Ques 1 :

a). How long would it take to load a 640 by 480 frame buffer with 12 bits per pixel, if 10^5 bits can be transferred per second ? How long would it take to load a 24 bit per pixel frame buffer with a resolution of 1280 by 1024 using this same transfer rate ? [2][CO#1]

Total number of bits for the frame = $640 \times 480 \times 12$
= 3686400 bits

Time needed to load the frame buffer : $3686400 / 10^5$
= 36.864 sec

1 Mark

Total number of bits for the frame = $1280 \times 1024 \times 24$
= 31457280 bits

Time needed to load the frame buffer = $31457280 / 10^5$
= 314.57280 sec

1 Mark

b). Suppose we have a computer with 32 bits per word and a transfer rate of 1 mip (one million instructions per second). How long would it take to fill the frame buffer of a 300 dpi (dot per inch) laser printer with a page size of 8.5 inches by 11 inches ? [2][CO#1]

Page Size = 8.5 inches * 11 inches
Resolution : 8.5 * 300 * 11 * 300 = 2550 * 3300
Bit per pixel = 1
Size of frame buffer = 2550 * 3300 * 1 bits

1 Mark

1 word = 32 bits
1 instruction = 32 bits
1 mips = $1 * 10^6$ instruction per sec = $32 * 10^6$ bits per sec

32×10^6 bits in 1 sec

2550 * 3300 * 1 bits in $\frac{2550 * 3300 * 1}{32 * 10^6}$ sec = 0.263 sec.

1 Mark

c). Suppose we have a video monitor with a display area that measures 12 inches across and 9.6 inches high. If the resolution is 1280 by 1024 and the aspect ratio is 1, what is the diameter of each screen point ? [2][CO#1]

No. of pixels in row = 1280

1280 pixels = 12 inches

$$1 \text{ pixel (diameter)} = \frac{12}{1280} = 0.009375 \text{ inches}$$

No. of pixels in column = 1024

1024 pixels = 9.6 inches

$$1 \text{ pixel (diameter)} = \frac{9.6}{1024} = 0.009375 \text{ inches}$$

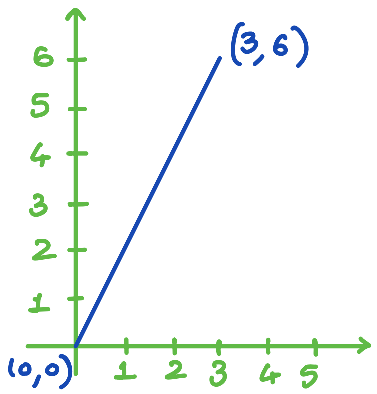
Ques 2 :

a). Show the derivation for Bresenham line drawing algorithm when slope m > 1. [3][CO#2]

$m > 1$

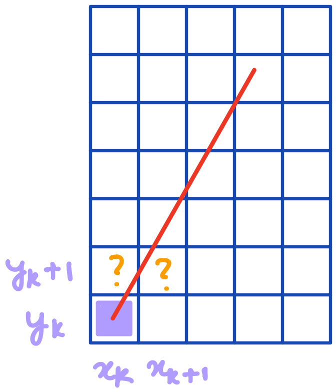
$$\frac{\Delta y}{\Delta x} > 1$$

$$\Delta y > \Delta x$$



$$m = \frac{\Delta y}{\Delta x} = \frac{6}{3} = 2$$

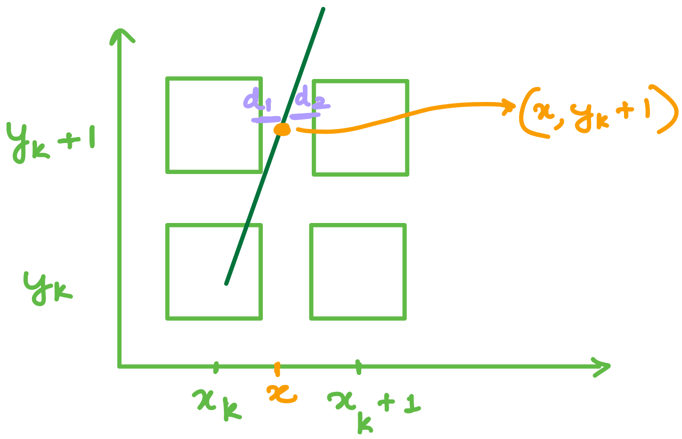
y is increasing with higher rate, so do sampling on y.



x_k, y_k

$y_{next} = y_k + 1$

$$x_{next} \begin{cases} \rightarrow x_k \\ \rightarrow x_k + 1 \end{cases} \quad ?$$



$y = mx + c$

at point (x, y_k+1) eqⁿ is:

$y_k + 1 = mx + c$

$$x = \frac{y_k + 1 - c}{m}$$

$$d_1 = x - x_k = \frac{y_k + 1 - c}{m} - x_k$$

$$d_2 = x_k + 1 - x = x_k + 1 - \left(\frac{y_k + 1 - c}{m}\right)$$

$d_1 - d_2 < 0 \Rightarrow d_1 < d_2 \rightarrow x_k$

$d_1 - d_2 > 0 \Rightarrow d_1 > d_2 \rightarrow x_k + 1$

$$d_1 - d_2 = \frac{(y_k + 1 - c)}{m} - x_k - x_k - 1 + \frac{(y_k + 1 - c)}{m}$$

$$d_1 - d_2 = \frac{2(y_k + 1 - c)}{m} - 2x_k - 1$$

multiply both side by Δy

$$\underbrace{\Delta y(d_1-d_2)}_{p_k} = 2\Delta x(y_k+1-c) - 2\Delta y\, x_k - \Delta y$$

p_k 2
decision parameter

$$p_k = \Delta y(d_1-d_2) = 2\Delta x\, y_k + 2\Delta x - 2\Delta x\, c - 2\Delta y\, x_k - \Delta y$$

$$p_k = \Delta y(d_1-d_2) = 2\Delta x\, y_k - 2\Delta y\, x_k + \underbrace{2\Delta x - 2\Delta x\, c - \Delta y}_{\text{constant value}}$$

$$\boxed{p_k = \Delta y(d_1-d_2) = 2\Delta x\, y_k - 2\Delta y\, x_k}$$

if $d_1-d_2<0 \Rightarrow d_1<d_2 \rightarrow$ Select x_k

$$p_k = \underbrace{\Delta y}_{+ve}\ \underbrace{(d_1-d_2)}_{-ve} = -ve$$

$$p_k<0 \Rightarrow x_k$$

Case 1: $p_k<0$
Select x_k

if $d_1-d_2>0 \Rightarrow d_1>d_2 \rightarrow$ Select x_k+1

$$p_k = \underbrace{\Delta y}_{+ve}\ \underbrace{(d_1-d_2)}_{+ve} = +ve$$

$$p_k>0 \Rightarrow x_k+1$$

Case 2: $p_k>0$
Select x_k+1

Decision Parameter for next pixel

$$p_k = \Delta y(d_1-d_2) = 2\Delta x\, y_k - 2\Delta y\, x_k$$

$$p_{next} = 2\Delta x\, y_{next} - 2\Delta y\, x_{next}$$

$$p_{next} - p_k = [2\Delta x\, y_{next} - 2\Delta y\, x_{next}] - [2\Delta x\, y_k - 2\Delta y\, x_k]$$

$$p_{next} - p_k = 2\Delta x(y_{next}-y_k) - 2\Delta y(x_{next}-x_k)$$

$y_{next} = y_k + 1$ (Sampling on y)

$$x_{next} \begin{cases} \nearrow x_k \\ \searrow x_k + 1 \end{cases}$$

$x_{next} = x_k$ and $y_{next} = y_k + 1$

$$p_{next} - p_k = 2\Delta x (y_k + 1 - y_k) - 2\Delta y (x_k - x_k)$$

$$p_{next} - p_k = 2\Delta x$$

$$\boxed{p_{next} = p_k + 2\Delta x}$$

$x_{next} = x_k + 1$ and $y_{next} = y_k + 1$

$$p_{next} - p_k = 2\Delta x (y_k + 1 - y_k) - 2\Delta y (x_k + 1 - x_k)$$

$$p_{next} - p_k = 2\Delta x - 2\Delta y$$

$$\boxed{p_{next} = p_k + 2\Delta x - 2\Delta y}$$

Initial value of p_k i.e. p_1

$$p_k = \Delta y (d_1 - d_2) = 2\Delta x\, y_k - 2\Delta y\, x_k + 2\Delta x - 2\Delta x\, c - \Delta y$$

$k = 1$

$$p_1 = 2\Delta x\, y_1 - 2\Delta y\, x_1 + 2\Delta x - 2\Delta x \cdot c - \Delta y$$

$$y = mx + c$$

$$y_1 = m x_1 + c$$

$$y_1 = \frac{\Delta y}{\Delta x} x_1 + c$$

$$c = y_1 - \frac{\Delta y}{\Delta x} x_1$$

$$p_1 = 2\Delta x\, y_1 - 2\Delta y\, x_1 + 2\Delta x - 2\Delta x\left[y_1 - \frac{\Delta y}{\Delta x} x_1\right] - \Delta y$$

$$p_1 = 2\cancel{\Delta x}\, y_1 - 2\cancel{\Delta y}\, x_1 + 2\Delta x - 2\cancel{\Delta x}\, y_1 + 2\cancel{\Delta y}\, x_1 - \Delta y$$

$$\boxed{p_1 = 2\Delta x - \Delta y}$$

b). Given the center as (2,6) and radius as 3, illustrate the steps in midpoint circle algorithm by determining raster positions along the circular path in the first octant. [3][CO#2]

lets assume center as (0,0)

$x = 0 \quad y = 3$

$p = 1 - r = 1 - 3 = -2$

0.5 marks

$x \le y$	plot (x,y)	pnext	y	x
$0 \le 3$	plot (0,3)	$p = -2 + 3 = 1$	3	1
$1 \le 3$	plot (1,3)	$p = 1 + 2 - 6 + 5 = 2$	2	2
$2 \le 2$	plot (2,2)	$p = 2 + 4 - 4 + 5 = 7$	1	3
$3 \le 1$ X stop				

1.5 Marks

Translate the plotted points by (2,6)

plot (0,3) $\longrightarrow$ plot (2,9)

plot (1,3) $\longrightarrow$ plot (3,9)

plot (2,2) $\longrightarrow$ plot (4,8)

1 Mark

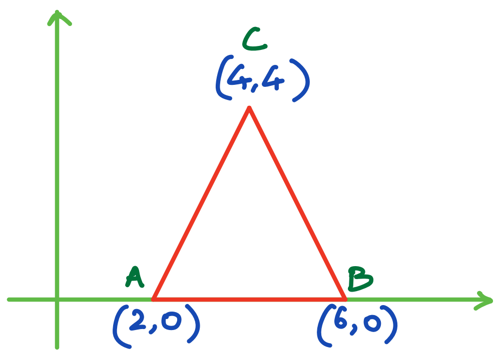
c). Explain in detail with algorithms and diagrams all the methods to fill a polygon with a particular color. [3][CO#2]

Polygon filling

- Scan line (1 Mark)
  - Explanation with diagrams
- Seed fill
  - Boundary fill (1 Mark)
    - Algorithm (0.5)
    - Explanation (0.5) with Diagram
  - Flood fill (1 Mark)
    - Algorithm (0.5)
    - Explanation (0.5) with Diagram

Ques 3:

Consider a triangle with end points at (2,0) (6,0) and (4,4). The coordinates of the triangle are translated by (-4,-2) and then rotated by an angle of 90 degree in anti-clockwise direction about the pivot point (1,3). What will be the coordinates of the end points of new triangle. [5][CO#3]



$$R = \begin{bmatrix} \cos\theta & -\sin\theta & x_r(1-\cos\theta)+y_r\sin\theta \\ \sin\theta & \cos\theta & y_r(1-\cos\theta)-x_r\sin\theta \\ 0 & 0 & 1 \end{bmatrix}$$

$\theta = 90^\circ \Rightarrow \cos 90 = 0$, $\sin 90 = 1$ $\quad x_r = 1$, $y_r = 3$

$$R = \left.\begin{bmatrix} 0 & -1 & 4 \\ 1 & 0 & 2 \\ 0 & 0 & 1 \end{bmatrix}\right\} \text{1 Mark}$$

$$T = \left.\begin{bmatrix} 1 & 0 & -4 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix}\right\} \text{1 Mark}$$

$$R \cdot T = \begin{bmatrix} 0 & -1 & 4 \\ 1 & 0 & 2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -4 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix}$$

$$R \cdot T = \left.\begin{bmatrix} 0 & -1 & 6 \\ 1 & 0 & -2 \\ 0 & 0 & 1 \end{bmatrix}\right\} \text{1 Mark}$$

$$P' = (RT)\, P$$

$$= \begin{bmatrix} 0 & -1 & 6 \\ 1 & 0 & -2 \\ 0 & 0 & 1 \end{bmatrix} \overbrace{\begin{bmatrix} 2 & 6 & 4 \\ 0 & 0 & 4 \\ 1 & 1 & 1 \end{bmatrix}}^{\text{1 Mark}} = \underbrace{\begin{array}{ccc} A' & B' & C' \\ \left[\begin{matrix} 6 \\ 0 \\ 1 \end{matrix}\right. & \begin{matrix} 6 \\ 4 \\ 1 \end{matrix} & \left.\begin{matrix} 2 \\ 2 \\ 1 \end{matrix}\right] \end{array}}_{\text{1 Mark}}$$

New Coordinates: $(6,0)$ $(6,4)$ $(2,2)$