Q1

Input Image					Target Image.			
3	3	0	1		0	0	0	1
3	2	1	2		6	3	3	2
2	6	0	0		3	0	0	0
3	1	1	2		3	1	1	2

So, max pixel value @ = 3, $L = 2^2 = 4$

$L-1$.

So max pixel levels are 3, where

For Input Image. $L = 4$

pixel values (r)   0   1   2   3

Number of pixels p(r)   4   4   4   4

For Output Image

pixel values (s)   0   1   2   3

Number of pixels g(s)   7   3   2   4

For Input

~~r = No. of pixels = p(r)~~

r	No. of pixels	Cumulative	$p(r)$
0	4	4	$4/16 = 0.25$
1	4	8	$8/16 = 0.5$
2	4	12	$12/16 = 0.75$
3	4	16	$16/16 = 1$

For Output

s	No. of pixels	Cumulative	$q(s)$
0	7	7	$7/16 = 0.4375$
1	3	10	$10/16 = 0.625$
2	2	12	$12/16 = 0.75$
3	4	16	$16/16 = 1$

Histogram Matching.

r	$F(r)$	s	$B(s)$	Mapping
0	0.25	0	0.4375	0
1	0.45	1	0.625	0
2	0.75	2	0.75	2
3	1	3	1	3

So we check for closest match of $F(r)$ to $g(s)$ and find the mapping.

$r = 0$, $F(r) = 0.25$,
closest match $g(s)$ @ $s=0$, 0.4375

$r = 1$ $F(r) = 0.5$
closest match $g(s)$ @ $s=0$, 0.4375

$r = 2$ $F(r) = 0.75$
closest match $g(s)$ @ $s=2 = 0.75$

$r = 3$ $F(r) = 1$
closest match $g(s)$ @ $s=3 = 1$

Q2

Image

$$I(x,y) = \begin{bmatrix} -1 & 2 & -1 \\ 3 & 0 & 1 \\ -2 & 1 & 2 \end{bmatrix}$$

3 × 3

Filter

$$f(x,y) = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix} \rightarrow origin$$

3 × 1

Size of o/p = 5 × 3

Step Now, we rotate the filter

$$\begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix} \rightarrow origin$$

Creating Operating matrix 7 × 3

$$\begin{bmatrix} 0 & 0 & 0 \\ 0① & 0 & 0② \\ -1 & 2 & -1 \\ 3 & 0 & 1 \\ -2 & 1 & 2 \\ 0③ & 0 & 0④ \\ 0 & 0 & 0 \end{bmatrix}$$

So, now we have the result matrix, we take the centre of f(x,y) on ① & iterate it for every possible point of overlap of columns rows till ② & rows till ③

1ˢᵗ iteration.

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & -1 & 2 & -1 \\ & -3 & 0 & 1 \\ & -2 & 1 & 2 \\ & 0 & 0 & 0 \\ & 0 & 0 & 0 \end{bmatrix}$$

$\Rightarrow 0 \times 1 + 0 \times 0 + (-1) \times (-1)$

$= ① ①$

Now we have our grid @ ①, we can multiply all elements & sum it up

2nd iteration

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ -1 & 2 -1 & -1 \\ 3 & 0 & 1 \\ -2 & 1 & 2 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Sum of element
wise multiplicati
$= 0 \times 1 + 0 \times 0 + 2 \times -1$
$= (-2)$ — ②

3rd (We keep sliding and multiplying in the same way)

⇒ Sum =
$0 \times 1 + 0 \times 0 + -1 \times -1 = 1$
③

next row

4th iteration   (origin at $\fbox{} (-1)$
element of array

Sum $= 0 \times 1 + 0 \times 0 + 3 \times -1 = -3$ — ④

5th Iteration

Sum $= 1 \times 0 + 0 \times 2 + -1 \cdot 0 = 0$
⑤

6th Iteration

Sum $= 1 \times 0 + 0 \times -1 + 0 \cdot 1 \times -1$
Next Row $= -1$
⑥

7th Iteration

Sum $= -1 \times 1 + 3 \times 0 + -2 \times -1 = 1$
⑦

8th Iteration

Sum $= 2 \times 1 + 0 \times 0 + 1 \times -1 = 1$ — ⑧

9th Iteration

Sum = $-1 \times 1 + 0 \times -1 + 2 \times -1 = -3$ ← ⑨

Next Row

10th Iteration

Sum = $3 \times 1 + -2 \times 0 + 0 \times -1 = 3$ ⑩

11th Iteration

Sum = $0 \times 1 + 1 \times 0 + 0 \times -1 = 0$ ⑪

12th Iteration

Sum = $1 \times 1 + 2 \times 0 + 0 \times -1 = 1$ ⑫

Next Row

13th iteration

Sum = $-2 \times 1 + 0 \times 0 + 0 \times -1 = (-2)$ ⑬

14th iteration

Sum = $1 \times 1 + 0 \times 0 + 0 \times -1 = 1$ ⑭

15th iteration

Sum = $2 \times 1 + 0 \times 0 + 0 \times -1 = 2$ ⑮

For all equations from ① − ⑮
our output matrix will look lik

$$\begin{bmatrix} 1 & -2 & 1 \\ -3 & 0 & -1 \\ 1 & 1 & -3 \\ 3 & 0 & 1 \\ -2 & 1 & 2 \end{bmatrix}$$ ← Output

Matrix