B.Sc. Engg. CSE 7th Semester /
B.Sc. Engg. SWE 5th Semester

Date: 16 September 2021

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION **WINTER SEMESTER, 2020-2021**

DURATION: 1 Hour 30 Minutes **FULL MARKS: 75**

CSE 4733 / CSE 4561: Digital Image Processing

Programmable calculators are not allowed. Do not write anything on the question paper.
There are **3 (three)** questions. Answer all **3 (three)** of them.
Figures in the right margin indicate marks and corresponding CO & PO are written in brackets.

Special Instructions:

i. **Limited Open Book Exam:** Use the *Hardcopy book "Digital Image Processing*" by Gonzalez & Woods, *Printed Lectures slides*, & *Handwritten Class-notes* only.
ii. **No Internet Browsing, No Keyboard use.**
iii. **No softcopy of any kind of Class Material or e-Book.**
iv. **Your full Monitor should be within your camera view.**

1. a) Show that 2D Fourier Transform can be computed by first computing 1D Fourier transform along the individual rows (columns) of an input image, followed by performing another 1D Fourier transform along the columns (rows) of the results from the first transform output. [8] [CO1, PO1]

b) Mathematically prove that multiplying an image $f(x,y)$ with $(-1)^{x+y}$ and then applying Fourier Transform shifts the frequency domain by $\left(M/2, N/2\right)$, i.e., [7] [CO3, PO3]

$$\Im\left\{f(x,y)(-1)^{x+y}\right\} = \mathrm{F}\left(\mathrm{u}-M/2, \mathrm{v}-N/2\right)$$

Note: Use the term $(-1)^{x+y} = e^{j\pi(x+y)}$.

c) Suppose, you have a 3×3 spatial mask which can enhance the edge structures of an image through convolution operation. How can you produce an equivalent filter that can give you the same output when applied with element-wise multiplication in the Frequency domain? [10] [CO3, PO3]

2. a) Design the required transformation function(s) for producing the complement transformation of color images using HSI color space. [5] [CO3, PO3]

b) In a 24-bit RGB image, the R, G, and B channels have the horizontal intensity profiles shown in Figure 1.What color would a person see in the middle column ($y=N/2$) of this image? Here, the column size of the image is N. [5] [CO2, PO2]

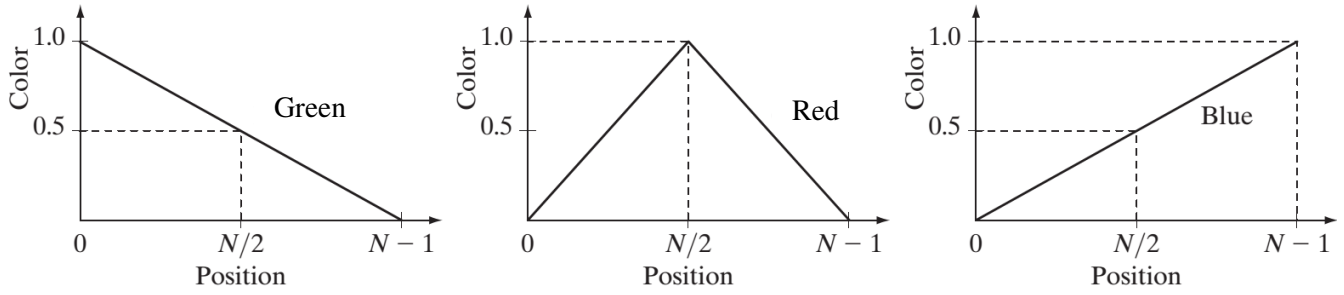

Figure 1.

c) In an automated assembly application, two classes of parts are to be color coded in order to simplify detection. However, only a monochrome TV camera is available to acquire digital images. Propose a technique for using this camera to detect the two different colors, such as *Red* and *Cyan*. [10] [CO3, PO3]

2. d) Suppose the objective is to detect edges in a color image using Sobel mask. Mr. **X** has applied the Sobel mask separately on each R,G,B color channels and added those responses to generate edge responses; whereas, Mr. **Y** has applied the same mask only on the I channel using HSI color space. Will the outputs of **X** and **Y** be the same? Justify your answer. 5 [CO2, PO2]

3. a) Suppose you want to detect the edges of a gray-scale image. Using morphological techniques only, develop a tool for detecting those edges. 10 [CO3, PO3]

b) From a given binary image with printed characters, your objective is to locate and detect all the characters 'B' as given in Figure 2. Hit-or-miss transform can be employed for the detection process. Explain how it can detect any given shape. Simplify this Hit-or-miss transform with a single morphological operation for detecting the character 'B'. 10 [CO1, PO1; CO3, PO3]

Figure 2.

Note: Consider Black objects as foreground.

c) The top-hat transformation of a grayscale image f is defined as f minus its opening with a structuring element of b: 5 [CO2, PO2]

$$T_{\text{hat}}(f) = f - (f \circ b)$$

What kind of effects do you expect in the output image after top-hat transform?