B.C.S.E. Third Year EXAMINATION 2017

1st Semester(Supplementary)

COMPUTER GRAPHICS

Time: 3 hours Full Marks: 100

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

1. a) A circle with radius r and center at (x_c, y_c) is to be transformed so that its area is doubled but the center remains unchanged. ***Develop*** the transformation matrix (in homogeneous coordinates) needed to do this and show (formally) that your matrix does perform the transformation correctly.

   b) Prove that a parallelogram when transformed by an arbitrary 2×2 matrix, the transformed figure is still a parallelogram. **(5+6)+(9)**

2. a) Consider the triangle given by 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 3×3 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?

   b) Define perspective projection. Give transformation matrices needed for performing orthographic projections on x = 0, y = 0 & z = 0 planes respectively. How can the same be obtained from corresponding perspective projection matrices? **(6+2+2)+(4+3+3)**

3. a) Develop the Edge-Fill algorithm. Illustrate by giving detailed steps(in tabular form) involved in filling the polygon defined by A(4, 2), B(25, 2), C(25, 10), D(23, 8), E(23, 6), F(21,6), G(18, 9), H(10, 9), I(6, 5) & J(4,7) in that order.

   b) Illustrate Mid-Point circle rasterization algorithm (using 2nd order partial difference) by rasterizing a circle with radius 10 units & center at (6, 4). All steps must be clearly shown, preferably, in tabular form and explained. **10+10**

4. a) An unit cube is placed such that one of its vertices coincides with the origin and the edges adjacent to this vertex are coincident with the positive X, Y and Z axes respectively. The cube is given a CCW rotation of 30° about Y-axis followed by a translation of –2 units along the same axis. This is then followed by a perspective projection on the z = 0 plane with center of projection at 3.5 on the Z-axis. Perform the above transformation/ projection and give position vectors for the transformed/ projected cube. How many & where will the vanishing points be?

   b) Develop the Mid-Point line rasterization algorithm and illustrate by rasterizing the line segment from A(-5, 12) to B(13, -10). **(7+3)+(6+4)**

5. a) Develop the Mid – Point ellipse rasterization technique. Your starting point should be the equation of an origin centered ellipse; all other details must be developed/ derived and explained precisely. Finally, present the technique as a formal algorithm.

b) Generate a piecewise – linear approximation for complete ellipse with semi-major axis a = 4 and semi-minor axis b=1, axes aligned to the coordinate axes and centered at (2, 2). The approximation should have 32 unique equi-spaced points on the ellipse. Give numerical details, preferably, in tabular form. **(8+4)+8**

6. a) The left & bottom edges of a rectangle are coincident with the Y & X axes respectively, while its top & right edges are at y = 512 & x = 1023 respectively. A line A(-56, 325) B(1056, -10) passes through this rectangle. Apply Cyrus–Beck algorithm to clip this line against this rectangle. List and explain all computational steps.

b) Develop the Sutherland – Hodgman polygon clipping technique. You can use any known method for clipping straight lines against convex window edge; all other details must be developed/ derived and explained precisely. Finally present the technique as a formal algorithm. **(10)+(7+3)**

7. a) Develop in details, the constraint(s) needed to join two cubic Bezier curves with C^2 continuity at the join. Explain the physical/ geometrical implications of the constraint(s) clearly.

b) Consider position vectors P_1[0 0], P_2[1 1], P_3[2 -1] and P_4[3 0] with tangent vectors at P_1 and P_4 both given by [1 1]. Determine the piece – wise cubic spline curve through them using the chord approximation for t_k's. Calculate intermediate points on the curve at τ = 1/3 & 2/3 for the segments. Numerical details for all relevant calculations must be shown. **(7+3)+(10)**

8. Write short notes on any four:
   i) Scan line seed fill
   ii) Bit- Planes and Colour Look-up tables
   iii) Sutherland Cohen's 3D line clipping
   iv) Joining of multiple Bezier curves
   v) Frame Buffer based polygon filling algorithms
   vi) Homogeneous coordinates
   vii) Fast Mid-Point line clipping
   viii) Angle/ Magnitude invariance under affine transformation **5+5+5+5**