B.Tech. TCS-501

FIVE SEMESTER EXAMINATION, 2008-2009

COMPUTER GRAPHICS

Time : 3 Hours *Total Marks : 100*

Note : *Answer All questions. All questions carry equal marks.*
(i) Attempt all questions.
(ii) All questions carry equal marks.

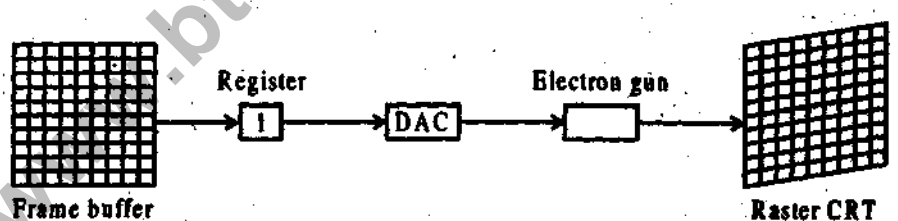
1: Attempt any two parts of the following: **10 × 2 = 20**

(a) Explain Bresenham's algorithm for line drawing.

Ans: Please see Q. No.1 (d) of 2002-03.

(b) What are rester scan display? Explain generating a raster image.

Ans. The most common type of graphics monitor employing a CRT is the raster-scan display based on television technology. In a raster-scan system, the electron beam is swept across the screen, one row at a time from top to bottom. As the electron beam moves across each row, the beam intensity is turned on and off to create a pattern of illuminated spots. Picture definition is stored in a memory are called the refresh buffer or frame buffer. This memory area holds the set of intensity values for all the screen points. Stored intensity values are then retrieved from the refresh buffer and "painted" on the screen one row at a time. Each screen point is referred to as a pixel. Intensity range for pixel positions depends on the capability of the raster system. In a simple black-and-white system, each screen point is either on or off, so only one bit per pixel is needed to control the intensity of screen positions.



(A single bit plane black and white frame buffer raster device)

(c) What do you understand by the term "corruption of display files"? Discuss how to avoid it.

Ans. When a file is not displayed properly called corruption of display files. e.g. shifted or broken pictures or simply no image displayed at all. When an image fails to display properly the cause (s) might be any or all of the following.

→ The display environment (drives, display resolution) is not properly configured or is inadequate.

→ The file format is not supported by the display program.

→ The display program is incorrectly interpreting the file.

→ The file data is bad or corrupt.

Most graphical display problems can be corrected by adjusting one or more aspects of the display environment. For example you attempt to display a true color image using a video graphics card or software driver that does not support the foll bit depth or resolution of the image, the display program will either reduce the number of colors in the displayed image, or simply refuse to display the image at all. In either case, the results will probably not look as you expected. Installing the proper software driver for the graphics card, resolution and number of colors desired may fix this display problem.

2. Attempt any two parts of the following: **10 × 2 = 20**

(a) Explain the algorithm for inside test to scan convert a polygon. Discuss its complexity.

Ans. Let us consider how we can determine whether or not a point is inside of polygon. One method of doing this is to construct a line segment between the point in question and a point known to be outside the polygon. e.g.,

→ Pick a point with an x-coordinate smaller than the smallest x-coordinate of the polygon's vertices.

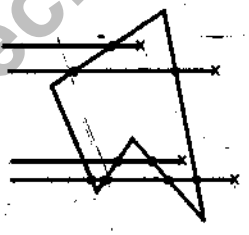
→ Counts how many intersections of the line segment with the polygon boundary occur.

→ If there are an odd number of intersection, the point is inside.

→ Otherwise an even number indicates that it is outside.

This is called even-odd method of determining polygon interior points.

Complexity is O(n).



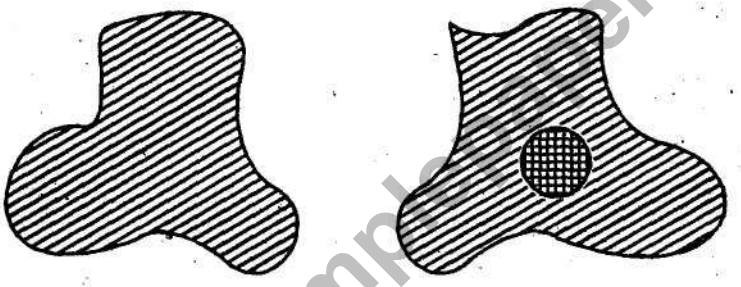
Even-odd inside test.

(b) Write the algorithm for filling polygons and explain it with a suitable example.

Ans. A boundary-fill procedure accepts as input the coordinates of an interior point (x, y), a fill color, and a boundary. Starting from (x, y), the procedure test neighboring positions to determine whether they are of the boundary color.

```
Procedure boundary fill (x, y, fill, boundary : integer); Var
Current : integer;
begin
current = getpixel (x, y);
if (current < > boundary) and (current <> fill) then
```

```
    begin
        Setheixel (x, y, fill);
        boundaryFill (x + 1, y, fill, boundary);
        boundaryFill (x – 1, y, fill, boundary);
        boundaryFill (x, y + 1, fill, boundary);
        boundaryFill (x, y – 1, fill, boundary);
    end
end; {boundaryFill}
```



(example color boundaries for a boundary-fill procedure)

(c) If the display device is storage tube type then discuss the relevance of segmented display files. Explain the algorithm for managing with the file to maintain a dynamically changing picture in such a case.

Ans. To reduce the computational overhead and improve performance, most storage to be displays are designed instead to plot vectors, i.e. segments of straight lines. The computer supplies the two and points of the vector. The display controller positions the electron beam at the first endpoint and moves it in a straight path to the other end. The beams path is determined by a vector generator which feeds the deflection yoke with voltayes that change at a steady rate as the vector is being traced out. A storage tube display that uses 10 bit positive integer co-ordinates must supply 20 bits of data with every instruction.

The display file for a storage-to be terminal consists of separate segments, each containing the actual display codes to be transmitted to the terminal. Whenever a segment is closed or deleted, this display file is modified accordingly. Calling update after making a batch of changes in the display file will cause the appropriate segments to be transmitted to the terminal. If no segment has been redefined deleted, or unposted, only newly posted segments are transmitted; otherwise the screen is erased and the entire display file is sent. The update function can determine whether to regenerate the display by the following algorithm.

1. If any segments are painted but unposted, or if any segment to the display all posted segments; otherwise transmit just those segments which are posted but unpainted.
2. Mark all posted segments painted and all unposted segments unpainted.

3. Answer any two parts of the following: **10 × 2 = 20**

(a) What do you understand by the term "Concatenation of transformations"? What are its advantages? If A and B are two different transformations, illustrate with suitable example that AB ≠ BA.

Ans. Consider the following sequence : sale a point with $S_x = S_y - 2$, then translate it with $T_x = 10$, $T_y = 0$. We have

$$[x' \; y' \; 1] = [x \; y \; 1]\begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad ...(i)$$

$$[x'' \; y'' \; 1] = [x' \; y' \; 1]\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 10 & 0 & 1 \end{bmatrix} \quad ...(ii)$$

The result $[x' \; y' \; 1]$ is merely an intermediate one, we can eliminate it by substituting the first equation into second.

$$[x'' \; y'' \; 1] = [x \; y \; 1]\begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 10 & 0 & 1 \end{bmatrix} \quad (iii)$$

This is called the concatenation of transformations. Advantages of concatenation is that we can describe the complex transformations very easily and take less time to solve a problem.

Let A is a scaling transformation with $S_x = S_y = 2$ and B is a translation with $T_x = 10$, $T_y = 0$ then

$$AB = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 10 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 10 & 0 & 1 \end{bmatrix}$$

$$BA = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 10 & 0 & 1 \end{bmatrix}\begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 20 & 0 & 1 \end{bmatrix}$$

ie, A.B ≠ B.A Proved.

(b) Explain with suitable example the Mid-point-sub division algorithm for line clipping. Discuss its complexity.

Ans. Please see Q. 2(*f*) of 2002–03

(c) Write notes on

(i) Transformation routines

Ans. Translation:

$$x' = x + tx$$

$$y' = y + ty$$

where tx, ty are translation distances to the original point (x,y).

i.e. $P' = P + T$

where $P = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, P' = \begin{bmatrix} x_1' \\ x_2' \end{bmatrix}, T = \begin{bmatrix} tx \\ ty \end{bmatrix}$

Rotation: To rotate a point (x, y) through a clockwise angle θ about the origin of the co-ordinate system, we write

$$x' = x\cos\theta + y\sin\theta, y' = -x\sin\theta + y\cos\theta$$

Scaling : The scaling transformations

$x' = xS_x, y' = yS_y$ can be used for a variety of purposes.

(ii) Display procedures

Ans. The display procedures are used to describe the display procedure call. The display procedure call is not a valid statement in PASCAL or any other common programming language. It is sometimes possible to pass the procedure name and the other parameters to a special Display function. Display (Inverter, 2.5, 90, 100, 200), here we are passing the procedure name, Inverter, as an argument to another procedure. The effect of the display procedure call, is to carry out the four steps.

→ Save transform function is called.

→ the appropriate instance-transformation functions are invoked

→ the procedure itself is called.

→ on return from the symbol procedure, set transform is called.

4. Attempt any two parts of the following: **10 × 2 = 20**

(a) Describe the construction and functioning of 3D acoustic tablets.

Ans. Acoustic tablets use sound waves to detect a styles position. Either strip microphones or point microphones can be used to detect the sound emitted by an electrical spark from a stylus tip. The position of the stylus is calculated by timing the arrival of the generated sound at the different microphone positions. 3D acoustic tablet use sonic or electromagnetic transmissions to record positions. One electromagnetic transmission method is similar to that used in the data glave: A coupling between the transmitter and receiver is used to compute the location of a stylus as it moves over the surface of an object.

(b) What do you mean by pointing and positing? Give the construction and functioning of an input device that is good at pointing but bad for positing and interacts with the screen directly.

Ans. Please see Q. No. 4 (a) (*i*) of 2006-07.

A mouse is small hand-held box used to position the screen cursor. Wheels or rollers on the bottom of the mouse can be used to record the amount and direction of movement. Another method for detecting mouse motion is with an optical sensor. For these systems, the mouse is moved over a special mouse pad that has a grid of horizontal and vertical lines. The optical sensor detects moves across the line in the grid. Additional devices can be included in the basic mouse design to increase the number of allowable input parameters. The Z mouse includes three buttons, a thumbwheel on the side, a truckball on the top, and a standard mouse ball underneath. This design provides six degree of freedom to select spatial positions, rotations, and other parameters. With the Z mouse we can pick up an object, rotate it and move it in any direction.

(c) Discuss the techniques for achieving realism in visualizing 3D scenes.

Ans.

1. **Parallel projections:** In parallel projection, co-ordinate positions are transformed to the view plane along parallel lines. When the projection is perpendicular to the view plane, we have an orthographic parallel projection. Otherwise we have an oblique parallel projection.
2. **Perspective projection:** For a perspective projection, object positions are transformed to the view plane along lines that converge to a point called the projection reference point.
3. **Intensity cues:** One depth cue that is not expensive to implement in hardware is a modulation of the intensity of lines with depth; lines for away appear fainter that those near the viewer.
4. **Stereoscopic views:** A dramatic depth cue is provided by generating two stereoscopic images. One image is shown to the left eye and is generated from a view appropriate to the location of that eye, while the other is generated analogously for the right eye.
5. **Hidden-line elimination:** The relative depth of objects in scene is readily apparent if the lines that are hidden from view by opaque objects are removed from the image.
6. **Shading with hidden surface removed:** On a raster-scan display, showing the color and intensity of surfaces helps to convey the depth and shape of an object.

5. Attempt any two parts of the following: $10 \times 2 = 20$

(a) What do you understand by back face removal? Explain Warnock's algorithm.

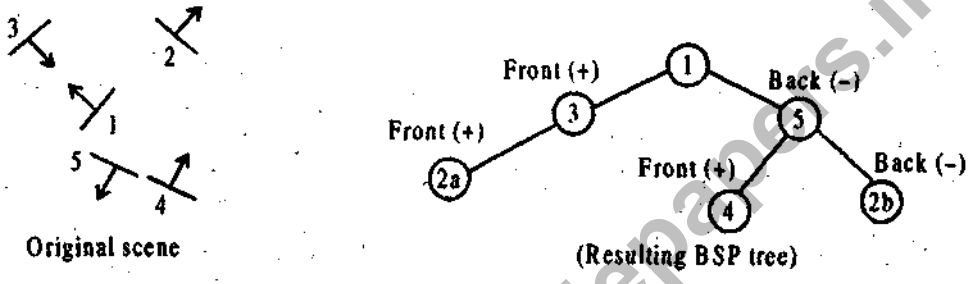
Ans. Back-face removal is a technique to remove the hidden-line surface. This is a simple test, which will eliminate most of the faces which cannot be seen. An interesting approach to the hidden-surface problem was presented by warnock. His method does not try to decide exactly what is happening in the scene but rather just tries to get the display right. As the resolution of the display increases, the amount of work which the algorithm must do to get the scene right also increase. The algorithm divides the screen up into sample areas. In some sample areas it will be easy to decide what to do. If there are no faces within the area, then it is left blank. If the nearest polygon completely cover it, then it can be filled in with the color of that polygon. If neither of these conditions holes, then the algorithm subdivides the sample area into smaller sample areas and considers each of them in turn. This process is repeated as needed.

(b) Explain the Binary Space-Partitioning method with a suitable example.

Ans. BSP algorithm assumes that for a given view point a polygon is correctly rendered if all the polygons on its side away from the viewpoint are rendered first; then the polygon itself is rendered; and finally all the

polygons on the side nearer the view point are rendered. BSP algorithm is a two-port algorithm. First the BSP tree is constructed and then it is displayed.

Constructing the BSP tree: BSP tree algorithm recursively subdivides space into two half spaces. Each half space is then recursively subdivided, using one of the polygons in the half space as the separating plane; subdivision continues until there is only a single polygon in each half space. The subdivided space is conveniently represented by a binary tree, with the original separating polygon as the root. The following figure shows a simple scene and the resulting BSP tree as it is constructed.



BSP Tree Traversal: In order to generate the visible surfaces from the BSP tree , it is only necessary to know the spatial relationship of the viewpoint to the root polygon of the tree, A variant of a_n in order tree traversal; i.e., traverse one subtree, visit the root, traverse the other subtree, is then used to generate the visible surfaces.

(c) Write note on rendering and illumination.

Ans. Please see Q. 5(b) of 2007-08.