

Paper CODE	EXAMINER	DEPARTMENT	TEL
CPT205		Computing	

**1st SEMESTER 2022/23 FINAL EXAMINATION**

**Undergraduate – Year 3**

**COMPUTER GRAPHICS**

**TIME ALLOWED: 2 Hours**

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**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.**
- 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]

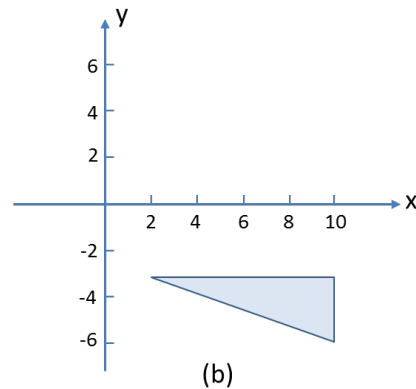
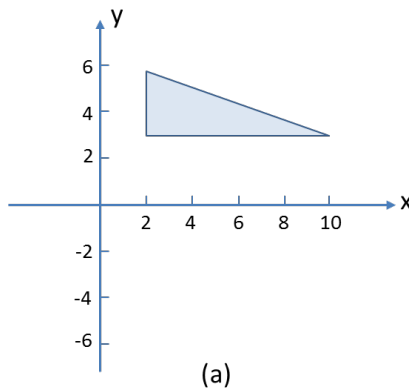
- 1.1. Give a brief definition of computer graphics. [2 marks]
- 1.2. List at least 4 main topics of computer graphics. [2 marks]
- 1.3. What is a framebuffer used for computer graphics? [2 marks]
- 1.4. Graphics packages use a fourth 'colour co-ordinate', A or alpha (in addition to Red, Green and Blue). What does it do? [2 marks]
- 1.5. Given two vectors,  $\mathbf{V}_1 = 3\mathbf{i} - 2\mathbf{j}$  and  $\mathbf{V}_2 = 6\mathbf{i} + 5\mathbf{j}$ , work out their dot product. [2 marks]
- 1.6. For two matrices,  $\mathbf{A} = \begin{bmatrix} 4 & 5 & 6 \end{bmatrix}$  and  $\mathbf{B} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ , work out  $\mathbf{AB}$ . [2 marks]
- 1.7. Decide which of the following statements about polygons is false; write down your answer in the answer book provided. [2 marks]
- (a) A polygon can have two faces;
  - (b) A polygon can be filled;
  - (c) A polygon must be convex;
  - (d) A polygon must have at least 3 vertices.
- 1.8. Use an example to explain a parametric representation of a curve. [2 marks]
- 1.9. Are there any restrictions to the placement of the viewing plane in graphic systems and why? [2 marks]
- 1.10. What would the following fragment of code do? [2 marks]

```
int x = x0, y = y0;
while (y <= y1)
do {
    DrawPoint(x,y);
    y = y + 1;
}
```

## Question 2. Transformation and viewing

[Total 20 marks]

- 2.1. Briefly explain the transformation pipeline including each of the stages. Diagrams can be used in your answer. [5 marks]
- 2.2. 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 homogeneous transformation matrix. Diagrams can be used in your answer. [8 marks]



- 2.3. Briefly explain line by line what the following fragment of code would do. [7 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);
}
```

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

- 3.1. 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]
- 3.2. For parametric curves, explain what interpolation and design curves are and how their local controls work. Diagrams can be used in your answer. [8 marks]
- 3.3. Briefly describe the two types of B-Rep model and how the validation can be done. Diagrams can be used in your answer. [4 marks]

## Question 4. Lighting and texture mapping

[Total 20 marks]

4.1. Attenuation of light received due to the distance from the light source can be applied.

- (a) Briefly explain the attenuation model implemented in graphics systems such as OpenGL.
- (b) Name a type of light source to which distance attenuation can be applied and explain why.

[6 marks]

4.2. Given two light sources (0.8, 0.6, 0.4) and (0.3, 0.3, 0.3), work out the combined lighting effect.

[2 marks]

4.3. A photograph of 1600\*1200 pixels is to be mapped onto a display screen of 800\*600.

- (a) How the mapping could be implemented?
- (b) What term of texture mapping would this case be called?
- (c) How the colour of each pixel in the display can be decided?

[6 marks]

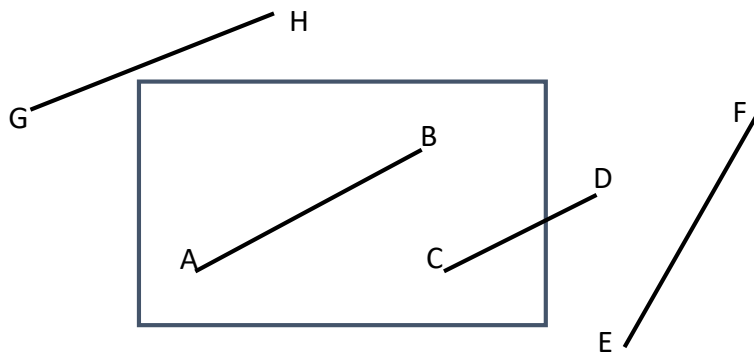
4.4. Briefly describe the co-ordinate systems used for texture mapping. Diagrams can be used in your answer.

[6 marks]

## Question 5. Clipping and hidden surface removal

[Total 20 marks]

- 5.1. Briefly explain the clipping window, viewport and display window relating to OpenGL where appropriate. Diagrams can be used in your answer. [6 marks]
- 5.2. The following figure shows four lines and a rectangular clipping window. Describe the sequence of clips that the Cohen-Sutherland clipping algorithm would perform for each of these lines. [8 marks]



- 5.3. Briefly describe the need, process and limitations of back-face culling for hidden-surface removal. Diagrams can be used in your answer. [6 marks]

**THIS IS THE END OF THE EXAM.**