

# Quiz - 2

1) a)  $p = \frac{m-1}{2} = \frac{3-1}{2} = 1$

b) Minors / padding

4	0	7	0	4	0	4	0
0	4	0	4	0	7	0	4
3	5	1	5	3	2	3	5
0	4	0	4	0	7	0	4
4	0	7	0	4	0	4	0
0	2	0	2	0	3	0	2
4	0	7	0	4	0	4	0
0	4	0	4	0	7	0	4

Edge padding

1	1	1	5	3	2	2	2
1	1	1	5	3	2	2	2
1	1	1	5	3	2	2	2
0	0	0	4	0	7	7	7
7	7	7	0	4	0	0	0
0	0	0	2	0	3	3	3
0	0	0	2	0	3	3	3
0	0	0	2	0	3	3	3



c) kernel,  $k =$

$$\begin{pmatrix} 1 & \frac{1}{2} & \frac{1}{4} \\ \frac{1}{2} & 1 & \frac{1}{2} \\ \frac{1}{4} & \frac{1}{2} & 1 \end{pmatrix}$$

$(-1, 1)$	$(0, 1)$	$(1, 1)$
$(-1, 0)$	$(0, 0)$	$(1, 0)$
$(-1, -1)$	$(0, -1)$	$(1, -1)$

d) With zero padding and minimum width 1 -

Hence,

$$H = \left( \frac{4 + 2 \times 1 - 3}{1} + 1 \right)$$

$$= 4$$

$$= W$$

0	0	0	0	0	0
0	1	5	3	2	0
0	0	4	0	7	0
0	7	0	9	0	0
0	0	2	0	3	0
0	0	0	0	0	0

$$m = n = 3$$

$$M = N = 4$$

$$p = 1$$

$$S = 1$$

$$1 + 5 \times \frac{1}{2} + 4 = 15/2$$

$$1 \times \frac{1}{2} + 5 + 3 \times \frac{1}{2} + 4 \times \frac{1}{2} = 9$$

$$5 \times \frac{1}{2} + 3 + 2 \times \frac{1}{2} + 4 \times \frac{1}{4} + 7 = 29/2$$

$$3 \times \frac{1}{2} + 2 + 7 \times \frac{1}{2} = 7$$

$$1 \times \frac{1}{2} + 5 \times \frac{1}{4} + 4 \times \frac{1}{2} + 7 \times \frac{1}{2} = 29/4$$

$$1 + 5 \times \frac{1}{2} + 3 \times \frac{1}{4} + 9 + 7 \times \frac{1}{4} + 4 = 19$$

$$5 + 3 \times \frac{1}{2} + 2 \times \frac{1}{4} + 4 \times \frac{1}{2} + 7 \times \frac{1}{2} + 4 \times \frac{1}{2} = 29/2$$

$$3 + 2 \times \frac{1}{2} + 7 + 4 \times \frac{1}{4} = 12$$

$$4 \times \frac{1}{4} + 7 + 2 = 10$$

$$4 \times \frac{1}{2} + 7 \times \frac{1}{2} + 4 \times \frac{1}{2} + 2 \times \frac{1}{2} = 17/2$$

$$9 + 7 \times \frac{1}{4} + 4 + 2 \times \frac{1}{4} + 3 = 53/4$$

$$7 \times \frac{1}{2} + 4 \times \frac{1}{2} + 3 \times \frac{1}{2} = 7$$

$$2 \times \frac{1}{2} + 2 \times \frac{1}{2} = 9/2$$

$$7 + 2 + 4 \times \frac{1}{4} = 11$$

$$9 \times \frac{1}{2} + 2 \times \frac{1}{2} + 3 \times \frac{1}{2} = 9/2$$

$$9 + 3 = 7$$

Blurred image -

$19/2$	9	$29/2$	17
$29/4$	14	$29/2$	12
10	$17/2$	$53/4$	7
$9/2$	11	$9/2$	7

$$\begin{aligned} 19/2 &= P + W \times P + W \times R + W \times S + W \times T \\ 29/4 &= F + W \times P + W \times R + W \times S + W \times T \\ 10 &= F + W \times P + W \times R + W \times S + W \times T \\ 9/2 &= F + W \times P + W \times R + W \times S + W \times T \end{aligned}$$



e) Unsharp mask = Original image - Blurred image

$$= \begin{pmatrix} 1 & 5 & 3 & 2 \\ 0 & 4 & 0 & 7 \\ 7 & 0 & 4 & 0 \\ 0 & 2 & 0 & 3 \end{pmatrix} - \begin{pmatrix} 1\frac{1}{2} & 2\frac{1}{2} & 2\frac{1}{2} & 7 \\ 2\frac{3}{4} & 14 & 2\frac{3}{2} & 12 \\ 10 & 17\frac{1}{2} & 5\frac{3}{4} & 7 \\ 9\frac{1}{2} & 11 & 9\frac{1}{2} & 7 \end{pmatrix}$$

$$= \begin{pmatrix} -1\frac{1}{2} & -4 & -2\frac{1}{2} & -5 \\ -2\frac{3}{4} & -10 & -2\frac{3}{2} & -5 \\ -3 & -17\frac{1}{2} & -3\frac{3}{4} & -7 \\ -9\frac{1}{2} & -9 & -9\frac{1}{2} & -4 \end{pmatrix}$$

(0.5)

(0.5)

(0.5)

(0.5)

Unsharp

b) High boost filtered = Original + k x blurred

$$= \begin{pmatrix} 1 & 5 & 3 & 2 \\ 0 & 4 & 0 & 7 \\ 7 & 0 & 4 & 0 \\ 0 & 2 & 0 & 3 \end{pmatrix} + \begin{pmatrix} 3\frac{1}{2} & 12 & 6\frac{1}{2} & 15 \\ 8\frac{3}{4} & 30 & 8\frac{3}{4} & 15 \\ 9 & 5\frac{1}{2} & 11\frac{1}{4} & 21 \\ 27\frac{1}{2} & 27 & 27\frac{1}{2} & 12 \end{pmatrix}$$

$$= \begin{pmatrix} -3\frac{1}{2} & -7 & -6\frac{1}{2} & -13 \\ -8\frac{3}{4} & -26 & -8\frac{3}{4} & -8 \\ -2 & -5\frac{1}{2} & -9\frac{1}{4} & -21 \\ -27\frac{1}{2} & -25 & -27\frac{1}{2} & -9 \end{pmatrix}$$

2) a)

Intensity  
A

cdf  
A

Intensity  
B

cdf  
B

0

0.17

2

0.15

1

0.33

0

0.36

2

0.22

3

0.23

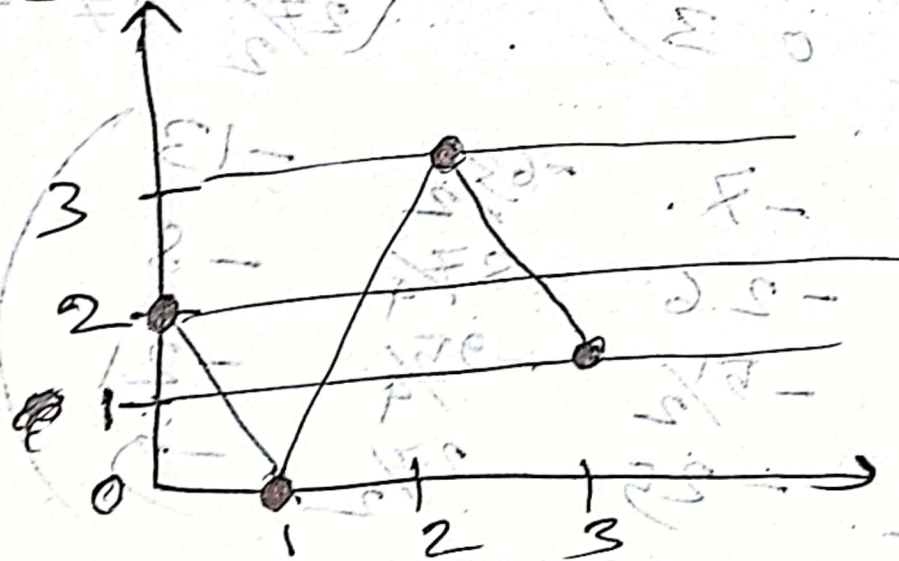
3

0.28

1

0.26

b)





3) a)

$$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \begin{pmatrix} \frac{4}{\sqrt{2}} & -\frac{4}{\sqrt{2}} & 0 \\ \frac{5}{\sqrt{2}} & \frac{5}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} \quad \text{--- (i)}$$

b)

$$\begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} a & 0 & 0 \\ 0 & b & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} \quad \text{--- (ii)}$$

From (i) & (ii),

$$\begin{pmatrix} a \cos \theta & -a \sin \theta & 0 \\ b \sin \theta & b \cos \theta & 0 \\ 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} \frac{4}{\sqrt{2}} & -\frac{4}{\sqrt{2}} & 0 \\ \frac{5}{\sqrt{2}} & \frac{5}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$\frac{a \cos \theta}{-a \sin \theta} = \frac{\frac{4}{\sqrt{2}}}{-\frac{4}{\sqrt{2}}} \Rightarrow \theta = \tan^{-1}(1) = 45^\circ \quad \checkmark$$

$$a \cos 45^\circ = \frac{4}{\sqrt{2}} \Rightarrow a = \sqrt{2} \times \frac{4}{\sqrt{2}} = 4 \quad \checkmark$$

$$b \cos 45^\circ = \frac{5}{\sqrt{2}} \Rightarrow b = \sqrt{2} \times \frac{5}{\sqrt{2}} = 5 \quad \checkmark$$