The Islamic University in Gaza Faculty of Information Technology Master of Information Technology Image Processing Dr. Ashraf Maghari	الإمتحان النصفي الفصل الأول 2021/2022 ICTS 6338	الجامعة الإسلامية بغزة كلية تكنولوجيا المعلومات ماجستير تكنولوجيا المعلومات المساق: معالجة الصور

Q1) Solve the following Questions (13 marks)

30 Pts

a) Consider the following image below. Apply a 3*3 median filter on the shaded pixels, and write the filtered image (3 Pts).

20 25 30 30 30 70 80 80 255

0 20 30 70 80 80 255 100 100

0 70 80 80 100 100 110 120 130

30 80 100

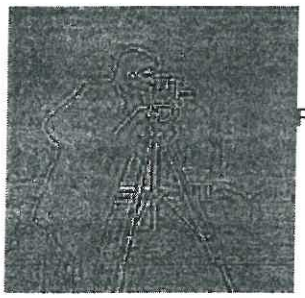
20	30	50	80	100
30	20	80	100	110
25	255	70	0	120
30	30	80	100	130
40	50	90	125	140

b) For the following table (7 Pts)

(1) Associate the left images with their corresponding Fourier transform (FFT).

(2) Give the name of each filter applied on the FFT on the right.

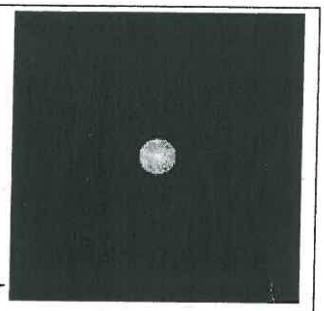
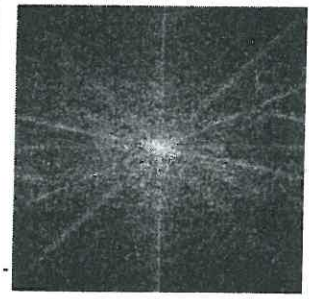
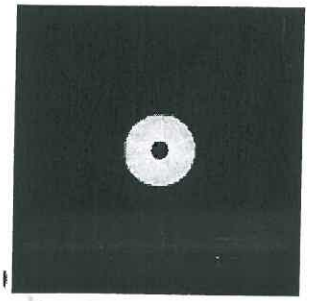
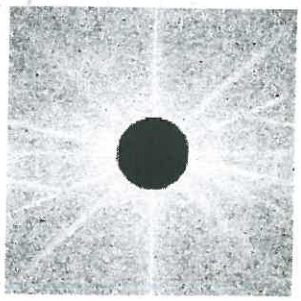
FFT no 2



FFT no 4

FFT no 1

FFT no 3

FFT No 1	
Filter Name: low-pass	
FFT No 2	
Filter Name: no-filter	
FFT No 3	
Filter Name: band-pass low-pass + high-pass	
FFT No 4	
Filter Name: high-pass	

c) If you want to smooth an image in frequency domain, what types of filters do you use? Give three examples of such filters. (3 Pts)

Ideal low pass filter $H(u,v) = \begin{cases} 1 & \text{if } D(u,v) \le D_0 \\ 0 & \text{if } D(u,v) > D_0 \end{cases}$

Butterworth lowpass filter $H(u,v) = \frac{1}{1+[D(u,v)/D_0]^{2n}}$

Gaussian lowpass filter $H(u,v) = e^{-D^2(u,v)/2D_0^2}$

Q2) For the following 8 x 8 image f(x,y) with integer intensities in the range from 0 to 7. (6 Pts)

a) Compute the histogram of the original image f(x,y).

b) Find the transformed (equalized) histogram, g(x,y).

1	1	1	1	1	1	1	1
0	2	5	5	5	5	2	0
0	3	2	6	7	2	3	0
0	3	3	2	2	3	3	0
0	2	3	2	2	3	3	0
0	3	2	4	4	2	4	0
0	2	6	4	4	4	2	0
1	1	1	1	1	1	1	1

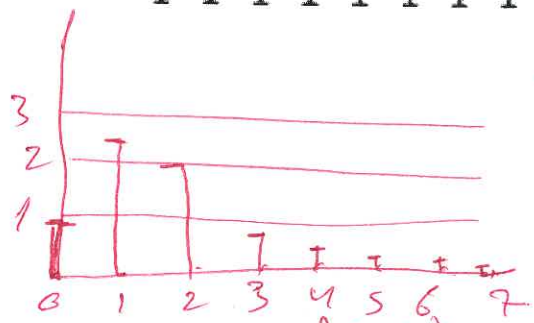
$= 64$

Hint:

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j) \quad k = 0,1,2,\ldots,L-1$$

$$p_r(r_k) = \frac{n_k}{MN}$$

r_k	n_k	$P(r_k)$	S_k	$P(S_k)$
0	12	0.19	1.33 → 1	0.19
1	16	0.25	3.08 → 3	0.25
2	13	0.20	4.48 → 4	0.20
3	10	0.16	5.6 → 6	0.25
4	6	0.09	6.23 → 6	
5	4	0.06	6.65 → 7	0.11
6	2	0.03	6.86 → 7	
7	1	0.02	7 → 7	



f(x,y)

g(x,y)

$S_0 = 7 * P_0(r_0) = 7 * 0.19 = 1.33$

$S_1 = 7[P_0(r_0) + P_1(r_1)] = 7[0.19 + 0.25] = 7 * 0.44 = 3.08$

Q3) A 5 x 5 image *f(x,y)* is given as $f(x,y) =$ (8 marks)
Compute the output images (only the selected box) after passing through:

10	3	2	5	4
11	8	3	1	6
7	5	6	2	7
2	1	9	4	2
2	3	3	0	1

a) The operator as specified by the mask w_1.

$$w_1 = \frac{1}{3}\begin{pmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{pmatrix}$$

5.67	2.67	-2
0.67	2.33	1
-2.33	1	2.67

b) The mask $w_2 = \frac{1}{3}\begin{pmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{pmatrix}$

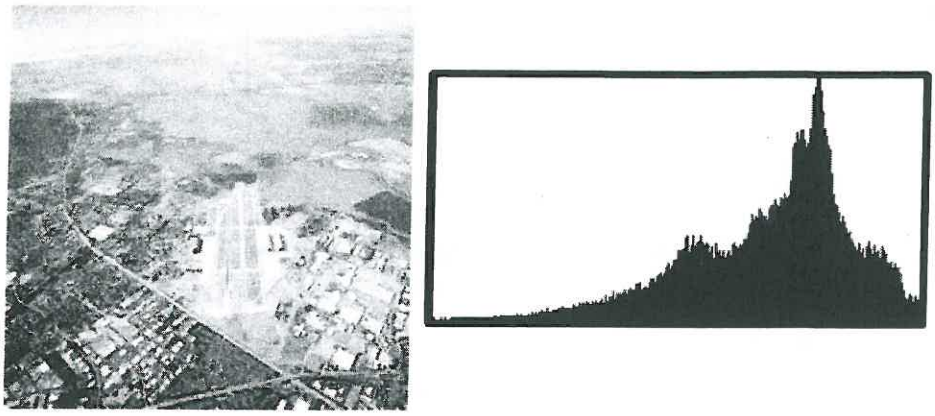
-1	-1	-1,33
3.33	-0.67	-1.67
3.33	2.33	3.67

c) Explain what the function of operators w1 and w2 in parts a and b.

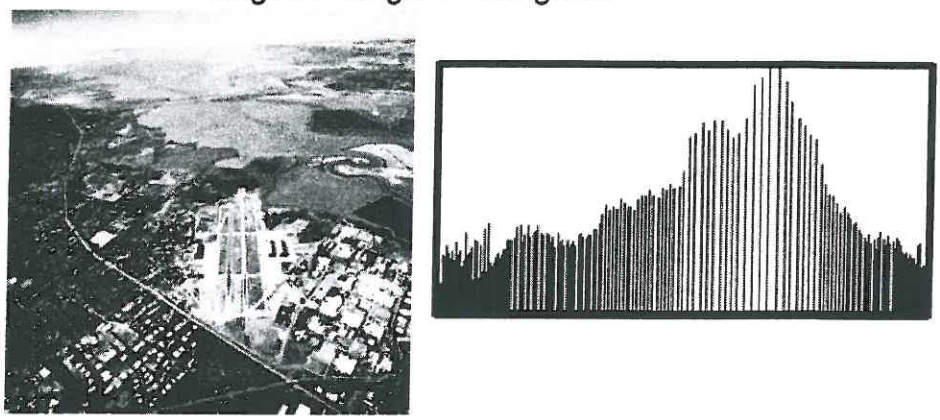
line sobel operators

edge detection

Q4) [4 Pts] From the original image below (+ histogram) which does not show a good contrast, we perform some linear transforms in order to improve the contrast. We obtain the next image (+ histogram).
Draw (approximatively) the linear transforms needed to obtain this result. Add extra explanations if needed. Hint: Your linear transform should have at least 3 segments (piecewise linear functions).



Original image + histogram



Result image + histogram