AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department: Computer Science and Engineering
Program: B.Sc. in Computer Science and Engineering
Semester Final Examination: Spring 2020
Year: 4th Semester: 2nd
Course Number: CSE4227
Course Name: Digital Image Processing

Time: 3 (Three) Hours **Full Marks: 60**

Use single answer script

Instructions:	i)	Answer script should be hand written and should be written in A4 white paper. You must submit the hard copy of this answer script to the Department when the university reopens.
	ii)	You must write the following information at the top page of each answer script: **Department:** **Program:** **Course no:** **Course Title:** **Examination:** **Semester (Session):** **Student ID:** **Signature and Date:**
	iii)	Write down Student ID, Course number and put your signature on top of every single page of the answer script.
	iv)	Write down page number at the bottom of every page of the answer script.
	v)	Upload the scan copy of your answer script in PDF format through provided **google form** at the respective course site (i.e., **google classroom)** using institutional email within the allocated time. Uploading clear and readable scan copy (uncorrupted) is your responsibility and you must cover all the pages of your answer script. However, for clear and readable scan copy of the answer script student should use only one side of a page for answering the questions.
	vi)	You must avoid **plagiarism;** maintain **academic integrity and ethics**. You are not allowed to take any help from another individual and if taken so can result in stern disciplinary actions from the university authority.
	vii)	Marks allotted are indicated in the **right margin.**
	viii)	Assume any reasonable data if needed.
	ix)	Symbols and characters have their usual meaning.
	x)	Before uploading, rename the PDF file as **CourseNo_StudentID.pdf** e.g., CSE4227_180104001.pdf

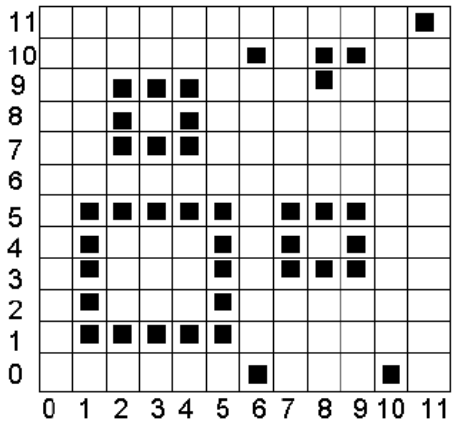
The answer script **(one single PDF file)** must be uploaded at designated location in the provided **Google Form link** available in the Google classroom.

There are 7 (Seven) Questions. Answer any 5 (Five).

Question 1. [Marks: 12]

a) In the Hough Transform, a point (x_0, y_0) in the xy-plane is mapped into a curve in the (ρ, θ)-parameter space. Write down the equation of the curve. **[2]**

b) Consider the following imge where each black square denotes a point and the numbers are the coordinates. **[5]**



If we apply the Hough transform on the image above, what would be the values of the following accumulator cells in the (ρ,θ)-space?

i) (2,0)

ii) (5,$\boldsymbol{0}$)

iii) (2,$\boldsymbol{\pi/2}$)

iv) (5,$\boldsymbol{\pi/2}$)

c) What is edge of an image? Describe the steps of Canny Edge Detection Algorithm in detail. **[5]**

Question 2. [Marks: 12]

a) Define median filter. "Median filtering is much better suited than averaging for the removal of salt-and-pepper noise"- justify the statement. **[2]**

b) i) Derive the following Laplace filter mask. **[5]**

1	1	1
1	-8	1
1	1	1

ii) Apply the following **Laplace** on the highlighted pixel as shown in below.
iii) Apply the following **Laplace 2nd derivative** on the highlighted pixel as shown in below.
iv) Apply a **3 × 3 Mean filter** on the highlighted pixel as shown in below.
v) Apply a **3 × 3 Median filter** on the highlighted pixel as shown in below.

0	−1	0
−1	4	−1
0	−1	0

153	157	156	153	155
159	156	158	156	159
155	158	**154**	156	160
154	157	158	160	160
157	157	157	156	155

c) The histogram of an image is shown in Table 1. Show the histogram table for a desired image where the number of pixel distribution will be in reverse order of the original image. **[5]**

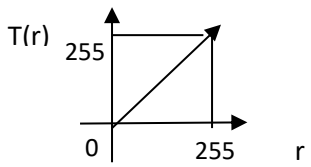
Table 1

Gray Levels (r)	2	18	33	58	67	96	114	152	184	206	220	245
No. of pixels	43	11	47	31	27	49	71	21	14	52	24	10

Sketch the normalize histograms of the original and desired images. What will be the output after applying histogram equalization process on the original image (Table 1)? Show your calculations.

Question 3. [Marks: 12]

a) The following figure illustrates the intensity transformation, T(r) = r. **[2]**



Now illustrate and explain the following intensity transformation functions:
i) T(r) = r + 100
ii) T(r) = r × 10

b) i) Explain a simple image enhancement technique that improves the contrast in an image by stretching the range of intensity values. **[5]**
ii) Define intensity transformation function T(r) for the Thresholding.

c) Consider figure ***I*** as a 2 X 2 image with 8-bit gray values. **[5]**

i. Give 8 bit planes of ***I***.

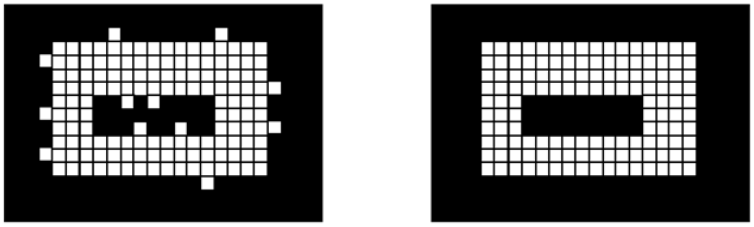
ii. Determine the reconstructed image using bit planes 8 and 7.

120	60
60	250

I

Question 4. [Marks: 12]

a) Consider the following images: **[2]**



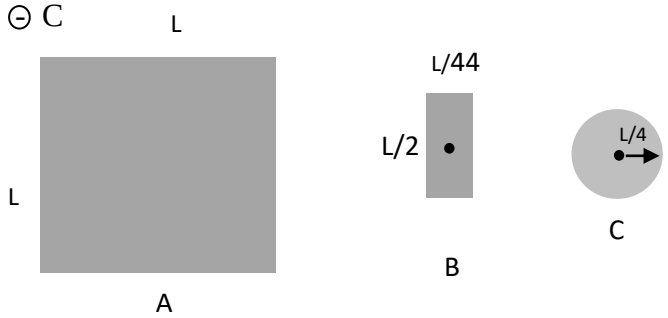
(a) (b)

Now propose a morphological procedure to clear the edge artifacts of the image given in (a) such that the image in (b) is obtained. Clearly state the structuring element(s) and number of iterations that you would use in your procedure.

b) Define the term **Dilation** and **Erosion** in morphological operations of image processing. Sketch the following morphological operations: (must show the calculations.) **[5]**

I. $A \oplus B$

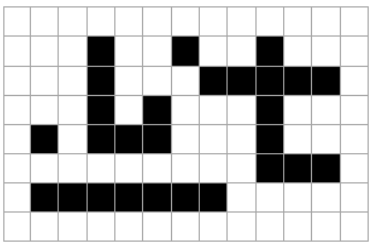
II. $A \ominus C$



c) i. Design Hit-or-miss transformation SEs for locating **4-connected endpoints** of an image. **[5]**

ii. Locate all the 4-connected endpoints of the following image using SEs obtained from the previous question i.

iii. Explain with example, if it is possible to achieve **edge detection** using morphological operations.



Question 5. [Marks: 12]

a) A 1024 X 1024 8-bit image with 5.3 bits/pixel entropy is to be Huffman Coding .What is the maximum compression that can be expected? **[2]**

b) Given a 4x8 pixel image and respective pixel values (8-bit code for each pixel) below, **[5]**

21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243

i. Compute the entropy of the image.
ii. Calculate the respective Huffman Codes for each symbol (each pixel value).
iii. What is the compression ratio achieved by employing Huffman Coding instead of 8-bit fixed length coding?
iv. Calculate the relative data redundancy of the given 8-bit image.
v. Compute the effectiveness of the Huffman coding.

c) i) Suppose we have a grayscale image with most of the values of pixels being same. What can we use to compress the size of the image? **[5]**

In the figure, * is representing the value of last three digits of your Student ID (e.g. for ID 160104001, *** will be 1).**

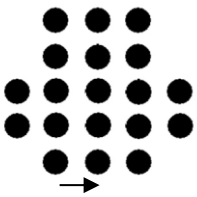
ii) Show your step by step **LZW** encoding process (to generate your codebook, use **4** bits). Any compression achieved by employing **LZW** in your above encoding process?

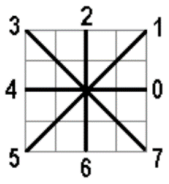
***	**4**	**3**	**7**
***	**4**	**3**	**7**
***	**4**	**3**	**7**
***	**4**	**3**	**7**

Fig. A 3-bit image

Question 6. [Marks: 12]

a) Consider the following image: **[2]**





Compute the chain code that is:
i. Invariant to starting point.
ii. Invariant to both starting point and rotation.

[The reference pixel and the direction are marked by an arrow, use 8-neighbor relationship.]

b) Describe the Region Growing and Region Splitting & Merging technique of image segmentation and illustrate example for each technique. **[5]**

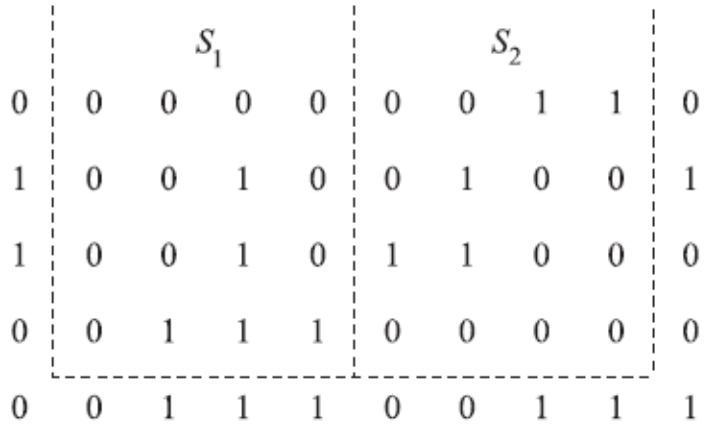
c) Why RGB colour model is called ***'Additive'***? Describe the RGB colour model with schematic of RGB colour cube. **[5]**

Question 7. [Marks: 12]

a) What do you understand by an indexed image? **[2]**

b) For images of the same size, the low detail image may need more pixel depth. Explain the statement. Illustrate key stages in digital image processing with the help of a block diagram. **[5]**

c) Consider the two image subsets, S1 and S2, shown in the following figure. For V = {1}, determine whether these two subsets are 4-adjacent, 8-adjacent or m-adjacent. **[5]**



Best of Luck!