TDI2131 Digital Image Processing
Trimester III, 2009/10

Term Test (1 hr)

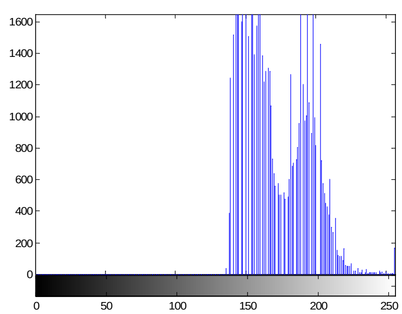
Name: Please write in **BLOCK** letters	
ID:	Marks: / 10

There are 10 questions in this paper, and 1 additional bonus question.
The total mark for this test is 10 marks, while the bonus question is worth 1 extra mark. This test constitutes 10% of coursework.
Do NOT write less than what is required and NOT more than what is necessary.
Please write your answers and workings (if required) CLEARLY. **PLEASE DO NOT USE PENCIL**.

Q1. In digital image processing, an example of **quantization** involves representing a grayscale image with 8 bits per pixel. What is the purpose of the **quantization** process?

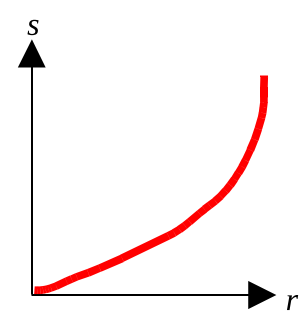
Quantization is used to space a finite number of discrete values in the given range of a signal. The acquired image is normally obtained in continuous/analogue form, and in order to represent the image signals in digital form, the process of quantization is needed.

Q2. The following image with the histogram given below can be appropriately enhanced using the power-law (gamma) gray level transformation, denoted by $s = cr^{\gamma}$, where *r* are the input pixels and *s* are the output pixels.
(a) Assume that the value of *c* is 1, suggest some suitable values/value range for gamma, γ?
(b) Draw an estimated transformation function that can possibly perform the required enhancement.



(a) **Value range for gamma, γ > 1.0**

(b)



Q3. A grayscale image has 256 intensity values. A true colour image has 3 channels of intensities – R, G, and B. What is an **indexed image**?

An indexed image contains indices that correspond to an index table of colors (or sometimes known as colormap). The index table or colormap contains the actual intensity values of all the colors in use.

Q4. Filter the following 8-bit grayscale image using a **3x3 minimum filter**. Apply zero padding to ensure that the resulting image is the same size as the original image.

Image:

245	198	107
205	16	98
45	57	79

Answer:

0	**0**	**0**
0	**16**	**0**
0	**0**	**0**

Q5. The Discrete Fourier Transform (DFT) of an image f(x,y), which is given by

$$F(u,v) = \frac{1}{MN} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) e^{-j2\pi(ux/M + vy/N)} ,$$

is applied to the 4x4 grayscale image given below. What is the result of the "***dc component***"?

249	250	134	172
254	213	56	45
149	131	100	24
56	51	1	0

Answer:

117.81, or 118 (if rounded up)

Q6. In terms of image enhancement, contrast the outcome of using **high-pass** and **low-pass** filters.

High-pass filters produced sharpened images. If applied excessively, it will produce grainy, rough images.
Low-pass filters produced smoothened images. If applied excessively, it will produce blurred images.

Q7. Explain why an arithmetic **mean filter** (sometimes commonly known as an **averaging filter**), will NOT perform well on an image distorted by salt-and-pepper noise.

An arithmetic mean filter (averaging filter) performs by taking the average value of the specified mask neighborhood area. In the presence of salt-and-pepper noise, the distortions caused by salt (fully white values) and pepper (fully black values) are also averaged out, thus they are not totally removed, and may be still visible. In other words, the salt-and-pepper noise are only smoothened out or blurred, not removed.

Q8. With the **composite Laplacian mask** given below, explain how this mask is produced from its original Laplacian mask.

-1	-1	-1
-1	9	-1
-1	-1	-1

This composite Laplacian mask is produced by adding its original Laplacian mask,

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

with the original input image.

Q9. **Erode** the following image with the given structuring element.

Image:

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

Structuring element
(reference point at center pixel):

0	1	0
0	**1**	0
0	1	0

Answer:

0	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**
0	**1**	**0**	**1**	**0**
0	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**

Q10. Describe the **hit-or-miss transform**, in terms of its morphological operations.

The hit-or-miss transform can be described in morphological terms, as the intersection of the erosion of the foreground object set, A by structuring element B^1, with the erosion of the background set A^c by the background of the structuring element B^2. Or in mathematical set notation:

$$A \otimes B = (A \Theta B^1) \cap (A^c \Theta B^2)$$

Bonus Question (Q11). Apply pseudo-coloring by performing **intensity slicing** on the given 8-bit grayscale image. A colormap of 4 colors (black, red, blue, and white) is used here, in the order of darkest to lightest intensities. Assume that the grayscale intensity values are linearly mapped to the new colors.

Indicate the new color by its code provided in the colormap.

4-color colormap:

Code	*R*	*G*	*B*
X	0	0	0
R	255	0	0
B	0	0	255
W	255	255	255

Grayscale image:

250	193	100	127	159
204	114	92	106	117
123	121	60	75	90
184	122	44	21	65
128	146	95	37	3

Linearly map the 256 grayscale intensity values down to 4 intensity ranges (X,R,B,W).
From darkest to lightest,
X: 0-63
R: 64-127
B: 128-191
W: 192-255

Pseudo-colored image:

W	W	R	R	B
W	R	R	R	R
R	R	X	R	R
B	R	X	X	R
B	B	R	X	X

End of Question Paper