Master of Computer Applications
MCAE 404: Digital Image Processing
Unique Paper Code: 223402404
Semester IV
May-2022
Year of Admission: 2020

Time: Three Hours | Max. Marks: 70

Attempt all questions.
Parts of a question must be answered together.

1.

a) Consider the two image subsets S_1 and S_2 shown in the figure below:

	S_1				S_2				
0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	1	1	0	0	0
0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

Assuming V= {1}, determine whether these two subsets are
i. 4-adjacent
ii. 8-adjacent
iii. m-adjacent
giving proper explanation to you answers.

[6]

b) Differentiate between Histogram equalization and specification in image processing.

[4]

2.

a) Find all the bit planes of the following 4-bit image: [4]

0	1	8	6
2	2	1	1
1	15	14	12
3	6	9	10

b) Write in brief about RGB, CMY and HSI color models.

[3]

c) How many different shades of gray are there in a color RGB system whose three component images are 8 bit images?

[3]

3.

a) Give a procedure for computing the median of an n×n neighborhood. [2]

b) You are given the following kernel and image.

$$w = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix} \qquad f = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Compute the convolution $w \star f$ using the minimum zero padding needed. Show the details of your computations when the kernel is centered on point (2,3) of f; and then show the final full convolution result. [4]

c) Use the sifting property of the impulse to show that convolving a 1-D continuous function, f (t), with an impulse located at t_0 shifts the function so that its origin is moved to the location of the impulse (if the impulse is at the origin, the function is not shifted). [4]

4.

a) Show that

$$\Im\{e^{j2\pi t_0 t}\} = \delta(\mu - t_0).$$

where t_0 is a constant.

Or

A continuous Gaussian low pass filter in the continuous frequency domain has the transfer function

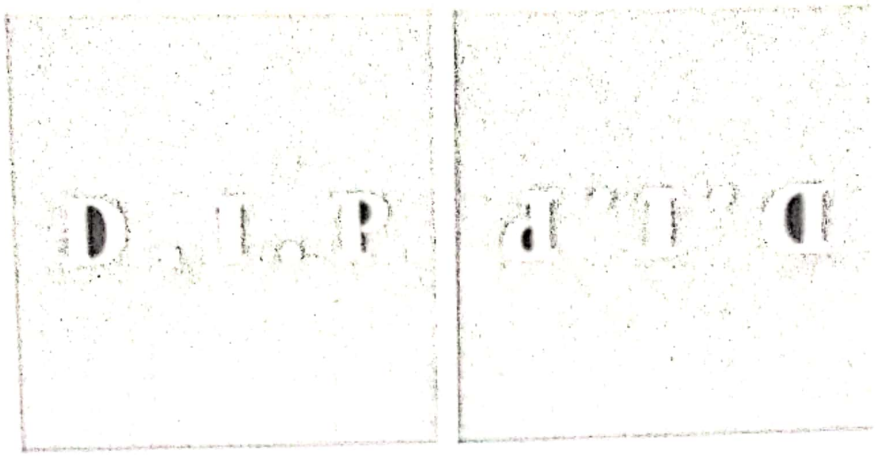
$$H(\mu,\nu) = Ae^{-(\mu^2 + \nu^2)/2\sigma^2}$$

Show that the corresponding filter kernel in the continuous spatial domain is

$$h(t,z) = A2\pi\sigma^2 e^{-2\pi^2\sigma^2(t^2 + z^2)}$$

[6]

b) Consider the images shown. The image on the right was obtained by: (i) multiplying the image on the left by $(-1)^{x+y}$; (ii) computing the DFT; (iii) taking the complex conjugate of the transform; (iv) computing the inverse DFT; and (v) multiplying the real part of the result by $(-1)^{x+y}$. Explain (mathematically) why the image on the right appears as it does. [4]



5.

a) Use the LZW coding algorithm to encode the 7-bit ASCII string "aaaaaaaaaaa" (Assume that the first 256 codes in the starting dictionary are the ASCII codes and ASCII code of "a" is 97). [4]

b) A 1024 × 1024 8-bit image with 5.3 bits/pixel entropy (computed from its histogram) is to be Huffman coded. [6]

i) What is the maximum compression that can be expected?

ii) Is it possible to obtain the maximum compression?

iii) If a greater level of lossless compression is required, what else can be done?

6.

a) Explain what would happen in image erosion and dilation if the structuring element is a single point, valued 1. Give reason(s) for your answer. [4]

b) How an image is compressed using JPEG image compression standard? Describe the process with the help of an example. [6]

7.

a) A binary image contains straight lines oriented horizontally, vertically, at 45°, and at −45°. Give a set of 3 × 3 kernels that can be used to detect one-pixel breaks in these lines. Assume that the intensities of the lines and background are 1 and 0, respectively. [4]

b) The arithmetic decoding process is the reverse of the encoding procedure. Decode the message 0.23355 given the coding model. [6]

Symbol	Probability
A	0.2
E	0.3
I	0.1
O	0.2
U	0.1
!	0.1