ROLL NO. ____________________

Code: CS40 **Subject: COMPUTER GRAPHICS**

ALCCS – OLD SCHEME

Time: 3 Hours **FEBRUARY 2012** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE:

- **Question 1 is compulsory and carries 28 marks. Answer any FOUR questions from the rest. Marks are indicated against each question.**
- **Parts of a question should be answered at the same place.**
- **All calculations should be up to three places of decimals.**

Q.1 a. Consider a 2D triangle B(a,b), A(c,d), C(e,f). Work out the transformation matrix to represent 90^0 clockwise rotation of the point A about the point C?

b. Using the outcodes of the end points of the line X(–20,15) – Y(20,50), examine whether the line is partially visible, trivially invisible or *trivially visible* against the clipping window A(0,0), B(40,0), C(40,30), D(0,30).

c. Indicate the operations used for CSG modeling.

d. Draw a rough sketch of the cubic Bezier curve corresponding to the control points P1(40,0), P2(0,0), P3(40,30), P4(0,30). What would be the starting slope of the curve?

e. Consider the transformation and projection relation

$$[x' \quad y' \quad z' \quad 1] = [\ x\ \ y\ \ z\ \ 1\ ]\ \ [\ T\ ]\ \ [\ P\ ]$$

where $[\ x\ \ y\ \ z\ \ 1\ ]$ refers to a point on the object, and $[x' \quad y' \quad z' \quad 1]$ refers to its projection on the screen. Indicate the elements of the matrices T and P to obtain the bottom view of a 3D object on the XY plane (z=0 plane). The 3 D coordinate system is shown in Fig.1.

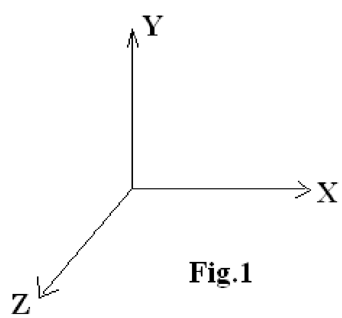

Fig.1

f. Briefly explain the Floating Horizon method.

g. Indicate the steps used to present animation of a vehicle starting from rest, accelerating and then moving with constant speed. **(7×4)**

Q.2 a. Using Cyrus Beck algorithm work out the coordinates of the portion of the line P1(15,25)- P2(35,10) clipped against the window S(0,20), T(0,0), Q(30,0), R(30,20). Construct the Cyrus beck table and show all the calculations. **(10)**

b. Indicate briefly the Binary Space Partitioning method. What is the significant advantage of the BSP tree algorithm? Show how the traversal is done when the viewpoint is *in front of* root polygon. **(8)**

Q.3 a. The characteristic basis matrix for a periodic cubic B-spline curve is given by

$$\left(\frac{1}{6}\right)\begin{bmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 0 & 3 & 0 \\ 1 & 4 & 1 & 0 \end{bmatrix}$$

Given 5 control points C1(0,0), C2(20,10), C3(40,0), C4(60 ,–20), C5(80 ,–30), show that the curve drawn with last 4 control points, starts from *the last point on the curve* drawn with first 4 control points. Also, show that the two curves join smoothly. **(10)**

b. What do you understand by fractal dimension? Find the fractal dimension of the self similar fractal shown in Fig.2. **(8)**

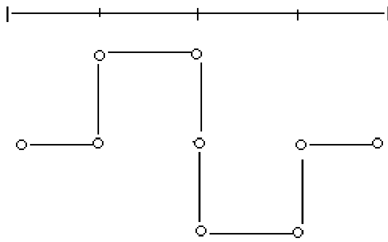

Fig.2

Q.4 a. A square tile A(–50, 0, 0), B(50, 0, 0), C(50,0, –100), D(–50, 0, –100) is lying on the 3D coordinate system shown in Fig.1. Work out the transformation matrix to generate a perspective view on the z=0 plane, with the centre of projection at T(0, 0, 25). Calculate the screen coordinates of A, B, C, D as viewed from the point T. **(10)**

b. Describe a polygon scan conversion algorithm used for filling. **(8)**

Q.5 a. A single point light source directed along the z axis is falling on an object. Develop an expression for the reflected light for a point on the object. This point is located at the origin, and the unit normal directions of the surface of the object at this point are N_x, N_y, N_z. **(10)**

b. Explain the steps involved in carrying out Gourad shading. What is the main disadvantage of this form of shading? How can it be taken care of? **(8)**

Q.6 a. Derive the Bresenham's integer line drawing algorithm to indicate the coordinates of the line that will be displayed, as the line moves from $P(x_1 , y_1)$ to $Q(x_2 , y_2)$, given that $x_2 > x_1$ and $y_2 > y_1$, and that the slope of the line is less than 45^o with the x axis. **(10)**

b. An object is placed on the y= 0 or XZ plane (for the coordinate system shown in Fig.1). All the points on the object have positive x values (>50). Work out the transformation needed to obtain mirror reflection of the object, in a mirror passing through the Z-axis at the origin. The mirror is inclined at 45 degrees with the X and Y axis. **(8)**

Q.7 a. It is desired to obtain isometric view of a cuboid $70 \times 30 \times 40$ on the z=0 plane. The cuboid is lying on the coordinate system shown in Fig.1, such that the front side of the cuboid has the coordinates (0,0,0), (70,0,0), (70,30,0) and (0,30,0). The depth is 40 units. The isometric view coordinates are given by

$[x' \quad y' \quad 0 \quad 1] = [\, x \;\; y \;\; z \;\; 1] \quad [\,T]$

where $[T] = [R_y\,]\,[R_x\,]\,[P]$

Work out the elements of the matrix T. How many isometric views are possible? **(12)**

b. In the Z-Buffer algorithm, show that depth calculation at each pixel on a scan line can be done incrementally if the plane equation for each polygon is available. **(6)**