BACHELOR OF COMPUTER SCIENCE & ENGG. EXAMINATION, 2015

(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) 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 list of pixels necessary to display the straight line from (- 8, - 4) to (0, 0) using Bresenham's algorithm (integer version). Your generation procedure should be fully illustrated in tabular form giving numerical values of all parameters of the algorithm in all steps with short explanatory comments, where appropriate. **[(8+5)+7]**

2. a) Give the formal algorithm for 'Scan Line Seed Fill'. Explain exactly how this is better/ worse than 'Simple Seed Fill' algorithm.

   b) A polygon is defined by vertices A(4, 4), B(12, 4) C(12, 10), D(14, 10), E(8, 16), F(2, 10) & G(4, 10) in that order. Fill this using Fence Fill technique. Give details of all your steps with neat sketches, if necessary. Justify your choice of 'fence'. **[(8+4)+8]**

3. a) Develop the Cyrus Beck 2D line clipping technique. Your starting point should be the definition of a general convex 2D window; all other details must be developed/ derived and explained precisely. Finally, present the technique as a formal algorithm.

   b) A regular window is defined by lower left & upper right corners at (-1, -1) & (1, 1) respectively Clip line A(-1.5, -1) to B(1.5, 2) against this window using Cohen Sutherland algorithm. Justify all your steps and show numerical values of all parameters in each step. Inside/ outside decisions should be supported by appropriate 'end-point-codes'. **[(8+5)+7]**

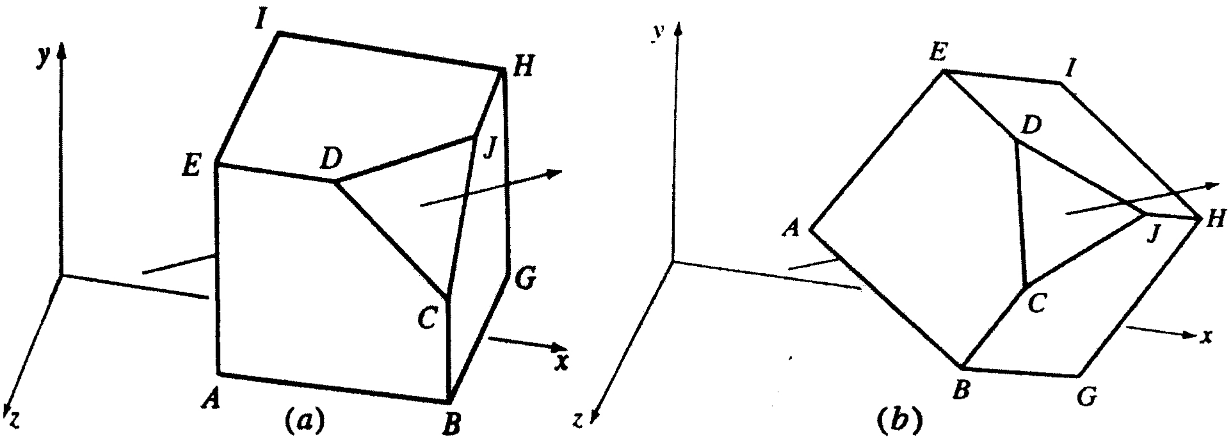
4. a) Describe the 'active – edge – list' technique for polygon rasterization briefly and then explain, in complete details, how floating – point operations can be avoided while implementing this technique.

   b) Rasterize complete circle with radius = 8 and centre at (-4, -4) using 2^{nd} order Mid-Point algorithm. Present your result in tabular form listing values of all parameters in each step. Explanatory comments should be provided wherever appropriate. **[(6+6)+8]**

5. a) Prove formally, that a pair of intersecting straight lines(2D) remain intersecting after both lines are given the same arbitrary 2D affine transformation. Justify any assumptions made and provide brief explanations where appropriate.

b) A triangle is given by vertices A(2, 4), B(4, 6) & C(2, 6). This is to be reflected about line given by $x - 2y + 4 = 0$. Derive transformation matrix to do this, explain briefly and then transform the given triangle to get position vectors for A*, B*, C*. **[10+(6+4)]**

6. a) An unit cube with one corner removed is shown in fig(a) below:



vertices are given by A(2, 1, 2), B(3, 1, 2), C(3, 1.5, 2), D(2.5, 2, 2), E(2, 2, 2), F(2, 1, 1), G(3, 1, 1), H(3, 2, 1), I(2, 2, 1) & J(3, 2, 1.5); corner F (lower left rear) is hidden in the figure. This cube is rotated by - 45° about a local axis passing through corner F and the diagonally opposite one (i.e., the one already removed). Rotated cube will appear as shown in fig(b) above. Derive transformation matrix to do this and find position vectors of the transformed cube. Provide adequate explanations wherever appropriate.

b) Prove that the matrix

$$\begin{bmatrix} (1-t^2)/(1+t^2) & 2t/(1+t^2) \\ -2t/(1+t^2) & (1-t^2)/(1+t^2) \end{bmatrix}$$

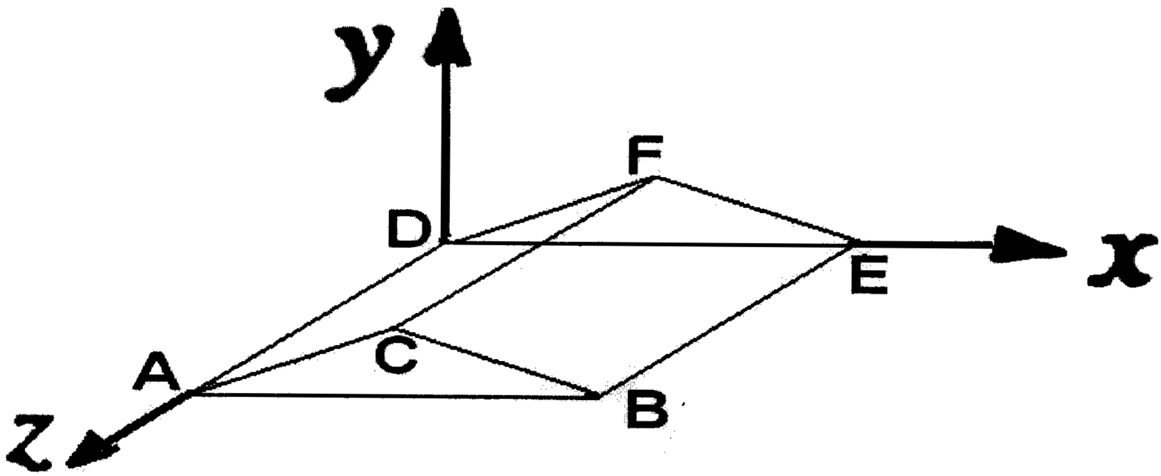
represents a pure rotational transformation for any arbitrary value of t. Do not make any prior assumptions and prove any results that you use. **[(8+5)+7]**

7. a) Develop the Mid Point Subdivision 2D line clipping technique. Your starting point should be the definition of a regular window. All other details must be developed/ derived and explained precisely. Finally, present the technique as a formal algorithm.

b) A regular window is defined by lower left & upper right corners at (0, 0) & (8, 4) respectively. Clip line P(-1, 1) to Q(9, 3) against this window using Liang Barsky algorithm. Justify all your steps and show numerical values of all parameters in each step. **[(6+4)+10]**

8. a) Derive the transformation matrix for single point perspective projection of a 3D object on to the z = 0 plane from a centre of projection on the z-axis. Show that this actually represents two different transformations and explain clearly how the projected figure closely approximates the actual visual perception of depth/ perspective of the 3D object.

b) A simple triangular prism is placed so that one of its triangular face lies on the x-y plane with one vertex coincident with the origin and one of its rectangular face lies on the x-z plane. This is shown in the figure below:



Vertices are A(0, 0, 1), B(1, 0, 1), C(0.5, 0.5, 1), D(0, 0, 0), E(1, 0, 0) & F(0.5, 0.5, 0). This prism is rotated about y-axis by angle $\Phi = -30°$, about x-axis by angle $\theta = 45°$ and projected on to the z = 0 plane from centre of projection at (0, 0, 2.5). Generate transformation matrix needed to do this and find position vectors of the projected prism vertices.

[(6+4)+(6+4)]

. Write short notes on any two

i) Sutherland Hodgeman algorithm
ii) Axonometric projection
iii) Vanishing point
iv) Homogeneous coordinates
v) Angle/ Magnitude invariance under affine transformation
vi) Bezier curve

[10+10]