BACHELOR OF COMPUTER SCIENCE & ENGG. EXAMINATION, 2018

($3^{rd}$ year,1st Semester)

COMPUTER GRAPHICS

Time: 3 hours Full Marks: 100

Answer any FIVE questions.
(Parts of a question must be answered contiguously)

1. a) An unit square with vertices A(0,0), B(1,0), C(1,1) & D(0,1) is to be stretched along its diagonal AC so that it gets converted into a parallelogram A*(0,0), B*(3/2,1/2), C*(2,2) & D*(1/2,3/2). Derive a transformation matrix that will do this. Explain your answer.

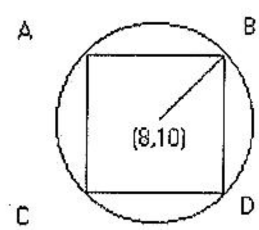
   b) Consider a triangle A(4, 1), B(5, 2), C(4, 3). This is first reflected about the x-axis and then the reflected triangle is further reflected about the line y = -x. Find the $3 \times 3$ transformation matrix to do this and also the position vectors of the final transformed triangle. Could the same transformation be brought about by rotating the original triangle ? If so, by what angle? **8+(8+4)**

2. a) Derive the transformation necessary to reflect a 3D object about an arbitrary plane. The reflection plane is defined by a known point lying on it and the direction cosines of a vector normal to it.

   b) You are given a unit cube which is placed so that one of its vertices is at the origin and the three mutually perpendicular edges from this vertex are coincident with the x, y & z axes respectively. Consider a plane passing through (1,1,1), and the line connecting (0,0,0) to (1,1,1) to be normal to this plane. Reflect the given cube about this plane and obtain position vectors for this reflected cube. **12+8**

3. a) Show formally that a triangle remains a triangle after undergoing an arbitrary affine Transformation.

   b)




A circle with radius $r = 5\sqrt{2}$, and centre at (8,10) circumscribes a square (square inside circle) with sides AB, BD,CD & AC respectively, such that two mutually perpendicular sides, ie., AB & AC are parallel to the x-axis and y-axis respectively. Using Bresenham's circle rasterisation technique, rasterise the arc from A to B. Give appropriate explanation where necessary. **10+10**

[ Turn over

4. a) With limited bit-planes, is it possible to choose from millions of available colour shades ? Justify your answer. Discuss additional timing overhead/ constraint, if any.

   b) A straight line with end points X [-307, 631] and Y [1150, 486] (screen coordinates) is to be clipped against a triangular window with vertices at A [0, 0], B [1023, 0] and C [1023, 1023]. Find the clipped line using Mid – Point – Subdivision algorithm and simple geometric transformations, if necessary. Give details of all steps.

   c) Briefly discuss a possible fast hardware implementation for Mid-Point-Subdivision clipping algorithm. **(3+3)+10+4.**

5. a) A unit cube is initially placed so that three of its mutually perpendicular adjacent faces lie on the **x** – **y**, **y** – **z** and **z** – **x** planes respectively. The cube is then given a CCW rotation of 60° about **y** – axis followed by a translation of –2 along the same axis and finally projected on to the **z** = 0 plane from a centre of projection at $\mathbf{z} = \mathbf{z_c} = 2.5$. Obtain composite transformation matrix to do this; comment on the nature of this projection & compute position vectors for the projected cube.

   b) For perspective projection, prove that plane of projection bisects the line between centre of projection and corresponding vanishing point. **(7+2+3)+8**

6. a) Briefly discuss the Scan-Line-Seed fill approach to filling polygons and then give the corresponding algorithm.

   b) Use Active Edge list approach to fill the polygon given by (5,12), (10,8), (13,4), (5,1) and (1,6) in that order. Give full numerical details & explain your answer properly. **(2+8)+10**

7. a) A Bezier curve segment is defined by control points $P_0(2,2)$, $P_1(4,8)$, $P_2(8,8)$ and $P_3(9,5)$. Another curve segment is defined by $Q_0(a,b)$, $Q_1(c,2)$, $Q_2(15,2)$ and $Q_3(18,2)$. These two segments join smoothly. Find values of a, b, c.

   b) Show that for a Bezier curve, the Bernstein basis $J_{n,i}(t)$ is maximised at $t = (i / n)$ for $0 \le i \le n$; Hence sketch variations of $J_{3,i}(t)$ as t increases from 0 to 1 for $0 \le i \le 3$

   c) For the Bernstein basis, it is known that

   $$\sum_{i=0}^{n} J_{n,i}(t) = 1,\ 0 \le t \le 1$$

   Show formally, that this is indeed true for a cubic Bezier curve. **[8+6+6]**

8. a) Write detailed notes on any four
   i) Liang Barsky 2D line clipping.
   ii) Edge Flag fill technique.
   iii) Splitting a Bezier curve.
   iv) Normalized Cubic Spline
   v) Second order difference approach to circle rasterisation
   vi) Parametric representation of conic sections.
   vii) Sutherland Hodgman clipping.
   viii) Homogeneous coordinate system **[5+5+5+5]**