



# **THE CO-OPERATIVE UNIVERSITY OF KENYA**

**END OF SEMESTER EXAMINATION DECEMBER -2022**

**EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER  
SCIENCE**

**(YR IV SEM I)**

**UNIT CODE: BCSC 4234**

**UNIT TITLE: COMPUTER GRAPHICS**

**DATE: MONDAY, 19<sup>TH</sup> DECEMBER, 2022**

**TIME: 2:00 PM – 4:00 PM**

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## **INSTRUCTIONS:**

- **Answer question ONE (compulsory) and any other TWO questions**

### **QUESTION ONE**

**[30 MARKS]**

- (a) Using a suitable illustration, explain the meaning of *trilinear interpolation* as applies to computer graphics. [4 Marks]
- (b) Differentiate between *spin* and *orbit* as applies to graphical objects. [4 Marks]
- (c) The Phong's reflection model is a sum of **three** terms that each models a specific type of light reflection. Name and describe the three terms. [6 Marks]
- (d) Distinguish between *supersampling* and *multisampling* as applies to computer graphics. [4 Marks]
- (e) In drawing transparent objects using for instance OpenGL, the triangles are typically divided in two groups i.e. the transparent ones and the opaque ones. Explain which of these two groups needs to be sorted and in which order. [4 Marks]
- (f) Describe the structure of a typical ray tracer by using the functions **main()**, **trace()**, **shade()**, and **findClosestIntersection()**. i.e. describe what these functions do and which functions they call (who calls who). [4 Marks]
- (g) In the 2D graphics obtain the 3x3 transformation matrix for translating a point (-1,2). Calculate the inverse of this matrix and show that the result is a matrix that translates a point by (1,-2). [4 Marks]

### **QUESTION TWO**

**[20 MARKS]**

- (a) Give **three** differences between *real-time graphics* and *offline computer graphics*. [6 Marks]
- (b) Explain why graphics hardware, e.g., graphics cards are useful for computer graphics. [4 Marks]
- (c) Explain how is color represented in computer graphics and how it relates to the Human Visual System (HVS). [4 Marks]
- (d) "GIF, PNG and JPEG are basically raster graphics formats". Discuss. [6 Marks]

### **QUESTION THREE**

**[20 MARKS]**

(a) A pair of transformations is said to commute if the order in which you apply them does not matter. In terms of transformation matrices, that means that  $\mathbf{AB} = \mathbf{BA}$ . Explain which of the following transformation pairs commute in 3D.

- (i) translate – translate [2 Marks]

- (ii) scale – scale [2 Marks]
- (iii) rotate – translate [3 Marks]
- (iv) rotate – scale [3 Marks]

(b) A line will be drawn from  $(x_1, y_1)$  to  $(x_2, y_2)$ . Scan conversions are started from both  $(x_1, y_1)$  to  $(x_2, y_2)$  and also from  $(x_2, y_2)$  to  $(x_1, y_1)$  simultaneously following Bresenham’s algorithm.

- (h) Write algorithm steps for such implementation. [6 Marks]
- (ii) What is the advantage of this technique? Why? [4 Marks]

**QUESTION FOUR [20 MARKS]**

(a) Using a well labeled diagram, explain the *Graphics Coordinate System*. [5 Marks]

(b) It takes three points to define an affine transformation in 2D. Say that the point (1, 1) goes to (4, 4), that (1, - 1) goes to  $(4 + \sqrt{2} ; 4 - \sqrt{2})$ , and that the point ( -1, 1) goes to  $(4 - \sqrt{2} , 4 - \sqrt{2})$ . Assume that the affine transformation is described by the following homogeneous matrix equation:

$$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \begin{pmatrix} a_{xx} & a_{xy} & b_x \\ a_{yx} & a_{yy} & b_y \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$$

- (i) Consider the points to be the corners of a triangle. Draw a picture showing the initial and final positions of the triangle, and give a matrix that transforms the initial triangle to the final one. [4 Marks]
- (ii) Write out six linear equations involving the unknowns in the matrix equation above and the coordinates of the given points. [6 Marks]
- (iii) Solve the equations to find the unknowns and hence write out the transformation matrix. [5 Marks]

**QUESTION FIVE [20 MARKS]**

- (a) Below are statements describing some of the basic terms common with computer graphics. For each statement, identify the term being described. [4 Marks]
  - (i) The smallest size object or colour spot being displayed and addressed on a monitor.
  - (ii) The distance from one pixel to another pixel.
  - (iii) The process of representing continuous picture or graphic objects as a collection of discrete pixels.
  - (iv) The technique used to diminish the jagged edges of an image so that the image appears to have smoother lines.
- (b) An observer standing at the origin sees a point P(1,1). If the point is translated one unit in the vector direction  $\mathbf{v} = \mathbf{j}$ , its new coordinates position is P<sup>1</sup>(1,2). Suppose instead that the observer stepped back one unit along the Y axis. Find the apparent coordinate of P with respect to the observer. [4 Marks]
- (c) “There are three basic methods used in generation of characters on a computer screen”. Do you agree with this statement? Support your answer. [4 Marks]
- (d) Explain the **two** basic principles of reflection transformation. [4 Marks]
- (e) Differentiate between *ray tracing* and *path tracing*. [4 Marks]