

Answer any **FIVE** questions
 All parts of a particular question must be answered consecutively

1. a) Define Digital Image. Explain the fundamental steps in digital image processing. 1+3
 b) Explain 4 connectivity, 8 connectivity, m connectivity with reference to relation between pixels? 3
 c) Knowing that adding uncorrelated images convolves their histograms, how would you expect the contrast of the sum of two uncorrelated images to compare with the contrast of its component images? Justify your answer. 2
 d) Consider an $N \times N$ image $f(x, y)$. From $f(x, y)$ create an image 3

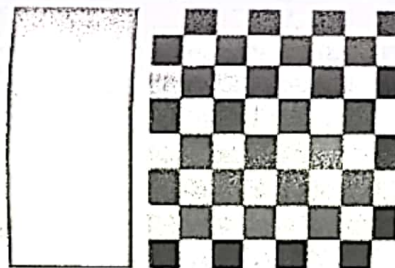
$$g(x, y) = -2f(x, y) + f(x, y-1) + f(x, y+1).$$
 Comment on the histogram of $g(x, y)$ in relation to the histogram of $f(x, y)$.

2. a) Explain the procedure to zoom a digital image using *nearest neighbor interpolation method*. 3
 b) Explain image Acquisition Using Sensor Arrays with proper illustration. 3
 c) Consider an $N \times N$ image $f(x, y)$. From $f(x, y)$ create an image 3

$$g(x, y) = f(x, y) - f(x, y-1).$$
 Comment on the histogram of $g(x, y)$ in relation to the histogram of $f(x, y)$.
 d) Let $V = \{0, 1\}$ be the set of intensity values used to define adjacency. Compute the lengths of the shortest 4-, 8-, and m-path between p and q in the following image. If a particular path does not exist between these two points, explain why. 3

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

3. a) Explain the procedure of image enhancement using *log transformation* and *power-law transformation*. 2+2
 b) The two images shown in the following figure are quite different, but their histograms are the same. Suppose that each image is blurred using a 3×3 box kernel. 2+2



- i) Would the histograms of the blurred images still be equal? Explain.
 ii) If your answer is no, either sketch the two histograms or give two tables detailing the histogram components.
 c) Consider a grey-level image $f(x, y)$ with histogram sketched below: 4

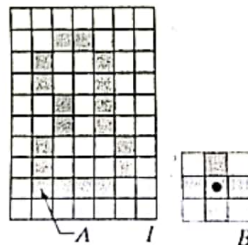


- i) What can we say about $f(x, y)$?
 ii) Propose an intensity transformation function which will improve the contrast of the image when it is used to modify the intensity of the image.
 iii) Sketch the histogram of the transformed intensity.
 iv) Calculate the mean and the variance of the two images

4. a) An image is filtered with three Gaussian lowpass kernels of sizes 3×3 , 5×5 , and 7×7 , and standard deviations 1.5, 2, and 4, respectively. A composite filter, w , is formed as the convolution of these three filters. 3
- Is the resulting filter Gaussian? Explain.
 - What is its standard deviation?
 - What is its size?
- b) What is the limitation of using *inverse filter* for image restoration? How does *winner filter* solve this problem? 3
- c) Explain about the restoration filters used when the image degradation is due to noise only. 6
If the degradation present in an image is only due to noise, then,

$$g(x, y) = f(x, y) + \eta(x, y)$$

$$G(u, v) = F(u, v) + N(u, v)$$
How 1. Mean filters 2. Order static filters and 3. Adaptive filters are applied to this image to restore it.
5. a) In which types of images median filter works well and which types it does not? 2
b) With relevant mathematical expressions, explain how a Wiener filter achieves restoration of a given degraded image. 2
c) A professor of archeology doing research on currency exchange practices during the Roman Empire recently became aware that four Roman coins crucial to his research are listed in the holdings of the British Museum in London. Unfortunately, he was told after arriving there that the coins had been recently stolen. Further research on his part revealed that the museum keeps photographs of every item for which it is responsible. Unfortunately, the photos of the coins in question are blurred to the point where the date and other small markings are not readable. The cause of the blurring was the camera being out of focus when the pictures were taken. As an image processing expert and friend of the professor, you are asked as a favor to determine whether computer processing can be utilized to restore the images to the point where the professor can read the markings. You are told that the original camera used to take the photos is still available, as are other representative coins of the same era. 4
Propose a step-by-step solution to this problem.
- d) Consider the problem of image blurring caused by uniform motion in the x direction. If the image is at rest at $t = 0$ and moves with a uniform velocity $x_0(t) = 2at/T$ for a time T , find the blurring function $H(u, v)$. You may assume that shutter opening and closing times are negligible. Now deduce an expression for $H(u, v)$ if there is a y component of velocity $y_0(t) = 2bt/T$. 4
6. a) Set A (shown shaded) contained in image I . B is the structuring element. Only the foreground elements are used in computations. How do you fill the hole of the image I using dilation, complementation, and intersection? 3



- b) A is a solid rectangle of 1's of size $M \times N$ with a 1-pixel border of 0's, and m and n below are odd integers. Discuss what the result will be in each case. 2+2
- A is opened with a structuring element of 1's of size $m \times n$.
 - A is closed with a structuring element of 1's of size $m \times n$.
- c) What is the limiting effect of repeatedly eroding a set of foreground pixels in an image? Assume that a trivial (one point) structuring element is not used. 3
- d) What is the purpose of Hit-or-Miss transformation? How does it work? 2
7. a) What do you understand by a decision boundary? What is the difference between a decision criterion and a decision boundary? 4
- b) What is the difference between supervised learning and unsupervised learning? 2
- c) "Suppose you want to recognize the address written on the envelope. The data here is probably an image of the envelope including the sub-images of all the characters to be classified and some background." How do you classify all the characters of the address? 3
- d) What is the k nearest neighbor (KNN) classification rule? How does it work? 1+2



Institute of Information Technology

Jahangirnagar University

4th Year 2nd Semester B.Sc (Hons.) Final Examination, 2020

Time: 3 Hours

IT4225: Digital Image Processing & Pattern Recognition

Full Marks: 60

Answer any **Five (05)** from the following questions. Figures at the right indicate the marks.

1. a) Show the fundamental steps of digital image processing. 3
b) How can we represent an image? How can we calculate the storage for any image? 2+2
c) Show the classifications of image. Given an image with impulse noise, Rahim applies MINMAX after MAXMIN while Karim adopts MAXMIN after MINMAX. Would they get the same results? Why or why not? 2+3
2. a) What is Gamma correction? 2
b) What is spatial resolution? How can you measure it? 3
c) For the given image $I = \begin{bmatrix} 10 & 15 \\ 20 & 25 \end{bmatrix}$ show the k-time zooming. 5
d) When the pixel replication method is applicable for zooming a digital image. 2
3. a) Briefly explain the histogram equalization technique for image enhancement. Can histogram equalization always provide a better result? State your reasons. 4
b) What is aspect ratio? For any image if aspect ratio is 6:2; pixel resolution is 480000; bits per pixel for grayscale image is 8bpp. Find the size of the image. 2+3
c) Explain dithering operation. 3
4. a) Write the differences between brightness and contrast? 3
b) Explain any grey level transform. 3
c) Explain any smoothing filter. 3
d) Explain any sharpening filter. 3
5. a) Explain how can you sharpen an image using Laplacian operator? 3
b) Explain about the restoration filters used when the image degradation is due to noise only. 3
c) What are the advantages of using a 'Wiener Filter' over a conventional 'Inverse Filter' for image restoration, discuss 3
d) What are high pass and low pass filters in frequency domain? How does it work? 3
6. a) Mention the characteristics used to distinguish colours. 2
b) Explain intensity slicing for colour image. 4
c) Mention the code redundancy. Explain any lossless image compression algorithm. 4
d) When we need lossy compression? 2
7. a) What is image segmentation? Explain edge detection segmentation. 6
b) Mention the phases of pattern recognition. Explain an unsupervised algorithm for pattern recognition. 6



Institute of Information Technology (IIT)
Jahangirnagar University

4th Year 2nd Semester B.Sc (Hons.) Final Examination 2021
Course: ICT-4259 (Computer Network Security)

Time: 3 Hours

Full Marks: 60

Answer any FIVE questions
All parts of a particular question must be answered consecutively

1. a) Distinguish between threat and attack. Explain three key concepts of the CIA triad. [4]
b) List and briefly define categories of security mechanisms. [3]
c) For each of the following assets, assign a low, moderate, or high impact level for the loss of confidentiality, availability, and integrity, respectively. Justify your answers. [5]
- i) A student maintaining a blog to post public information.
 - ii) An examination section of a university that is managing sensitive information about exam papers.
 - iii) An information system in a pathological laboratory maintaining the patient's data.
 - iv) A student information system used for maintaining student data in a university that contains both personal, academic information and routine administrative information (not privacy related). Assess the impact for the two data sets separately and the information system as a whole.
 - v) A university library contains a library management system, which controls the distribution of books among the students of various departments. The library management system contains both the student data and the book data. Assess the impact for the two data sets separately and the information system as a whole.
2. a) What is a KDC? How can Alice send a confidential message to Bob using the KDC? [3]
b) What does 'symmetric-key agreement' mean? Illustrate the processes of creating a symmetric-key between Alice and Bob using Diffie-Hellman Key Agreement protocol. [3]
c) What is Kerberos and why it is named so? Describe the function of each servers involved in Kerberos protocol. [3]
d) What are the approaches to distribute a public key? What is a digital certificate and what information it carries? [3]
3. a) What does authentication mean? Briefly describe three types of factors that are used for authentication. [3]
b) A message can be authenticated either by hash code or MAC code. Give proper illustration for any one of these two methods. [3]
c) Illustrate the processes of verification by hashing the fixed password approach. [3]
d) List several attacks while authentication is done by fixed password. What are the benefits of one-time password over fixed password for verification? [3]
4. a) Illustrate the encryption algorithm of DES. [4]
b) Perform encryption and decryption using the RSA algorithm, for the following: [4]
i. $p = 3; q = 11, e = 7, M = 31$
ii. $p = 5; q = 11, e = 3, M = 9$
c) Analyze and explain the various techniques an attacker can use to perform a man-in-the-middle attack on a Wi-Fi network and evaluate the potential impact on resources of the network and its users. [4]

5. a) Illustrate the general idea behind symmetric-key and asymmetric-key cryptography. [3]
 b) What services are provided by cryptography? How does asymmetric-key cryptography prove the authenticity of the message originator? [3]
 c) Suppose you are the network administrator of an organization. To provide confidentiality of your organization's data, you have to choose either symmetric-key or asymmetric-key cryptosystem. Which system do you want to choose for the organization and why? [4]
 d) Which components a cryptographic process must have? Three Pass Protocol can be used to send sensitive information across an insecure network. Give a postal analogy. [2]
6. a) An encryption key used in a transposition cipher is given as 4 1 5 3 2. Determine the corresponding decryption key and then decrypt the message "GLHUA ITSRE BTEEH ESDMT NIEIC" using keyed transposition cipher with the decryption key you determined. [3]
 b) What are the three steps in which encryption or decryption is done in columnar transposition cipher? Encrypt the message "The enemy of my enemy is my friend" using Columnar transposition cipher with the help of encryption key as 41532. [3]
 c) Encrypt the message 'crypto' using any TWO of the following substitution ciphers. (Ignore the space between words and use modulo 26). Decrypt the message to get the original plaintext. [3]
 (i) Affine cipher with key = (11, 9) [$11^{-1} = 19$]
 (ii) Autokey cipher with initial key = 12
 (iii) Vigenere cipher with keyword = 'pabna'
 (iv) Playfair cipher with the keymatrix you consider
 d) List two types of traditional symmetric-key ciphers. Suppose you want to encrypt a message using 33 modulus. What will be the possible key domain if Affine cipher is used? [3]
7. a) What is binary operation? Is not division a binary operation? Express the following set of integers in set notation: [3]
 (i) Set of all positive integers (ii) Set of all non-negative integers
 (iii) Set of additive inverse in 10 modulus (iv) Set of multiplicative inverse in 10 modulus
 b) What does Z_{13} and Z_{13}^* mean? Using Euler's Phi-Function, determine the number of elements in- [3]
 i) Z_{59}^* ii) Z_{64}^* iii) Z_{33}^* iv) Z_1^*
 c) Assume that A and B are two integers in N modulus. Write the appropriate condition such that - [3]
 (i) A is the multiplicative inverse of B
 (ii) A is the additive inverse of B .
 Prove using extended Euclidean algorithm that the multiplicative inverse of 10 does not exist in 26 modulus.
 d) When two integers X and Y are called co-prime? Find the result of the following operations: [3]
 (i) $0 \bmod N$ (ii) $-15 \bmod 8$ (iii) $35 \bmod 29$ (iv) $N \bmod N$
 [Here, N is a positive integer].

5. a) Define P-box and S-box. Mention the necessary condition for an S-box to be invertible. [3]
 b) Show the permutation table for the following P-box. [3]

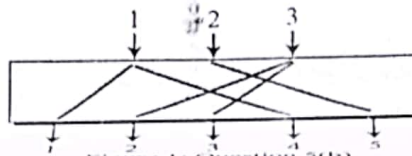


Figure 1: Question 5(b)

Show the P-box defined by the following table. How to invert this permutation table?

7	5	2	3	4	8	6	1
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- c) The input/output relationship in a 4X4 S-box is shown by the following table. Show the corresponding table for the inverse S-box. [4]

		LSBs of Input			
		00	01	10	11
MSBs of Input	00	1000	0101	1010	0000
	01	1011	0001	1100	0010
	10	0100	1111	0110	1101
	11	1100	0111	1001	0011

Figure 2: Question 5(c)

If the input to the above S-box is 1001, then what is the output?

- d) A message has 600 characters. If it is supposed to be encrypted using a block cipher of 64 bits, find the size of the padding and the number of blocks (Assume that 8-bit ASCII is used for encoding each character). [2]
6. a) Illustrate the general idea behind symmetric-key and asymmetric-key cryptography. [3]
 b) Distinguish between- [3]
 i) cryptography and cryptanalysis
 ii) symmetric-key and asymmetric-key cryptography
- c) How does asymmetric-key cryptography provide the message confidentiality and prove the authenticity of the message originator? [3]
 d) Three Pass Protocol can be used to send sensitive information across an insecure network. Give a postal analogy. [3]
7. a) What is a digital signature? Differentiate between conventional signature and digital signature. [3]
 b) Differentiate between - [3]
 i) Digital Signature and Cryptosystem
 ii) MAC Algorithm and Hash Algorithm
- c) Briefly describe three services provided by a digital signature. [3]
 d) Define hash function. Briefly describe some desirable properties of a hash function. [3]