Q.1 Consider the image segment shown below

Let $\boldsymbol{V} = \{\mathbf{0}, \mathbf{1}\}$and compute the lengths of the shortest 4-, 8-, and m-path between p and q.

if a particular path does not exist between these two points, explain why.

	3	1	2	1	(q)
	2	2	0	2	
	1	2	1	1	
(p)	1	0	1	2	

Q.2 Consider the image segment shown below

Let $\boldsymbol{V} = \{\mathbf{1}, \mathbf{2}\}$and compute the lengths of the shortest 4-, 8-, and m-path between p and q.

if a particular path does not exist between these two points, explain why.

	3	1	2	1	(q)
	2	2	0	2	
	1	2	1	1	
(p)	1	0	1	2	

Q.3 Consider the image segment shown below

Let $\boldsymbol{V} = \{\mathbf{1}\}$ and use the **4-Connected Component Labeling Algorithm** to mark the object pixels with a distinctive label **(**sort all equivalent pairs**)**

0	1	1	0
1	1	0	1
0	0	1	1

Q.4 Suppose that you have a 3-bit image with the following histogram:

Gray-Level Value	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
No. of Pixels (Histogram Values)	**10**	**8**	**9**	**2**	**14**	**1**	**5**	**2**

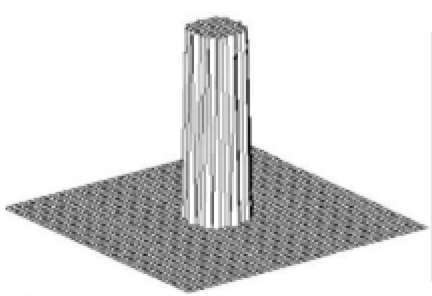
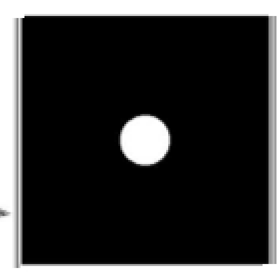
Find the **histogram equalization mapping tables** and use it to get from the original histogram to the **specified histogram** listed below

Gray-Level Value	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
No. of Pixels in Specified Histogram	**1**	**5**	**10**	**15**	**20**	**0**	**0**	**0**

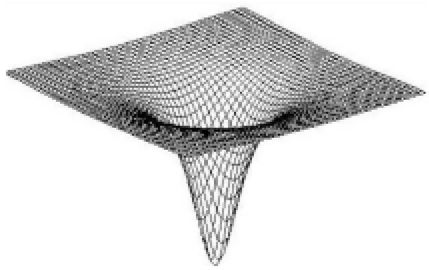
Q.5 Consider the following 5x5 image. Apply a 3x3 median filter on the shaded pixels, and write the filtered image.

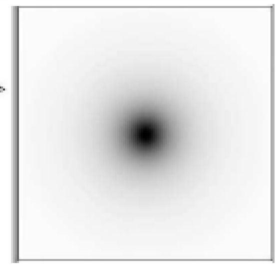
20	**30**	**50**	**80**	**100**
30	**20**	**80**	**100**	**110**
25	**255**	**70**	**0**	**120**
30	**30**	**80**	**100**	**130**
40	**50**	**90**	**125**	**140**

Q.6 Specify the following images then writes MATLAB code to display it

Q.7 Specify the following images then writes MATLAB code to display it





Q.8 Show that subtracting the Laplacian from an image is proportional to unsharp masking.

[Use the definition for the Laplacian given by:

$$\nabla^2 f = [f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1)] - 4f(x,y) \quad]$$

Q.9 Use the following 3x3 mask

0	**1/6**	**0**
1/6	**1/3**	**1/6**
0	**1/6**	**0**

To perform the convolution process on the shaded pixel in the 5x5 image below. Write the filtered image.

30	**40**	**50**	**70**	**90**
40	**50**	**80**	**60**	**100**
35	**255**	**70**	**0**	**120**
30	**45**	**80**	**100**	**130**
40	**50**	**90**	**125**	**140**

Q.10 Compute the **2D-DFT** of the following 4x4 image.

$$\mathbf{X} = \begin{bmatrix} 1 & 3 & 6 & 8 \\ 9 & 8 & 8 & 2 \\ 5 & 4 & 2 & 3 \\ 6 & 6 & 3 & 3 \end{bmatrix}$$

Q.11 Compare between the frequency and spatial domain in image processing

Q.12 Give short note about Low-pass and High-pass frequency domain filters

Q.13 Use the histogram equalization algorithm to equalize the following image

A 4x4, 4bits/pixel image

2	8	9	9
2	3	10	9
8	3	3	11
8	3	10	11

Q.14 Apply Robert gradient operator to detect the edge of the 9x9 image shown below:

2	9	9	9	9	9	9	9	9
2	8	9	9	9	9	2	2	9
2	9	9	9	9	9	3	2	9
2	9	9	9	9	2	2	2	9
2	9	9	9	9	2	2	2	7
2	9	9	9	2	2	2	2	9
2	9	9	9	2	2	2	4	9
2	9	9	2	2	2	2	2	9
2	9	2	2	2	2	1	2	9

Use $|\boldsymbol{g}(\boldsymbol{m},\boldsymbol{n})| = \sqrt{\boldsymbol{g}_1^2(\boldsymbol{m},\boldsymbol{n}) + \boldsymbol{g}_2^2(\boldsymbol{m},\boldsymbol{n})}$ to estimate the gradient magnitude, and use T=5 as the threshold for edge detection.

Q.15 Write MATLAB program to represent the following formula

$$g(i,j) = \begin{cases} 0 & if \quad A(i,j) \quad \le T \\ 255 & if \quad A(i,j) \quad > T \end{cases}$$

Where: g (i,j) is the output image , A(i,j) is the input image of size MXN , T=128 is the threshold value

Q.16 Suppose the inverse 2D-DFT weight matrix F_N^* for image of size (8x8), and then compute the second and third row only.

Q.17 Give a 3×3 mask for performing **Unsharp Masking** in a single pass through an image

Q.18 Write MATLAB program to compute the **mean, standard deviation, and the variance** of (256X256) gray image stored on derive D. Display your result using **msgbox**

Q.19 Given the following $\mathbf{5} \times \mathbf{5}$ image **I** and $\mathbf{3} \times \mathbf{3}$ kernel **h**

$\mathbf{I} = [\,\mathbf{17\ \ 24\ \ 1\ \ 8\ \ 15}\,;\ \mathbf{23\ \ 5\ \ 7\ \ 14\ \ 16}\,;\ \mathbf{4\ \ 6\ \ 13\ \ 20\ \ 22}\,;\mathbf{10\ \ 12\ \ 19\ \ 21\ \ 3}\,;\ \mathbf{11\ \ 18\ \ 25\ \ 2\ \ 9}\,]$

$\boldsymbol{h} = [\,\mathbf{8\ \ 1\ \ 6}\,;\ \mathbf{3\ \ 5\ \ 7}\,;\ \mathbf{4\ \ 9\ \ 2}\,]$

Apply the **correlation** and **convolution filters** to compute the result at $(\mathbf{2}, \mathbf{4})$

Q.20 The following figure shows

(a) a 3-bit image of size 5×5 , with x and y coordinates specified,
(b) a Laplacian filter and
(c) a low-pass filter.

y \ x	0	1	2	3	4
0	3	7	6	2	0
1	2	4	6	1	1
2	4	7	2	5	4
3	3	0	6	2	1
4	5	7	5	1	2

(a)

Laplacian filter

0	1	0
1	- 4	1
0	1	0

(b)

Low pass filter

0.01	0.1	0.01
0.10	0.56	0.10
0.01	0.1	0.01

(c)

Compute the following:

(1) The output of a 3×3 average filter at (2,2)
(2) The output of a 3×3 median filter at (2,2)
(3) The output of the 3×3 Laplacian filter shown above at (2,2)
(4) The output of the 3×3 low-pass filter shown above at (2,2)
(5) The histogram of the whole image

Q.21 B is a digital image. The image B is in frequency domain:

$$B=\begin{bmatrix} 77 & 2-5j & 3 & 2+5j \\ 4-9j & -11+8j & -4-7j & -5-4j \\ -13 & -6+13j & -11 & -6+13j \\ 4+9j & -5+4j & -4+7j & -11-8j \end{bmatrix}$$

Find Inverse Fourier Transform for the image B

Q.22 **A** is a digital image with 4 bit/pixel. The image A has the following intensity values:

$$A=\begin{bmatrix} 15 & 8 & 8 & 15 & 15 & 11 \\ 15 & 2 & 6 & 8 & 2 & 11 \\ 15 & 6 & 2 & 6 & 6 & 11 \\ 15 & 8 & 8 & 8 & 11 & 8 \\ 11 & 2 & 8 & 2 & 6 & 11 \\ 11 & 15 & 11 & 15 & 15 & 11 \end{bmatrix}$$

a/ Compute the number of bits required to store this image after Huffman coding

b/ Find the entropy

Q.23 Write a Matlab program to carry out the following requirements with the image Lena of size 380×380 stored in 'D:\ Lena. jpg' :

a/ Implement histogram based segmentation on Lena image to decompose the range of pixel values into the following discrete intervals $R_1 = [100, 149]$ and $R_2 = [150, 220]$

b/ Perform thresholding on Lena image where T=200.

Q.24 Consider the 8-bit gray image shown below. Use Huffman coding technique for eliminating coding redundancy in this image then find the entropy and compression ratio.

$$\begin{bmatrix} 80 & 200 & 150 & 80 \\ 200 & 80 & 150 & 150 \\ 80 & 80 & 40 & 80 \\ 40 & 40 & 80 & 80 \end{bmatrix}$$

Q.25 If $S = \{A, B, C, \#\}$ and $P = \{0.4, 0.3, 0.1, 0.2\}$. Use Arithmetic Coding Compression method to encode the message ABBC#

Q.26 Write simple program, to calculate the histogram of image with any size

Q.27 Write short notes on Connected Component Labeling Algorithm

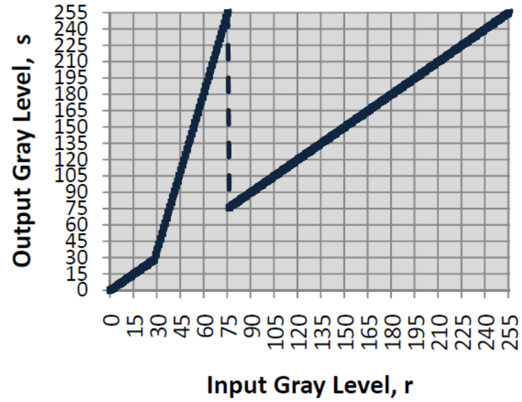
Q.28 Write a Matlab program to carry out the following requirements with the image Lena of size 380 × 380 stored in ' D:\ Lena. jpg':

a/ transpose the image

b/ Flip the image vertically

a/ Create padded image and move Prewitt filter to get edge detection image result

Q.29 Determine the piecewise linear function of the corresponding gray level transform shown below



Q.30 Consider the following 8-bit image **f**; determine **f** with a gray-level resolution of 2^k For **(i)** $k = 1$ and **(ii)** $k = 3$

200	152	141	130
147	100	193	115
93	75	88	100
137	50	101	157

Q.31 The following matrix represents the pixels values of an **8 bit image**, apply the negative **gray level transformation** to find the resulting image

100	110	90	95
98	140	145	135
89	90	88	85
102	105	99	115

Q.32 What is segmentation? Write short note on **segmentation** approaches then give the mask used for **line detection**.

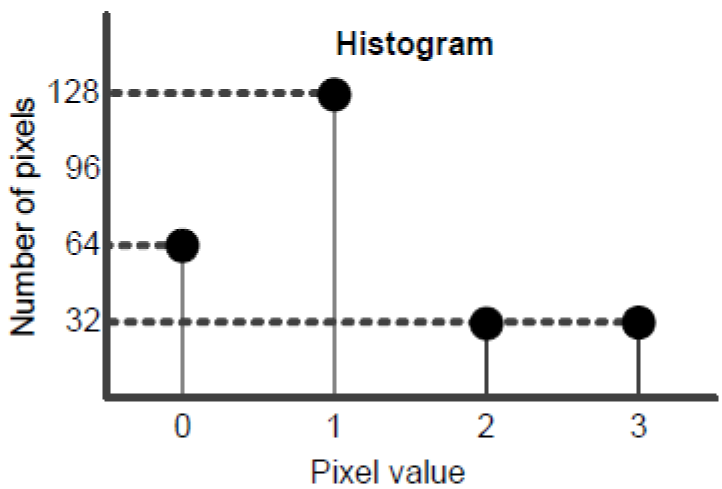
Q.33 What is meant by **Laplacian filter**? Illustrate why Laplacian filter cannot be used for edge detection?

Q.34 Write short note on smoothing filters in the frequency domain **(ILPF, BLPF, GLPF)** stating their frequency response and determine their effects on the image

Q.35 Given a sequence $x(n)$ for $0 \le n \le 3$, **where** $x(0) = 1$, $x(1) = 2$, $x(2) = 3$, and $x(3) = 4$. Evaluate its DFT

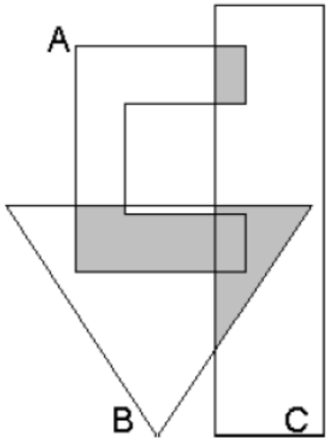
Q.36 Write MATLAB program to detect the edges of (NXN) image

Q.37 Given a 16×16, 2-bits image with the histogram shown in the figure below. Find an **arithmetic code** for this row: [0 0 3 1]



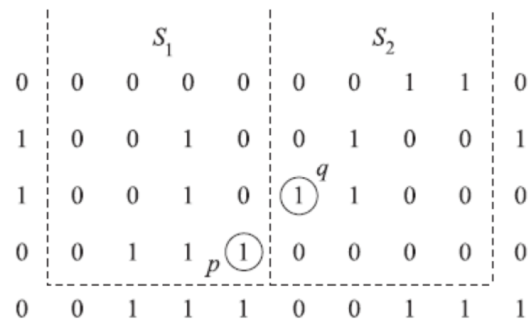
Q.38 Write short note on morphology and its basic operations

Q.39 The following figure shows three closed sets A, B, and C. Give an expression for the shaded part using the basic concepts of the set theory (∪ & ∩) between these sets



Q.40 Calculate the inverse of the following 2D-DFT $\widetilde{\boldsymbol{x}} = \begin{bmatrix} \mathbf{14} & \mathbf{-8} \\ \mathbf{0} & \mathbf{2} \end{bmatrix}$

Q.41 Consider the two image subsets, S_1 and S_2 , shown in the following figure. For $V = \{1\}$, determine whether these two subsets are (a) 4-adjacent, (b) 8- adjacent, or (c) m-adjacent



Q.42 Specify the concept of spatial domain methods.

Q.43 What do you meant by shrinking of digital images?

Q.44 What is meant by masking?

Q.45 **Give** the formula for negative and log transformation.

Q.46 Differentiate linear spatial filter and non-linear spatial filter.

Q.47 What do we mean by point processing?

Q.48 What is Variable Length Coding?

Q.49 Define each of the following: 1) Convolution 2) Image Zooming 3) Image histogram 4) Order statistics filter

Q.50 Write short notes on neighbors of a pixel.

Q.51 Find the number of bits required to store a 256 X 256 image with 32 gray levels

Q.52 Write the expression to find the number of bits to store a digital image?

Q.53 Compare between lossless and lossy compression

Q.54 Explain the types of connectivity.

Q.55 Give the formula for calculating D_4 and D_8 distance.

Q.56 Give the mask used for high boost filtering.

Q.57 Write the steps involved in frequency domain filtering.

Q.58 Write short notes on Fourier spectrum and spectral density

Q.59 Use Laplacian equation to derive the sharpening filter.

Q.60 Why Laplacian filter cannot be used for edge detection

Q.61 Describe Sobel and Prewitt edge detectors. Which one is better? Why?

Q.62 Write short notes on sampling and quantization

Q.63 Write short notes on Robert Gradient operator

Q.64 Give the properties of the second derivative around an edge

Q.65 What are the different types of data redundancies?

Q.66 What is ringing effect and why ILPF and IHPF lead to ringing effect?

Q.67 What is run length coding?

Q.68 Write short notes on Huffman coding

Q.69 Write short notes on Arithmetic coding

Q.70 How we can reduce the gray values down to 16 possible values in gray image (where each pixel containing 256 possible gray level values

Q.71 Write short notes on Data compression and image compression

Q.72 Assume that you are given an input image that has the following intensity histogram

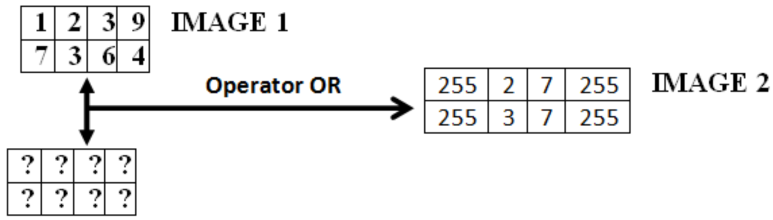
a) Calculate the cumulative intensity histogram for this image in the space above

b) What is the mapping function you need to perform histogram equalization?

c) Draw normalized histogram, mapping function, the histogram of the equalized image

i	0	1	2	3	4	5	6	7	8	9
h(i)	10	25	15	5	5	5	10	25	30	20

Q.73 Define the mask-image, that transforms image 1 into image 2 using the OR operand



Q.74 Find the entropy for the following 3-bit sub-image

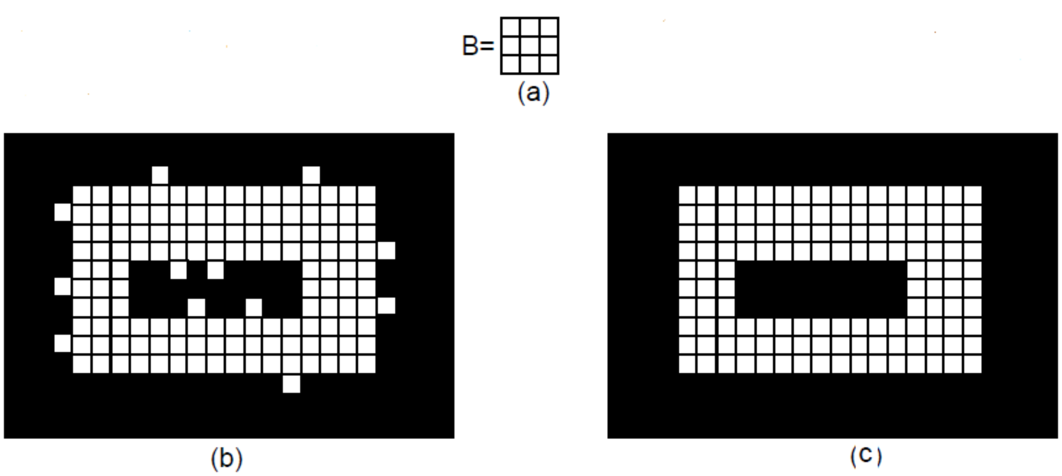
$$\begin{matrix} 1 & 0 & 7 & 2 \\ 3 & 4 & 2 & 5 \\ 3 & 4 & 5 & 6 \\ 0 & 1 & 7 & 6 \end{matrix}$$

Q.75 Given a 5x5 pixel image and respective pixel values (8-bit code for each pixel) below,

a) Calculate the respective Huffman Codes for each symbol (each pixel value) of the given image,
b) What is the compression ratio achieved by employing Huffman Coding instead of 8-bit fixed length coding,
c) Calculate the relative data redundancy of the given 8-bit image and comment on the type of the redundancy used by Huffman coding,
d) Calculate the *entropy* and the *bpp* (bits per pixel) of the image after Huffman Coding.

$$\begin{bmatrix} 180 & 160 & 160 & 140 & 120 \\ 110 & 110 & 120 & 140 & 120 \\ 110 & 140 & 120 & 120 & 140 \\ 120 & 160 & 160 & 170 & 170 \\ 170 & 120 & 110 & 140 & 110 \end{bmatrix}$$

Q.76 Use the structuring element in (a) to state a morphological procedure (erosion and dilation) to clear the edge artifacts of the image in (b) to obtain the image in (c)



(a)

(b) (c)

Q.77 Describe how *Butterworth low pass filtering* works. Draw diagrams to illustrate the "cross section" of this filter in the frequency domain.

Q.78 Describe how *Gaussian low pass filtering* works. Draw diagrams to illustrate the "cross section" of this filter in the frequency domain.

Q.79 What is zig zag sequence?

Q.80 Consider the 8x8 image below. In this question, you will explain how ***Run length coding*** and ***Huffman coding*** can be used to compress this data.

0	**0**	**0**	**0**	**1**	**1**	**1**	**1**
0	**0**	**0**	**1**	**1**	**1**	**1**	**1**
0	**0**	**1**	**1**	**1**	**1**	**1**	**1**
0	**1**	**1**	**1**	**1**	**1**	**1**	**1**
1	**1**	**1**	**1**	**1**	**1**	**1**	**1**
2	**2**	**2**	**2**	**3**	**3**	**3**	**3**
5	**6**	**6**	**6**	**5**	**6**	**5**	**6**
7	7	7	7	7	7	7	7

a) Apply run length coding on the image above

b) How many bits are needed to compress this image with the run length coding above? Assume we use 3-bits to store all integer values.

c) Describe the algorithm for *Huffman coding*.

d) Use the Huffman coding algorithm to find the codes for the pixel values [0..7]

e) How many bits are needed to compress the image using this Huffman code? You do NOT need to compress the whole image to figure this out.

f) Which of these methods requires the fewest bits to encode this image?