SL NO of QP : 9948

Unique Paper Code	: 2343010027
Name of Course	: B.Sc. (H) Computer Science (NEP)
Name of the Paper	: Digital Image Processing
Semester	: VII
Duration	: 3 Hours
Maximum Marks	: 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. 1 is compulsory.
3. Attempt any 4 of Question Nos. 2 to 7.
4. Parts of a question must be answered together.
5. Use of simple non programmable calculator is allowed.

Section A

1. (a) Calculate the 1D spatial correlation for the given input signal X = [1, 2, 2, 4, 3] using kernel k = [1, 0, −1]. Assume zero padding. 3

(b) Briefly explain the two processes involves in converting an analog image into digital image. 3

(c) Draw the bit planes for given 3-bit sub-image of size 3×3. 3

5	4	2
6	3	1
4	7	0

Sub-image

(d) Differentiate between image enhancement in spatial domain and image enhancement in frequency domain? 3

(e) What is the gamma correction? Explain its significance. 3

(f) Compute D_4 distance (city block distance) and D_8 distance (chess board distance) between s and t in the given 4×4 digital sub-image. 3

4 (s)	4	4	2
2	4	4	4
4	2	2	2 (t)
2	1	1	0

Sub-image

(g) State the morphological operator used for the following operations: 3

i. To fills small holes and gaps in objects without significantly altering their boundaries.

ii. To extract the boundary of objects.

iii. To detect specific shapes or patterns in an image.

(h) Consider a 24-bit image of size 512×512. After compression, the image size is reduced to 1 MB. Compute the compression ratio. 3

(i) Write 3×3 masks used to detect vertical lines and lines oriented at +45° present in an image. 3

(j) An image is corrupted by salt-and-pepper noise at a probability 0.1. Calculate the fraction of pixels affected in a 256×256 image. How can salt-and-pepper noise be removed from the image? 3

Section B

2. (a) Calculate the first order partial derivatives and second order partial derivatives for the given 1-D array. 7

6	6	4	3	2	1	0	0	0	6	0	0	1	3	1	0	0	8

1-D array

(b) Consider the following 3-bit gray-scale sub-image of size 4×4. 8

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

Sub-image

Apply the following transformations on the above sub image:

i. Negative of the sub image.
ii. Contrast stretching of the sub image.

3. (a) Compare the Ideal, Gaussian, and Butterworth high-pass filters with respect to their definitions and radial cross-section responses. 7

(b) Given the following 5×5 gray-scale sub-image, apply the basic global thresholding method to determine the threshold value (T) and obtain the segmented binary sub image. 8

52	55	61	59	79
62	59	55	104	94
63	65	66	113	144
72	73	70	122	145
69	68	64	110	123

Sub-image

Use an initial threshold T_0=80. Stop the iteration when the threshold change between steps is less than 1.

4. (a) Define three type of adjacencies in a binary image. Identify spatial coordinates of all the M-adjacent pixels of the pixel P in the given 4×4 binary image. Assume V= {1} be the set of intensity value used to define adjacency. 7

0	1	1	0
1	1	0	1
0	1	1(P)	0
1	0	0	1

Sub-image

(b) Explain the steps for filtering an image in the frequency domain. 8

5. (a) Write the steps performed for edge detection in an image. Consider a 3×3 sub image. 7

10	10	10
10	**20**	30
10	10	10

Sub-image

Compute the gradient magnitude at the center pixel using the Prewitt operator.

(b) Consider a source having symbols {A, B, C, D} with probabilities {0.5, 0.25, 0.15, 0.1}. Compute the following: 8

i. Huffman code for each symbol.
ii. Average code length.
iii. Compression ratio
iv. Relative data redundancy

Assume a fixed-length code is 2 bits per symbol.

6. (a) Given 5×10 binary sub-image with gaps (shown as zero value): 7

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

Sub-image

1	1	1
1	(1)	1
1	1	1

B

Apply the morphological closing operation using the structuring element B on the above sub image. The origin of the structuring element B is indicated with an encircled value. Discuss the effect of applying closing morphological operation on the given sub-image.

(b) Consider the following 3-bit sub-image of dimensions 5×5: 8

1	1	3	2	2
2	3	3	2	2
1	3	1	3	2
2	3	1	3	3
1	1	1	2	2

sub-image

i. Plot the histogram of the above sub-image.
ii. Perform the histogram equalization. Also, plot the histogram of the resultant sub-image.

7. (a) Show that erosion and dilation are duals of each other with respect to set complementation and reflection. How does structuring element affect the result of erosion morphological operation? Explain with the help of example. 7

(b) Consider a 3-bit sub-image of size 5×5. 8

5	6	4	7	4
6	7	7	6	3
6	6	4(P)	4	3
4	5	4	5	4
3	3	2	0	7

Sub-image

Perform the following operations at pixel P in the given sub-image:

i. 3×3 Laplacian filter
ii. 3×3 mean filter
iii. 3×3 median filter
iv. 3×3 max filter