Name:- Sumit Kumar Yadav

Roll No.:- 18CS30042

Page No.

Date

Sol^n:- 1:- (a) Transformation functions for generating the individual bit-planes of a 4-bit monochromatic image:

for bit plane 1:

$$f_1(x) = \begin{cases} 0 & \text{if } x \% 2 == 0 \text{ (ie; } x \text{ is even)} \\ 1 & \text{otherwise} \end{cases}$$

for bit plane 2:

$$f_2(x) = \begin{cases} 0 & \text{if } x \% 4 == 1 \text{ or } x \% 4 == 0 \\ 1 & \text{otherwise} \end{cases}$$

for bit plane 3:

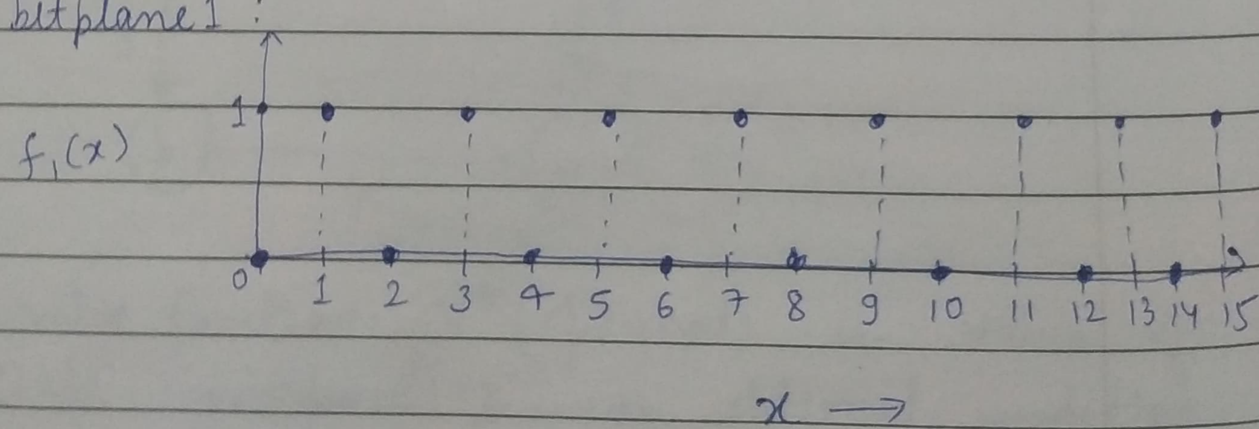
$$f_3(x) = \begin{cases} 0 & \text{if } x \% 8 \leq 3 \\ 1 & \text{otherwise} \end{cases}$$

for bit plane 4:

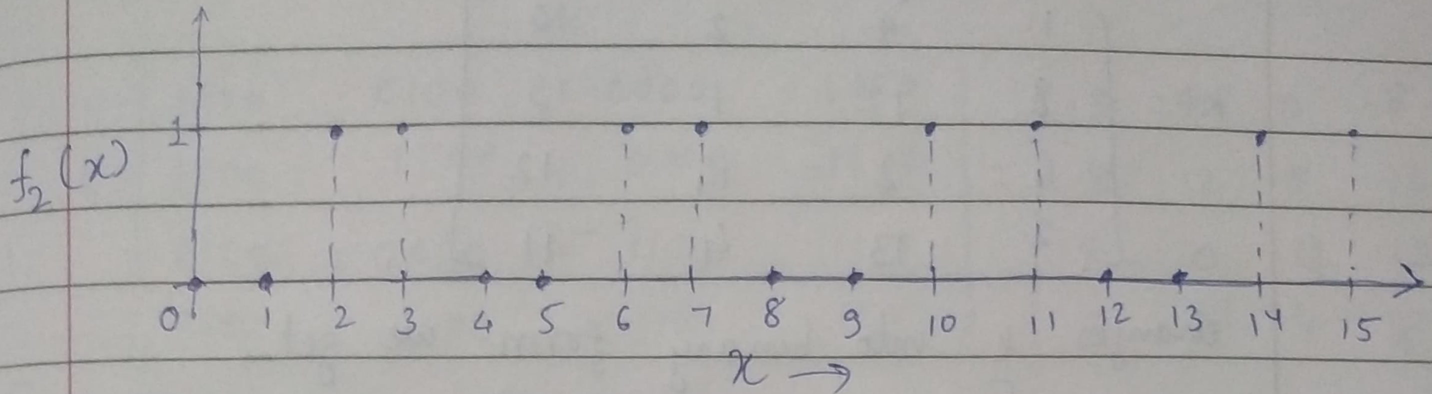
$$f_4(x) = \begin{cases} 1 & \text{if } x \geq 8 \\ 0 & \text{otherwise} \end{cases}$$

Plots for each bit-plane:-

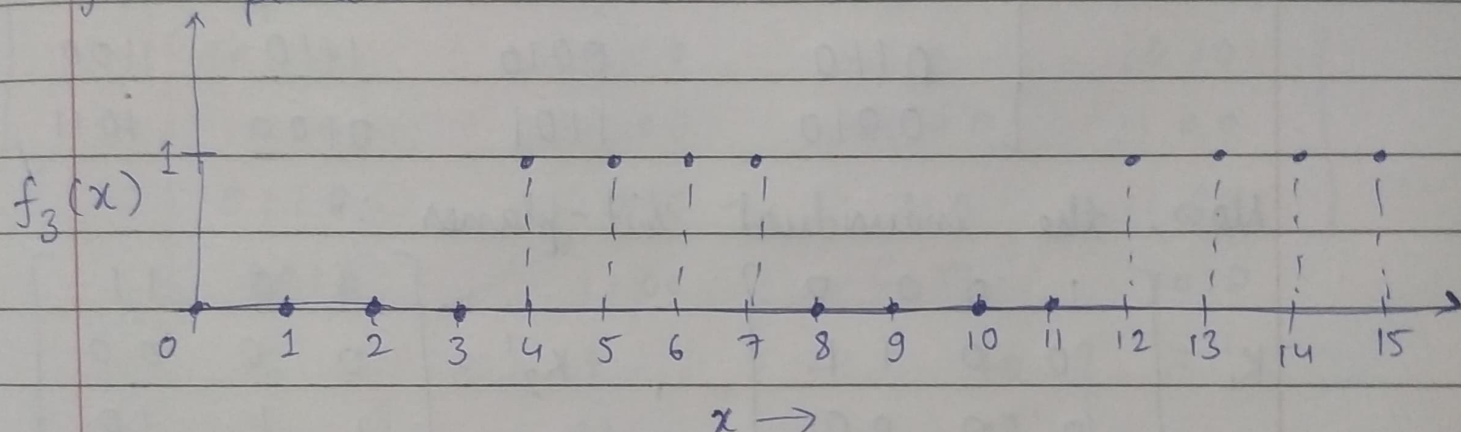
for bitplane 1:



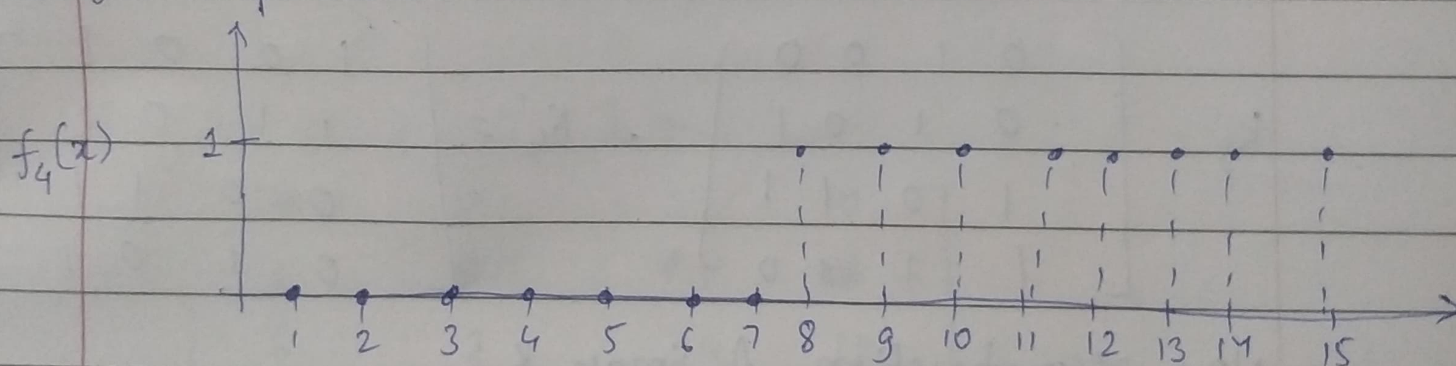
for bitplane 2 :-



for bit plane 3 :-



for bitplane 4 :-



(b) 4-bit gray level image K:

$$K = \begin{bmatrix} 11 & 4 & 2 & 10 \\ 8 & 12 & 1 & 13 \\ 6 & 2 & 14 & 12 \\ 2 & 13 & 4 & 11 \end{bmatrix}$$

changes K into binary form we get,

$$K' = \begin{bmatrix} 1011 & 0100 & 0010 & 1010 \\ 1000 & 1100 & 0001 & 1101 \\ 0110 & 0010 & 1110 & 1100 \\ 0010 & 1101 & 0100 & 1011 \end{bmatrix}$$

Now, the individual bit-planes :-

$$K_1' = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix}, \quad K_2' = \begin{bmatrix} 1 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 \end{bmatrix}$$

$$K_3' = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}, \quad K_4' = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 1 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$

Now, reconstruction of image K:

(i) bit-plane 4

$$K = \begin{bmatrix} 1000 & 0000 & 0000 & 1000 \\ 1000 & 1000 & 0000 & 1000 \\ 0000 & 0000 & 1000 & 1000 \\ 0000 & 1000 & 0000 & 1000 \end{bmatrix}$$

$$= \begin{bmatrix} 8 & 0 & 0 & 8 \\ 8 & 8 & 0 & 8 \\ 0 & 0 & 8 & 8 \\ 0 & 8 & 0 & 8 \end{bmatrix}$$

(ii) bit plane 3 and 4

$$K = \begin{bmatrix} 1000 & 0100 & 0000 & 1000 \\ 1000 & 1100 & 0000 & 1100 \\ 0100 & 0000 & 1100 & 1100 \\ 0000 & 1100 & 0100 & 1000 \end{bmatrix} = \begin{bmatrix} 8 & 4 & 0 & 8 \\ 8 & 12 & 0 & 12 \\ 4 & 0 & 12 & 12 \\ 0 & 12 & 4 & 8 \end{bmatrix}$$

(iii) bit plane 2, 3 and 4

$$K = \begin{bmatrix} 1010 & 0100 & 0010 & 1010 \\ 1000 & 1100 & 0000 & 1100 \\ 0110 & 0010 & 1110 & 1100 \\ 0010 & 1100 & 0100 & 1010 \end{bmatrix}$$

$$= \begin{bmatrix} 10 & 4 & 2 & 10 \\ 8 & 12 & 0 & 12 \\ 6 & 2 & 14 & 12 \\ 2 & 12 & 4 & 10 \end{bmatrix}$$

(iv) bit-plane 1, 2, 3 & 4 :

$$K = \begin{bmatrix} 11 & 4 & 2 & 10 \\ 8 & 12 & 1 & 13 \\ 6 & 2 & 14 & 12 \\ 2 & 13 & 4 & 11 \end{bmatrix}$$

Sol^n:- 2:- $\because$ $P_r(r) = 2 - \frac{2r}{3}$

& $P_z(z) = \frac{2z}{3}$

$\therefore$ Transformation (in terms of r & z):

$$\cancel{2}\int_0^r P_r(r)\,dr = \cancel{2}\int_0^z P_z(z)\,dz$$

$$\Rightarrow 2r - \frac{r^2}{3} = \frac{z^2}{3}$$

$$\Rightarrow z^2 = 6r - r^2$$

$$\Rightarrow r^2 - 6r = -z^2$$

$$\Rightarrow r^2 - 6r + 9 = 9 - z^2$$

$$\Rightarrow (r-3)^2 = (9 - z^2)$$

$$\Rightarrow r - 3 = -\sqrt{9 - z^2}$$

$$\because \{0 \le z, r \le 3\}$$

$$\Rightarrow r = 3 - \sqrt{9 - z^2}$$

Sol^n: ~~3~~:-

Solⁿ:- 6:- Advantages of gaussian filter:

→ uniform smoothing in all directions is achieved.

→ gaussian filter has advantages that its fourier transform is also a gaussian distribution centered around then zero frequency.

Advantages of box filter:-

→ It reduces the effect of smoothing on edges.

→ Simple and separable low pass filter.

Solⁿ:- 7:- ∵ We have to consider image $f(x,y)$ and spatial filter mask $\omega(x,y)$. using convolution.

∵ convolution is defined as

~~$f(x,y) * \omega(x,y) = \Sigma_s = -a,$~~

$$f(x,y) * \omega(x,y) = \sum_{s=-a}^{a} \sum_{t=-b}^{b} \omega(s,t)\, f(x-s, y-t)$$

where the dimensions of $\omega(x,y)$ is $(2a+1)(2b+1)$

∵ the elements of convolution array are formed as the center the mask at particular pixel and then form the sum of products of mask coefficients with corresponding pixels in the image. The mask traverse and convolution operation is applied for each pixel in the image only once.

Now, if the coefficient of mask sum to zero the sum of products of the coefficients with the same pixel also sum of to zero. Hence, for each pixel in image the sum of elements of convolution array sum to zero.

for ex :-

$w(x,y) = [a \ b \ c]$ where $a+b+c=0$

$f(x,y) = [p \ q \ r \ s]$

$\therefore$ zero padded square will be $f(x,y) =$ ~~[o p q r s]~~
$= [0 \ p \ q \ r \ s \ 0]$

$\therefore$ convolution array,

$f(x,y) * w(x,y) = [cp \quad bp+cq \quad ap+bq+cr \quad aq+br+cs \quad ar+bs \quad as]$

$\therefore$ add elements we get

$p(a+b+c) + q(a+b+c) + r(a+b+c) + s(a+b+c)$

$\because a+b+c=0 \Rightarrow$ above expression $= 0$.

In:- 8:- consider the horizontally & vertically.

$\because$ each mask yields a value $= 0$ when centered a pixel of an unbroken 3-pixel segment oriented in direction favoured by mask.

$\therefore$ horizontal $\rightarrow$

0	0	0
1	-2	1
0	0	0

Vertical $\rightarrow$

0	1	0
0	-2	0
0	1	0

Solⁿ:- 4:- (a) image 1:-

$P(r_0) = 2/64$ $P(r_5) = 16/64$

$P(r_1) = 2/64$ $P(r_6) = 12/64$

$P(r_2) = 2/64$ $P(r_7) = 8/64$

$P(r_3) = 8/64$ $P(r_8) = 1/64$

$P(r_4) = 12/64$ $P(r_9) = 1/64$

Plot:-

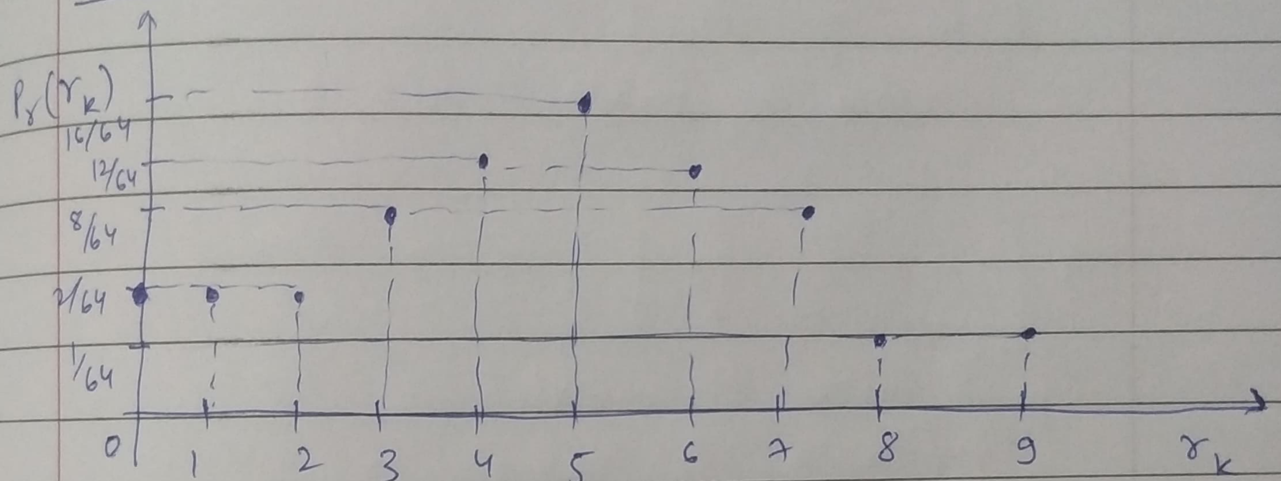


image 2:-

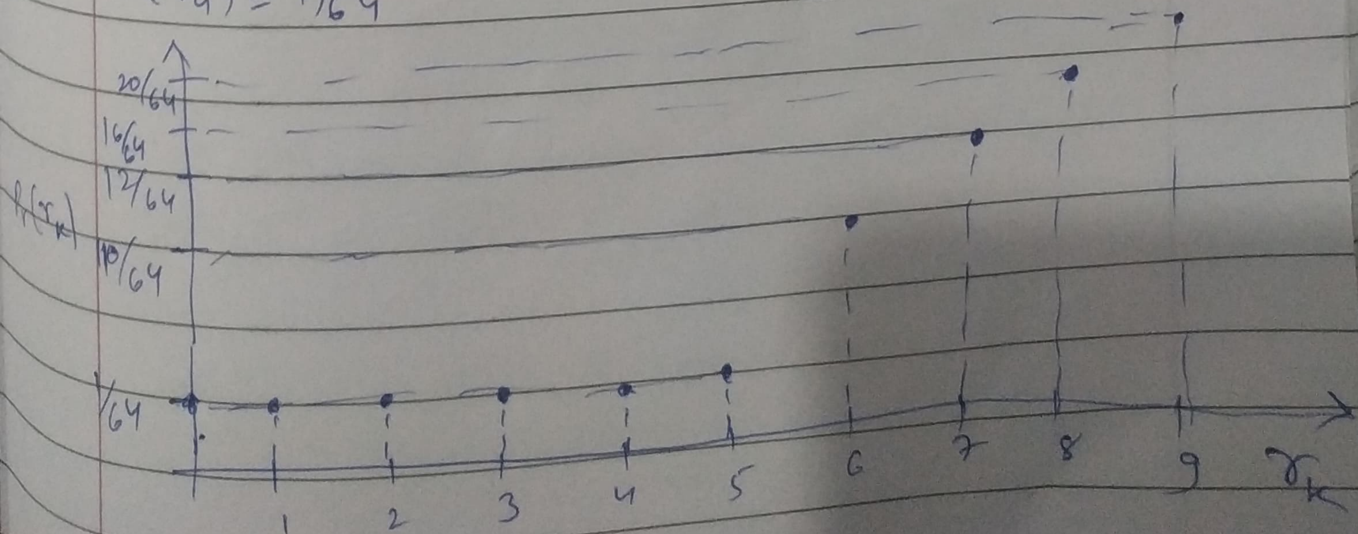
$P(r_0) = 1/64$ $P(r_5) = 1/64$

$P(r_1) = 1/64$ $P(r_6) = 10/64$

$P(r_2) = 1/64$ $P(r_7) = 12/64$

$P(r_3) = 1/64$ $P(r_8) = 16/64$

$P(r_4) = 1/64$ $P(r_9) = 20/64$



Sol^n:- 3:(a) for checker board pattern:

let the dark intensity be M & light intensity be 0.

$$B = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

for $\begin{bmatrix} M & 0 & M \\ 0 & M & 0 \\ M & 0 & M \end{bmatrix}$ as centre

$\therefore$ value of pixels $= 5M/9$

$\therefore$ for $\begin{bmatrix} 0 & M & 0 \\ M & 0 & M \\ 0 & M & 0 \end{bmatrix}$ $\therefore$ its value $= \frac{4M}{9}$

$\therefore$ pixel with M converted to $5M/9$

pixel with 0 converted to $4M/9$

(b) 3×3 median filter:-

$\begin{bmatrix} M & 0 & M \\ 0 & M & 0 \\ M & 0 & M \end{bmatrix}$ $\therefore$ median $= M$

$\begin{bmatrix} 0 & M & 0 \\ M & 0 & M \\ 0 & M & 0 \end{bmatrix}$ median $= 0$

$\therefore$ pixel with M converted to M

" " 0 " " 0

(c) Laplacian mark with center -8.

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

$\therefore \begin{bmatrix} M & 0 & M \\ 0 & M & 0 \\ M & 0 & M \end{bmatrix}$ value is $-8M + 4M = -4M$

$\begin{bmatrix} 0 & M & 0 \\ M & 0 & M \\ 0 & M & 0 \end{bmatrix}$ value is $4M$

$\therefore$ pixel with M converted to $-4M$
pixel with 0 " to $4M$

(d) $\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$

$\therefore \begin{bmatrix} M & 0 & M \\ 0 & M & 0 \\ M & 0 & M \end{bmatrix} \Rightarrow$ value $= -M + M - M + M$
$= 0$

$\begin{bmatrix} 0 & M & 0 \\ M & 0 & M \\ 0 & M & 0 \end{bmatrix} \Rightarrow$ value $= -2M + 2M$
$= 0$

$\therefore$ m pixel converts to 0
0 pixel converts to 0.

Page No.

Date

(e) Similarly, vertical sobel

M pixel converts to 0

0 pixel converts to 0

(symmetry)

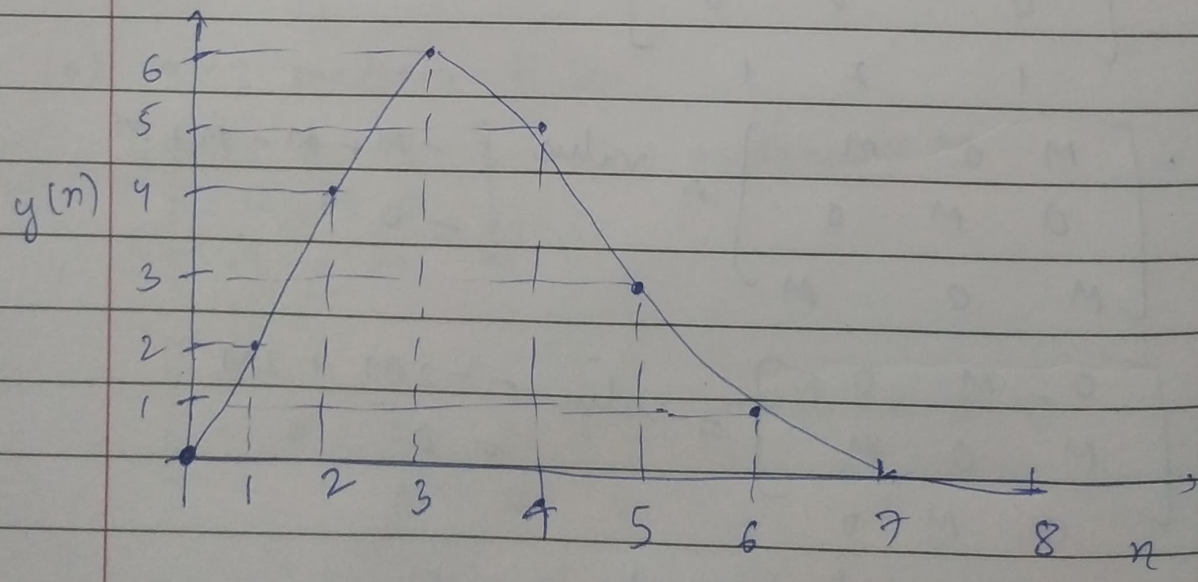
Sol^n :- 5 :- consider s(N) & M(N) becomes

$s(N) = [0, 1, 1, 1, 0]$

$M(N) = [2, 2, 2, 1, 0]$

$$\therefore s(n) * M(n) = \sum_{k=-\infty}^{\infty} s(k)\, M(n-k)$$

$\therefore y(n) = [0, 2, 4, 6, 5, 3, 1, 0, 0]$



Soln:- 10:(a) $\because K = \begin{bmatrix} 11 & 4 & 2 & 10 \\ 8 & 12 & 1 & 13 \\ 6 & 2 & 14 & 12 \\ 2 & 13 & 4 & 11 \end{bmatrix}$

$\because$ for 2D-DFT

$$F(u,v) = \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} f(x,y)\, e^{-2\pi j\left(\frac{ux}{M} + \frac{vy}{N}\right)}$$

$\because m = 4,\ n = 4$

$$F(0,0) = \sum_{x=0}^{3} \sum_{y=0}^{3} f(0,0)\, e^{-2\pi j(0)}$$

$$= \sum_{x=0}^{3} \sum_{y=0}^{3} f(0,0)$$

$\Rightarrow F(0,0) = 125.$

(c) aliasing refers to the sampling phenomunon that cause different signals to becomes indistinguishable from one another after sampling.
Aliasing can be controlled & reduced by smoothing the inp. fn. to alternate its higher frq.

(d) finite duration discrete signal can be generated from indefinite duration discrete signal by passing the ~~indef~~ infinite duration discrete signal into low pass filter with cutt off frq.