BACHELOR OF COMP. SC. & ENGINEERING EXAMINATION, 2012

(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) Rasterise the first quadrant of a circle with radius = 6 and centre at (6,6) using Bresenham's algorithm; give details of all steps, preferably in tabular form.

   b) Rasterise the first quadrant of the same circle as in (a), i.e., radius = 6 & center at (6,6) using the 2^{nd} order difference Mid-Point algorithm; give details of all steps, preferably in tabular form.

   c) Compare the list of pixels obtained in (a) with that obtained in (b) and comment; also compare the actual number of computation steps required in (a) with those in (b) and comment. **8+8+4**

2. a) Using Liang Barsky's algorithm, clip the line A(- 1,1) B(9,3) against a regular 2D window with lower-left and upper-right corners at (0,0) and (8,4) respectively.Give numerical details of all your steps.

   b) Clip the same line A(- 1,1) B(9,3) as in (a), against the same regular 2D window, i.e., lower-left & top-right corners at (0,0) and (8,4) respectively, using the Sutherland – Cohen's algorithm. Give numerical details of your steps. **10+10**

3. a) Develop a computationally efficient technique to approximate an ellipse using piecewise linear approximation. Your technique should take into account variation of curvature along the ellipse.

   b) A polygon is given by A(6,14), B(9,11), C(6,8), D(12,2), E(18,8), F(15,11) and G(18,14) in that order. Fill this polygon using Active-Edge-List technique. Avoid over/ under filling and give details of all steps in tabular form.

   c) Can you device a simple parametric representation for a 3D helix? **7+9+4**

4. a) Prove that angle between pair of intersecting straight lines remains invariant under pure rotational transformation.

   b) A 2D object is reflected about the line $y = m_1x$; the reflected object is once again reflected about another line $y = m_2x$, ($m_1 \neq m_2$), to get the final reflected object. Prove that the same result can also be obtained by pure 2D rotation.

   c) Prove that a pair of parallel lines remain parallel after arbitrary 2D transformation (transformation matrix is non-singular).

   d) Given a 2D position vector [2 3 1], give at least 3 distinct homogeneous representations for the same; draw a neat diagram showing locations of your distinct representations in 3D space with respect to the location of conventional cartesian coördinate system. Explain briefly. **6+5+5+4**

5. a) Reflection about line $y = x$ is equivalent to reflection about x-axis followed by a CCW rotation about origin by an angle φ; find the value of φ.

   b) Find equation of the line $y' = mx' + b$ in x-y coordinates if the x'-y' coordinate system is obtained by a 45° CCW rotation of the x-y coordinate system.

   c) Write down the Sutherland Hodgman polygon clipping algorithm; Explain in details.

   5+5+10

6. a) Develop the transformation matrix for rotating a 3D object CCW by angle θ about the line through points $A(x_1,y_1,z_1)$ $B(x_2,y_2,z_2)$. Explain all your steps.

   b) An unit cube is placed with one of its vertices at the origin and three of its mutually perpendicular adjacent faces coincident with the x-y, y-z and z-x planes. This cube is rotated CCW about y-axis by 60°. The rotated cube is translated by – 2 along y-axis. Finally, the transformed cube is projected onto the $z = 0$ plane from a centre of projection at $z = z_c = 2.5$. Find position vectors for the projected cube; draw a neat sketch showing the projected picture. **10+(8+2)**

7. a) Is it possible to reconstruct 3D objects from their perspective projections (2D pictures)? If yes, explain in details, how; If not, explain why.

   b) Consider four 2D points $P_1[0,0]$, $P_2[1,1]$, $P_3[2.-1]$ and $P_4[3,0]$, with tangent vectors at the beginning and end given by $P_1'[1\ 1]$ and $P_4'[1\ 1]$ respectively. Determine the first segment of piece-wise normalized cubic spline curve through these four points. Calculate intermediate points at $t = 1/3$ and $t = 2/3$ for the segment.

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

   7+8+5

8. Write short notes on any four:
   i) Scan-line Seed-fill technique.
   ii) Parametric representation of conic sections.
   iii) Ellipse rasterization.
   iv) Localized shape control techniques for Bezier curves
   v) Sutherland – Cohen 3D clipping
   vi) Vanishing point (formal derivation)
   vii) Colour look-up table
   viii) Cyrus Beck 2D clipping **5 × 4**