Charles Sturt University

School of Computing and Mathematics

Sample Examination

ITC363 Computer Graphics

This paper is for Bathurst Campus and Distance Education (Distance) students.

EXAM CONDITIONS:
This is a closed book exam
Non-programmable calculator permitted
Notes are NOT permitted in the Exam
No dictionary permitted
The student may NOT retain the question paper

WRITING TIME: 2 hours plus 10 minutes reading time
Writing is permitted during reading time

MATERIALS SUPPLIED BY UNIVERSITY: 2 x 12 page answer booklet

MATERIALS PERMITTED IN EXAMINATION: As listed in Exam Conditions

(No electronic aids are permitted e.g. laptops, phones)

NUMBER OF QUESTIONS: 4

VALUE: 55%

INSTRUCTIONS TO CANDIDATES:

1. Enter your name, student number and signature into the box below.
2. Attempt ALL questions.
3. Start a new page for each new question, but not for each part of a question.
4. Read each question carefully to ensure that you have answered everything that is required in the question. Most questions have multiple parts.
5. There are 120 possible marks for this examination.
6. This examination is worth 55% of the final assessment for this subject. You must pass this examination in order to pass the subject.

STUDENT NAME: …… STUDENT ID: ……

SIGNATURE ……

CALCULATOR USED (IF ANY) ……

The nominal total marks for this examination paper is 120, equivalent to 1 mark per minute for 2 hours.

Question 1 (30 marks)

(a) Give a brief description of the following 2D polygon types, providing an example diagram to aid your description of each one:

i) a non-simple polygon
ii) a concave polygon
iii) a convex polygon

[3+3+3=9 marks]

(b) In WebGL any convex polygon can be drawn filled using a single `glDrawArrays` call. Write down the WebGL primitive that must be specified in this call and draw a diagram showing how the convex polygon would be represented as triangles.

[6 marks]

(c) Explain how the surface of a sphere can be approximated by triangles (i.e. **triangulated**) using WebGL primitives. There is no need to write any code, but you need to describe the way you would choose vertices on the surface of the sphere and with what WebGL primitives these vertices would be associated for drawing filled sequences of triangles.

[10 marks]

(d) Describe the main advantage of using homogeneous coordinates in Computer Graphics.

[5 marks]

Question 2 (30 marks)

(a) Describe the purpose and characteristics of *uniform* variables used in WebGL shader language. You need to describe the kind of data they are used for, how they are changed, how often this may occur, and briefly describe an example of use.

[10 marks]

(b) i) Write down the transformation matrix $R_z(\theta)$ that will rotate a point, specified in 3D, by an angle θ in the usual positive sense about the z-axis through the origin. You should use homogeneous coordinates.

ii) Write down the transformation matrix $T(d_x, d_y, d_z)$ that will translate a point in 3D by the homogeneous displacement vector $\boldsymbol{d} = (d_x, d_y, d_z, 0)^T$. Again you should use homogeneous coordinates.

iii) Compare the effects of applying a translation matrix to a point and to a vector.

[4+4+4=12 marks]

(c) A plane is characterised by a unit vector n normal to the surface and a point P_0 lying in the plane. Let Q_0 be a point lying off the plane. Show that the perpendicular distance from Q_0 to the plane is the magnitude of the quantity

$$(Q_0 - P_0) \cdot n$$

[8 marks]

Question 3 (30 marks)

(a) Explain what an instance transformation is and specify how an instance transformation matrix would be constructed from elemental translation, rotation and scaling transformation matrices.

[8 marks]

(b) Describe how a viewing coordinate system is established. Include in your description how the origin point and axis vectors of the viewing coordinate system are obtained.

[10 marks]

(c) Briefly explain the meaning of each of the following terms and provide a labelled diagram or diagrams to support your explanations.

i) centre of projection
ii) projectors
iii) projection plane
iv) view volume
v) near and far clipping planes

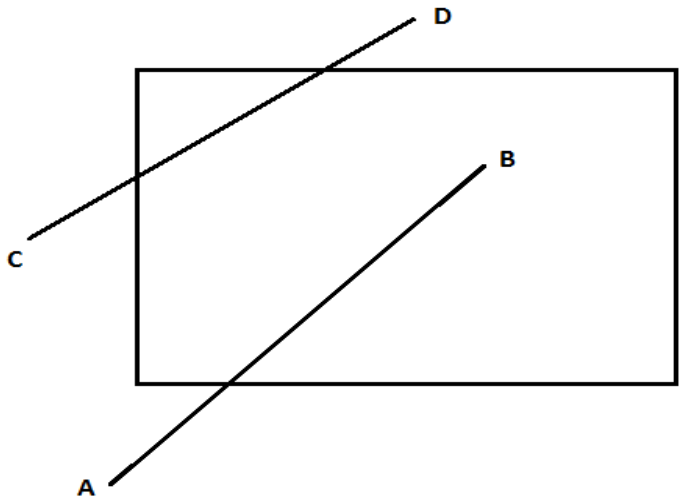
[12 marks]

Question 4 (30 marks)

(a) Suppose the line segments in the figure below are to be clipped against the rectangular window using Liang-Barsky 2D line clipping. You may assume that for these line segments the parametric line equations are specified with $\alpha = 0$ at A and C, and $\alpha = 1$ at B and D and F.

For each of the line segments specify the relative values for the Liang-Barsky parameters $\alpha_1, \alpha_2, \alpha_3$ and α_4, and whether each is in $\alpha < 0$, $0 \leq \alpha \leq 1$ or $\alpha > 1$. Hence explain how each line segment would be clipped.

[10 marks]



(b) i) Name the two broad classes of *hidden–surface-removal* algorithms.

ii) To which of these classes does the z-buffer algorithm belong?

iii) Briefly explain the operation of the z-buffer algorithm.

[2+2+6=10 marks]

(c) List and briefly describe five important properties of Bezier curves.

[10 marks]

END OF EXAMINATION