Ex/CSE/T/311/11/2010

BACHELOR OF COMP. SC. & ENGINEERING EXAMINATION, 2010

(3rd Year, 1st Semester)

COMPUTER GRAPHICS

Time :- Three Hours **Full Marks : 100**

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

1. a) A colour display device has 8 bitplanes and a lookup table of 256 entries, each of which can hold a 24 bit number. The manufacturer claims it can 'display 256 colours out of a palette of 16 million'. Explain this statement.

   b) If a display monitor screen has 525 scan lines and an aspect ratio of 3:4 and each pixel needs to be displayable in 256 different intensities, what memory transfer rate in bits/second is required to display at 30 frames/second ?

   c) Using generalised Bresenham's algorithm find pixel locations approximating a straight line from A(0,0) to B(-4,-8). All computations and values of different parameters in each step must be shown clearly in tabular form. Neatly sketch the rasterised line.

   5+5+10

2. a) Develop mid-point rasterisation algorithm for an ellipse with major axis parallel to the x-axis.

   b) Find pixel positions that approximate the third quadrant of a circle with radius 4 and centre at (4,5). Use general Bresenham's algorithm and show details of all intermediate steps in a neat tabular form. Sketch the rasterised quadrant. **10+10**

3. a) The area of an arbitrary 2D object is α ($\alpha \neq 0$). Find its area after being transformed by a general 2×2 transformation matrix. Explain your answer with proper reasoning.

   b) Prove that for $x = p^2$ & $y = p$, transforming the position vector $[x\ y\ 1]$ using transformation matrix:

$$\begin{bmatrix} 0 & -2 & 2 \\ -2 & 2 & -2 \\ 1 & 0 & 1 \end{bmatrix}$$

   yields position vectors of the form $[x^*\ y^*\ 1]$ that represent points lying on an unit circle. **10+10**

4. a) Develop the transformation matrix necessary to reflect a 3D object about an arbitrary plane. Assume that this plane is defined by a point P_0 (x_0,y_0,z_0) on it and a unit vector normal to it. Explain your answer properly.

   b) A cube with sides of length 15 is placed such that three of its mutually perpendicular adjacent faces lie on three planes given by $\mathbf{x} = 5$, $\mathbf{y} = 7$ & $\mathbf{z} = 10$ respectively. This cube is to be rotated CCW by 45° about its principal diagonal passing through (20,22,25).

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Obtain the required transformation matrix and find position vectors for vertices of the rotated cube. **10+10**

5. a) A unit cube is initially placed so that three of its mutually perpendicular adjacent faces lie on the $\mathbf{x}-\mathbf{y}$, $\mathbf{y}-\mathbf{z}$ and $\mathbf{z}-\mathbf{x}$ planes respectively. The cube is then given a CCW rotation of 60° about $\mathbf{y}$ – axis followed by a translation of –2 along the same axis and finally projected on to the $\mathbf{z}=0$ 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) Deveop the Sutherland & Cohen's algorithm for clipping lines against regular windows.

   b) Can this algorithm be extended to clip lines against regular 3D volumes? If so how? Give specific details and explain your answer.

   c) 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 details & explain your answer properly. **8+5+7**

7. a) Develop a general cubic blending function to intrapolate a smooth curve through given sample points and present it in matrix form.

   b) Two Bezier curves are defined by control points

      P1(-1,0), P2(-1,1), P3(0,1) &

      Q1(0,1), Q2(1,1), Q3(1,0)

   respectively. Sketch both curves taking at least three equispaced intermediate points on both curves; Do the curves join smoothly? Justify your answer. **8+(8+2+2)**

8. Write short notes on any two:
   i) Sutherland – Hodgeman polygon clipping.
   ii) Edge – fill algorithm.
   iii) Cyrus – Beck line clipping.
   iv) Windows and view – ports. **10 + 10**