B.C.S.E. Third Year EXAMINATION 2013

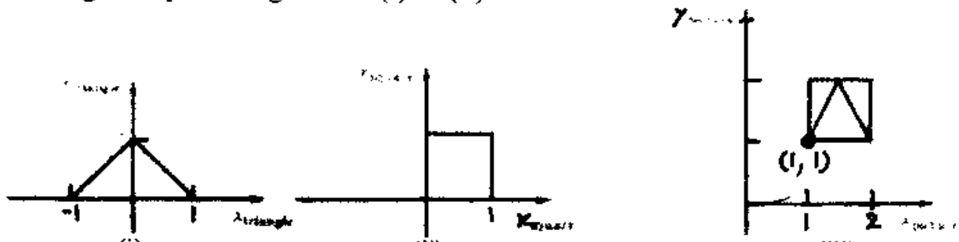
1st Semester

COMPUTER GRAPHICS

Time: 3 hours Full Marks: 100

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

1 a) Obtain the complete transformation matrix needed to create the picture given in (iii) below, using the symbols given in (i) & (ii) **10**



(i) (ii) (iii)

b) Derive the general conditions necessary to keep the enclosed area of a 2D object invariant under arbitrary transformation. **10**

2 a) A circle with radius 8 units and center at (4,4) is to be rasterized using Bresenham's circle rasterization algorithm. Compute and list the complete set of pixel positions. You need not give the actual algorithm, but must clearly show all intermediate steps in your computations. **8**

b) Develop an active-edge-list incremental scan-conversion technique for line rasterization. Discuss computational & storage overheads of your technique. **8+2+2**

3 a) Derive transformation matrix necessary to reflect a 3D object about an arbitrary plane. You may define the plane using any of the methods available for doing so. **10**

b) An unit cube is placed so that a corner lies on the origin and three mutually perpendicular edges from this corner lie on the three coordinate axes. A plane is defined by the point (1,1,0) lying on it and the line segment joining (0,0,1) to (1,1,0) is normal to this plane. Reflect the given cube about this plane and obtain position vectors for the reflected cube. **10**

4 a) There are two triangles. The first one T_{r1} is given by A(2,2), (14,2), C(8,8) while the second one T_{r2} is defined by D(6,3), E(10,3), F(8,5). Use any scan-line oriented polygon filling technique that you know, and fill the space between triangles T_{r1} and T_{r2}. Make sure that your technique avoids over/under filling & give details of all your steps. **8**

b) Explain briefly the Scan Line Seed-fill technique for filling arbitrary polygons. **8**

c) Discuss the storage and computation/memory access overheads for the Seed-fill technique. **4**

5 a) Develop equation of the Bezier curve that passes through (1, 1) and (3, 1) and has its shape controlled by (2, 3) and (4, 3) in that order. Explain your answer properly. **10**

b) A cubic Bezier curve segment is described by control points $P_0(2, 2)$, $P_1(4, 8)$, $P_2(8, 8)$, $P_3(9, 5)$. Another curve segment is defined by $Q_0(a, b)$, $Q_1(c, 2)$, $Q_2(15, 2)$ &$Q_3(18, 2)$. Determine values of a, b & c so that two curves join smoothly. Explain you answer. **10**

6 a) Develop a technique to clip a line against one edge of an arbitrary convex window and then use this technique to develop a complete algorithm for clipping convex polygons against arbitrary convex windows. **7+5**

b) The lower-left & upper-right corners of a regular window are at (100,10) & (160,40) respectively. Find visible portion of line segment from A(120,20) to B(140,8) when clipped against this window using Mid-point –subdivision clipping algorithm. Clearly show all steps in your computations. **6**

c) Comment on the possibility & feasability of modifying your clipping algorithm so that it runs faster on a multiprocessor system. **2**

7 a) An unit cube is placed symmetrically so that its edges are parallel to the coordinate axes and its centroid is at the origin. Translate this cube by 8 units along both X and Y axes and then perform a single point perspective projection onto the $z = 0$ plane from a centre of projection at $z = 20$.Give a neat sketch of the projected cube & explain how 3D nature of the original object is visually apparent from this 2D picture. **8+4**

b) Define perspective projection formally and use your definition to derive a transformation matrix for this. **8**

8 Write short notes on any two:

i) Mid-point ellipse rasterisation.
ii) Sutherland & Cohen 2D line clipping.
iii) Fence-fill and Edge-Flag algorithms.
iv) Generalized cubic polynomial curve fitting. **10+10**