Q1. a. Find the convolution of $f(x,y)$ given by

2	3
4	5

With $w(x,y)$ given by

1	2
2	1

Origin is at top leftmost element for both. [2]

b. Write a program to compute this convolution and verify if both the results are in consensus. You can use built in functions. Refer to the lecture notes. [2]

Q2. Find the response of a 3x3 median filter on $f(x,y)$ given by

3	4	1
8	6	6
5	4	3

Assume zero padding at the borders. The first output should correspond to the response of the filter with center at element 3 at top left. Similarly last response should be at bottom right 3. [2]

Q3. a. Perform histogram equalization (HE). Assume bit depth to be 2. [1]

r	p(r)	z	p(z)
0	0.8	1	0.3
1	0.2	2	0.7

Give the output pixel values.

b. Write a code to perform HE for part a. You can refer to the lecture notes. [2]

Q4. In a local/adaptive processing for a 4x4 image given by [1]

3	3	0	0
3	3	0	1
1	0	1	0
0	0	0	1

Considering the global image to be 4x4, the mean is 1 and variance is 3/2. Consider the 2x2 local window in red color. Compute its mean and variance. Suppose you want to enhance the intensity in this region, and use constraints

$\mu_w < K\mu_g \quad and \quad \sigma_w^2 < C\sigma_g^2$, K >0, C > 0

$$g(x,y) = \begin{cases} Ef(x,y) & \text{When the constraints are satisfied} \\ f(x,y) & otherwise \end{cases}$$

$$\mu_g \quad is\ global\ mean, \mu_w \quad is\ local\ mean\ of\ a\ window, \sigma_g^2\ is\ global\ variance, \sigma_w^2\ is\ local\ variance,$$

$$f(x,y) is\ input\ pixel, g(x,y) is\ output\ pixel, E > 1\ is\ a\ constant$$

Find K, C.