DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DATA SCIENCE

UNIT TEST-I SOLUTION

Class: SE **Semester: III** **Subject: Computer Graphics**
Max marks: 40

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<tr><td>Q.1.</td><td>Attempt any two.</td><td></td></tr>
<tr><td>i)</td><td>Compare Raster Scan and Random Scan
Ans
<table><tr><th>Random Scan</th><th>Raster Scan</th></tr><tr><td>1. It has high Resolution</td><td>1. Its resolution is low.</td></tr><tr><td>2. It is more expensive</td><td>2. It is less expensive</td></tr><tr><td>3. Any modification if needed is easy</td><td>3.Modification is tough</td></tr><tr><td>4. Solid pattern is tough to fill</td><td>4.Solid pattern is easy to fill</td></tr><tr><td>5. Refresh rate depends or resolution</td><td>5. Refresh rate does not depend on tl picture.</td></tr><tr><td>6. Only screen with view on an area is displayed.</td><td>6. Whole screen is scanned.</td></tr><tr><td>7. Beam Penetration technology come under it.</td><td>7. Shadow mark technology came und this.</td></tr><tr><td>8. It does not use interlacing method.</td><td>8. It uses interlacing</td></tr><tr><td>9. It is restricted to line drawing applications</td><td>9. It is suitable for realistic display.</td></tr></table></td><td>[5]</td></tr>
<tr><td>ii)</td><td>Draw the diagram of CRT and explain itsworking.</td><td>[5]</td></tr>
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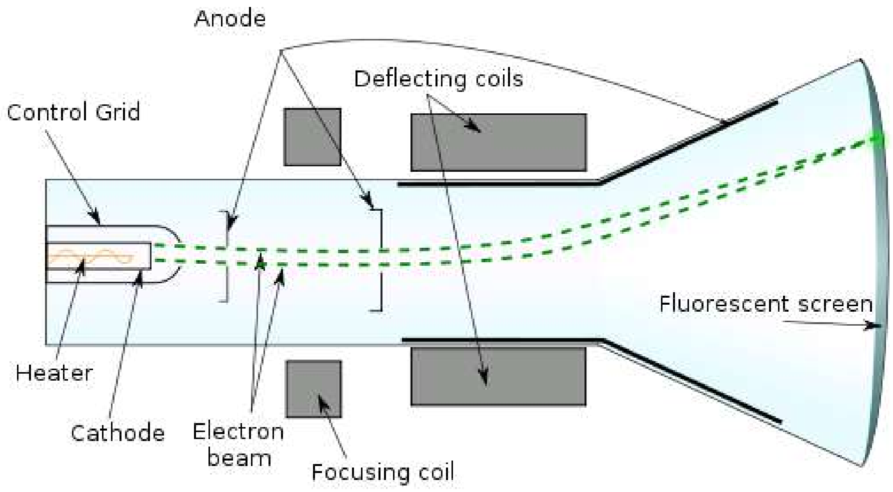


Parts of a CRT

The features of a CRT can be split into 3 main sections: The electron gun, the deflection system and the fluorescent screen.

Electron Gun

The role of this section is to produce electrons at a high, fixed, velocity.
This is done through a process known as thermionic emission.
A filament in the cathode is heated to the point where its electrons become loose.
An anode with a high voltage applied to it accelerates the electrons towards the screen due to electrostatic attraction.
On the way, the electrons pass through a series of control grids which control the brightness of the image produced.
The more negative the grid, the darker the image and vice versa.

Deflection system

The role of the deflection system is to control the image produced by controlling the position that the electrons hit the screen.
It consists of Two PERPENDICULAR sets of Electric/Magnetic fields.
This allows control over both horizontal and vertical axes.
By controlling the Voltage applied to the fields, it is possible to vary the deflection through Electrostatic force/Motor effect.

Fluorescent screen

The role of this part is to display where the electrons are hitting the CRT.
It is a screen coated with a material that emits light when struck by electrons.
Zinc sulfide or Phosphorus are two commonly used materials.

iii) Define the terms - computer graphics, scan conversion, pixel, aspect ratio, frame buffer. [5]

Ans:

1. Computer Graphics:

- The computer graphics is one of the most effective and commonly used way to communicate the processed information to the user. It displays the information in the form of graphics objects such as pictures, charts, graphs and diagrams instead of simple text.
- The Computer Graphics is rendering (Service) tool for generation of images and manipulation of images.
- Computer graphics is the technology that deals with designs and pictures on computers, which studies about manipulating visual content, Synthesizing digitally.

	2. Scan Conversion: • It is a process of representing graphics objects a collection of pixels. The graphics objects are continuous. The pixels used are discrete. Each pixel can have either on or off state. • The circuitry of the video display device of the computer is capable of converting binary values (0, 1) into a pixel on and pixel off information. 0 is represented by pixel off. 1 is represented using pixel on. Using this ability graphics computer represent picture having discrete dots. 3. Pixel: • A pixel is the smallest unit of a digital image or graphic that can be displayed and represented on a digital display device. • A pixel is the basic logical unit in digital graphics. Pixels are combined to form a complete image, video, text, or any visible thing on a computer display. • A pixel is also known as a picture element (pix = picture, el = element). 4. aspect ratio: • An aspect ratio is an attribute that describes the relationship between the width and height of an image. Aspect ratio is expressed by the symbolic notation: X:Y. The values of X and Y are not the actual width and height of the image, but describe the relationship between them. • As a simple example, a square image has an aspect ratio of 1:1 since the height and width are the same. But the image could be 500px × 500px, or 1500px × 1500px, and the aspect ratio would still be 1:1. 5. frame buffer: • An area of memory (RAM) used to hold the frame of data that is continuously being sent to the screen. The frame buffer is the size of the maximum image that can be displayed, and it may be a separate memory bank on the graphics card (display adapter), GPU or a reserved part of regular memory. Today's sophisticated graphics systems are built with several memory planes, each holding one or more bits of the pixel. See video RAM and GPU. See also frame grabber.	
iv)	State the various application of computer graphics. Explain any one in detail. Ans: Computer graphics are very useful. Today almost every computer can do some graphics, and people have even come to expect to control their computer through icons and pictures rather than just by typing.Computer-generated imagery is used for movie making, video game and computer program development, scientific modeling, and design for catalogs and other commercial art. Some people even make computer graphics as art. We can classify applications of computer graphics into four main areas: • **Display of information.** • **Design.** • **User interfaces.** • **Simulation.** There are several uses of CG which are very useful in the current scenario. Some of its uses include, A).Computer program Development B).Making movies C).Video Games (Ex: Platformers, Role-playing games, sidescrollers, first person shooters)	[5]

D).Catalogs designing
E).Creating Commercial Arts
F).Scientific Modelling (Ex: Weather Forecasts, Meteorological data)

<u>Applications of Computer Graphics:</u>

Computer Graphics are very useful to create any object effectively using Graphics application.

A).Video Games:
These games requires human interaction with the User Interface for making nice visual result on the Video Device

B).Education Field:
In the learning process, acquiring knowledge and skills required for better career path CG is needed. So Computer generated models in economic, financial and physical systems are often used.
We regularly love to have computerized model to understand any topic easily.
Equipments, Physiological systems, physical systems are coded using CG

C).Computer Aided Design (CAD):
Most of engineering and Architecture students are concerned with Design.CAD is used to design various structures such as Computers, Aircrafts, Building, in almost all kinds of Industries (where designing is necessary)
After making a full diagram, we can even see its animation (Operation and working of a Product)

D).Computer Arts:
If we are intelligent enough we can rock by making creative arts using these Graphics tools. For making these arts we generally use CAD packages, paint and Paint brush programs and in animation too
Computer Arts Examples include Logo design (for companies, college, Industries, Institutions), Cartoon drawing, Product advertisements and many

E).Simulation:
Using CG graphics reproduction or duplicating already existing thing will be done. For Instance, if we go for the Flight simulators, these computer generated images are very much needed for training pilots to understand easily (learning standard methods)

F).Entertainment:
When we talk about Entertainment, immediately movies and games get in to picture.CG are mostly used in music videos, motion pictures, cartoon animation films. For finding out tricks to be used in Games, for its interactivity we often use CG

G).Image Processing: (Medical)
In Medical field, concerning Image Processing CG is used to various technologies to interpret already existing pictures and is useful to modify Photographs and TV scans. Basically CG is used to improve the picture quality, and visualizing effects. Some of its applications include,
i).Tomography
ii).Ultrasonic medical scanners
iii).Picture enhancements

H).User Interfaces (Graphical User Interfaces)
CG is effectively used to make Menus, Icons (Graphical Symbols),to make window manager(multiple windows).And Some of the Graphic packages includes PHIGS,Graphics Kernel System,Painting,drawing.

Q.2.	Attempt any two	

i)	Plot a line from A(10,15) to B(5,25) using the DDA line drawing algorithm. What are the disadvantages of DDA line algorithm?	[10]

DDA algorithm:

```
Algo_DDA(x1, y1, x2, y2)
{
    dx = x2 - x1
    dy = y2 - y1
    if (abs(dx) > abs(dy))
    {
        steps = abs(dx)
    }
    else
    {
        steps = abs(dy)
    }
    x_inc = dx/steps        -0.5
    y_inc = dy/steps        10/10 = 1
    for(i=0; i<=steps; i++)
    {
        put_pixel(x1, y1)
        x1 = round(x1 + x_inc)
        y1 = round(y1 + y_inc)
    }
}   (~~xn, yn~~)   (~~xn, yn~~)
```

→ Given : Starting point A(10,15) and Ending point : (5,25)

Step1: Find dx, dy

$\therefore x_1 = 10 \quad x_2 = 5 \quad y_1 = 15 \quad y_2 = 25$

$\therefore dx = x_2 - x_1 = 5 - 10 = -2$

$dy = 25 - 15 = 10$

Step2:

$|dx| < |dy| \quad : \quad 5 < 10$

$\therefore$ Steps: $dy = 10$

Step3: ~~xk+1~~ : $x_{inc} = dx/steps$

$= -5/10 = -0.5$

$y_{inc} = dy/steps$

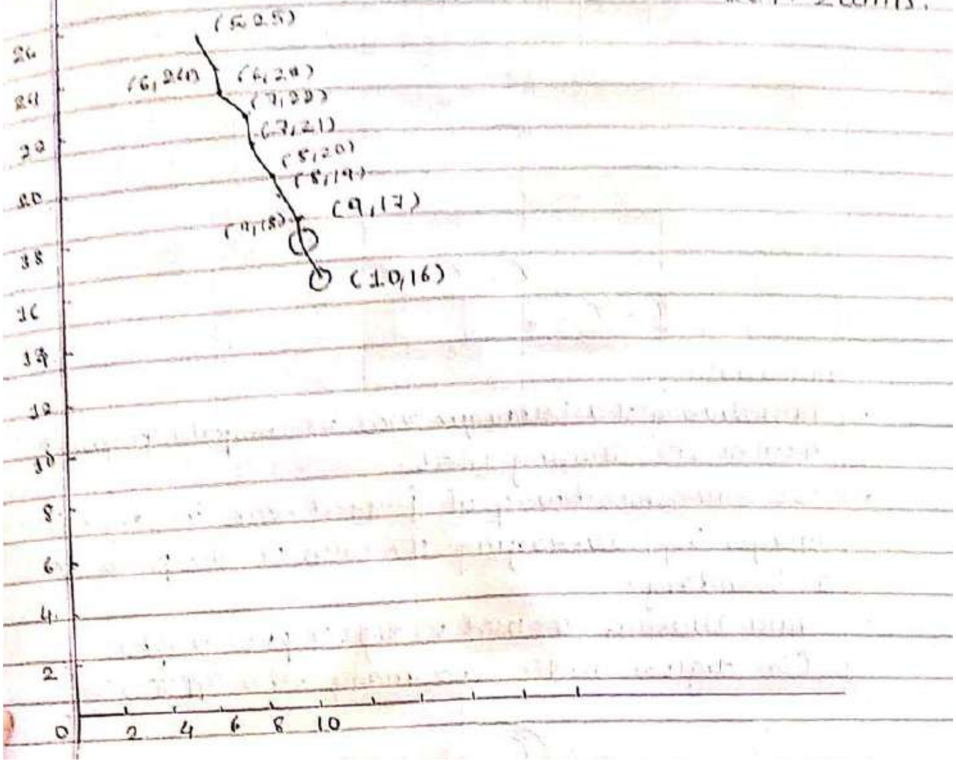
$= 10/10 = 1$

$x_{k+1} = x_k + x_{inc}$

$y_{k+1} = y_k + y_{inc}$

x_k	y_k	x_{k+1}	y_{k+1}	Round(x_{k+1}, y_{k+1})
10	15	9.5	16	(10,16)
		9	17	(9,17)
		8.5	18	(9,18)
		8	19	(8,19)
		7.5	20	(8,20)
		7	21	(7,21)
		6.5	22	(7,22)
		6	23	(6,23)
		5.5	24	(6,24)
		5	25	(5,25)

on both axis
1 cm : 2 units.



ii) Draw a line from A(10,10) to B(18,16) usingBresenham's Line Drawing algorithm. Further differentiate between DDA and Bresenhams line drawing algorithm. [10]

A(10,10) to B(18,16) - Bresenham's algorithm

Algorithm:

```
Algo_Bresenham(x1, y1, x2, y2)
{
    dx = x2 - x1
    dy = y2 - y1
    p = 2dy - dx
    for (i=0 to dx)
    {
        put_pixel(x,y)
        x++
        if (p<0)                else
        {                       {
            p = p+2dy               p = p+2dy-2dx
                                    y+1
        }                       }
    }
```

$x_1 : 10 \quad x_2 : 18 \quad y_1 : 10 \quad y_2 : 16$

Step1: Calculate dx & dy

$\therefore dx = x_2 - x_1 = 18 - 10 = 8$

$dy = y_2 - y_1 = 16 - 10 = 6$

$2dy - 2dx : 2\times6 - 2\times8$

$: 12 - 16 : -4$

Step2: $P = 2dy - dx$

$= 2\times6 - 8 = 12 - 8 = 4$

Step3: $x{+}{+}$

check $P<0$ $P = P + 2dy$ else $P = P + 2dy - 2dx$

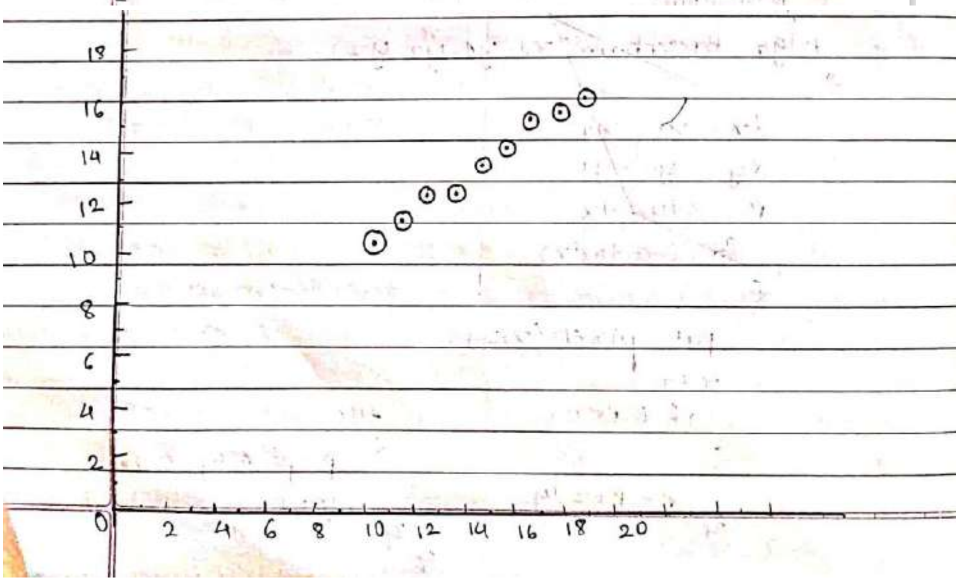
$y{+}{+}$

	x	y	P
	10	10	4
1	11	11	0
2	12	12	-4
3	13	12	8
4	14	13	4
5	15	14	0
6	16	15	-4
7	17	15	8
8	18	16	4.

$4 + 2\times6 - 2\times8$

$4+12-16$

$16-16$



iii) Apply midpoint circle algorithm for plottinga circle with radius 8 units and center at (10,10) also write algorithm for the same. [10]

14. Midpoint circle algorithm:

1. Plot the initial (x_k, y_k) i.e $x_k = 0$ and $y_k = r$
2. Calculate initial Decision Parameter $P_0 = \frac{5}{4} - r$
3. If $P_k < 0$ then choose $y_{k+1} = y_k$
   - $x_{k+1} = x_k + 1$
   - $y_{k+1} = y_k$
   - $P_{k+1} = P_k + 2x_k + 3$
4. If $P_k >= 0$ then choose $y_{k+1} = y_{k-1}$
   - $x_{k+1} = x_k + 1$
   - $y_{k+1} = y_{k-1}$
   - $P_{k+1} = P_k + 2x_k - 2y_k + 5$

(x_c, y_c): current value of x & y

5. $x\,plot = x_c + x_0$ $\quad$ $y\,plot = y_c + y_0$
6. Determine symmetry points in the other 7 octants.
7. Repeat step 3 to 5 until $x_{k+1} \geq y_{k+1}$

Given: centre = $(x_0, y_0) = (10, 10)$
Radius: 8 units

Steps:

Assign starting point (x_0, y_0) as $x_0 = 0$! $y_0 = r$
$\therefore (0, 8)$

Step 2: initial Decision parameter

$P_0 = \frac{5}{4} - r = -6.75$
≈ -7

Step 3: $P_0 < 0$

Thus: $x_{k+1} = x_k + 1 = 1$
$y_{k+1} = y_k = 8$ $\quad -7$
$P_{k+1} = P_k + 2x_k + 3 = -6.75 + 2.0 + 3$
$= -3.75$
≈ -4

Step 4: (current, centre)
$x\,plot = x_c + x_0$ $\quad$ $y\,plot = y_c + y_0$
$= 0 + 10 = 10$ $\quad$ $= 8 + 10 = 18.$

K	Pk	(x_{k+1}, y_{k+1})	Quadrant 1 (x_{plot}, y_{plot}) (+, +)	Quad 2 (x, y) (−, +)	Quad 3 (x, y) (−, −)	Quad 4 (x, y) (+, −)
0	~~-7~~ -7	(0, 8)	(10, 18)	(-10, 18)	(-10, -18)	(10, -18)
1	-4	(1, 8)	(11, 18)	(-11, 18)	(-11, -18)	(11, -18)
2	1	(2, 8)	(12, 18)	(-12, 18)	(-12, -18)	(12, -18)
3	-6	(3, 7)	(13, 17)	(-13, 17)	(-13, -17)	(13, -17)
4	3	(4, 7)	(14, 17)	(-14, 17)	(-14, -17)	(14, -17)
5	2	(5, 6)	(15, 16)	(-15, 16)	(-15, -16)	(15, -16)
6	5	(6, 5)	(16, 15)	(-16, 15)	(-16, -15)	(16, -15)

Q.3. Attempt any one.

i) Rotate a triangle ABC by an angle 90º where the triangles has the coordinates A(0,0), B(1,0), C(1,1). Calculate new coordinates of the triangle. [10]

We rotate a polygon by rotating each vertex of it with the same rotation angle.

Given-

- Old corner coordinates of the triangle = A (0, 0), B(1, 0), C(1, 1)
- Rotation angle = θ = 90º

For Coordinates A(0, 0)

Let the new coordinates of corner A after rotation = (X_{new}, Y_{new}).

Applying the rotation equations, we have-

X_{new}

$= X_{old} \times \cos\theta - Y_{old} \times \sin\theta$

$= 0 \times \cos 90^{o} - 0 \times \sin 90^{o}$

$= 0$

Y_{new}

$= X_{old} \times \sin\theta + Y_{old} \times \cos\theta$

$= 0 \times \sin 90^{o} + 0 \times \cos 90^{o}$

$= 0$

Thus, New coordinates of corner A after rotation = (0, 0).

For Coordinates B(1, 0)

Let the new coordinates of corner B after rotation = (X_{new}, Y_{new}).

X_{new}

	$= X_{old} \times \cos\theta - Y_{old} \times \sin\theta$ $= 1 \times \cos 90^o - 0 \times \sin 90^o$ $= 0$ Y_{new} $= X_{old} \times \sin\theta + Y_{old} \times \cos\theta$ $= 1 \times \sin 90^o + 0 \times \cos 90^o$ $= 1 + 0$ $= 1$ Thus, New coordinates of corner B after rotation = (0, 1). **<u>For Coordinates C(1, 1)</u>** Let the new coordinates of corner C after rotation = (X_{new}, Y_{new}). X_{new} $= X_{old} \times \cos\theta - Y_{old} \times \sin\theta$ $= 1 \times \cos 90^o - 1 \times \sin 90^o$ $= 0 - 1$ $= -1$ Y_{new} $= X_{old} \times \sin\theta + Y_{old} \times \cos\theta$ $= 1 \times \sin 90^o + 1 \times \cos 90^o$ $= 1 + 0$ $= 1$ Thus, New coordinates of corner C after rotation = (-1, 1).	
ii)	Perform scaling on a square with coordinates A(2,2), B(4,2), C(4,4), D(2,4). The scaling factor along the x-axis is 3 andthe scaling factor along the y-axis is 2.	[10]

10: Given:

- Old coordination of square A(2,2) B(4,2) C(4,4) D(2,4)
- Scaling factor along x axis: 3
- Scaling factor along y-axis: 2

For coordinates A(2,2): (X,Y)

Let the new coordinates of A after scaling be (X', Y')

Applying scaling equation:

- $X' = X \cdot Sx$ $\qquad$ $Y' = Y \cdot Sy$

$X' = 2 \cdot 3$ $\qquad$ $Y' = 2 \cdot 2$

$X' = 6$ $\qquad$ $Y' = 4$

∴ New coordinate of A after scaling (6, 4)

For coordinates B(4,2): (X,Y)