National University of Computer and Emerging Sciences, Lahore Campus

Course Name:	Digital Image Processing	Course Code:	EE402
Program:	BS(CS)	Semester:	Spring 2018
Duration:	180 Minutes	Total Marks:	100
Paper Date:	05-29-18	Weight	40
Section:	ALL	Page(s):	
Exam Type:	Final		

Student : Name:_______________________________

Roll No.________________

Section:_______

Instructions

1: Please show all your work.

2: You are allowed to bring 2 pieces of paper (both sides) with you on the exam.

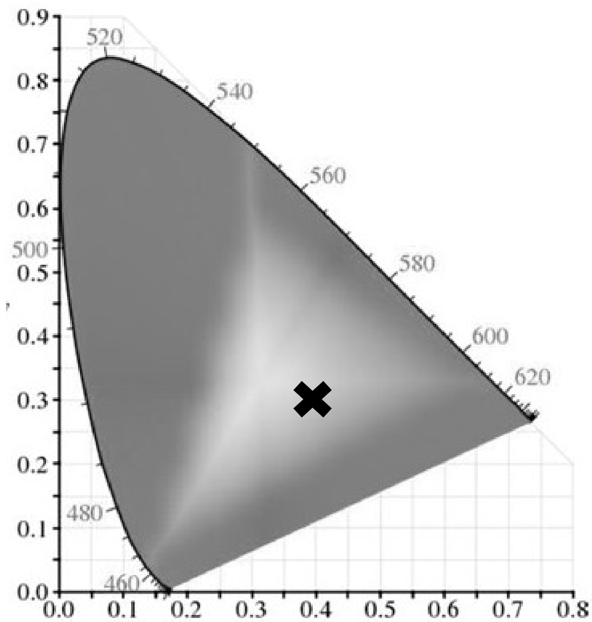
3: Where asked to prove a relationship, showing an example will not be sufficient.

4: There are 5 problems in this exam. All problems carry equal marks.

Good luck!

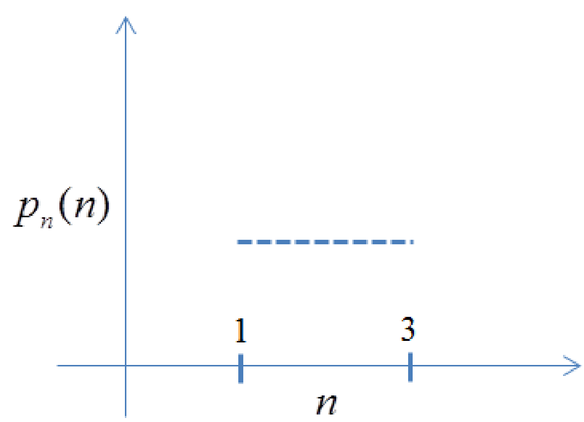
Problem 1: (8+12)

(a): In the following chromaticity diagram, specify at least two colors in XYZ coordinate system that correspond to the point $(x, y) = (0.4, 0.3)$ indicated in figure by a cross (✖).



(b): Noise in one pixel of an image is modeled as a random variable such that $f = g + n$ where g is the true value of the pixel and n is the uniformly distributed noise as shown in figure below. If the true pixel value at the point is 1, find the expected value of the noisy pixel.

If the true pixel value is g, how is σ_f the variance of f, related to σ_n.



Problem 2: (10+10)

(a) Farid and Simoncelli filter has:

$$K = [0.069321\ \ 0.245410\ \ 0.361117\ \ 0.245410\ \ 0.069321]$$

$$D = [0.125376\ \ 0.193091\ \ 0.000000\ \ -0.193091\ \ -0.125376]$$

The Farid and Simoncelli filter (FS) is then defined as: FS = $K * D$, where * denotes convolution operation.

What does the FS filter do to an image? Please give a precise answer by using the definitions of FS, K and D filters.

(b): A filter when applied to the image $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ produces $\begin{bmatrix} 3 & 0 & 1 \\ 0 & 2 & 0 \\ 0 & 0 & 0 \end{bmatrix}$. What is the point-spread function of the filter?

Problem 3: (10+10)

(a): Give the output of erosion of image A by structuring element B. The size of structuring element B is the same as a small character in A.

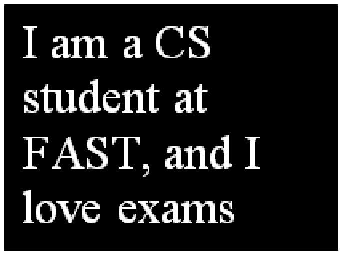
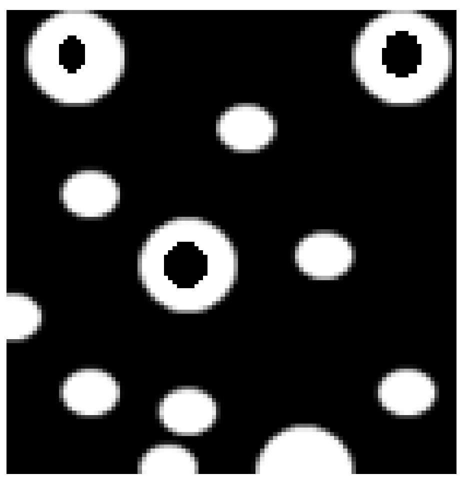


Image A

Structuring element B

(b): In the following tomographic reconstruction, find morphological steps needed to:

1. Fill the holes in the discs
2. Find all discs clipped by the boundary of the image



Problem 4: (10+10)

(a): If $A = \begin{bmatrix} 1 & 2 \\ 2 & 4 \end{bmatrix}$, find Eigen-space and null-space of A. Represent these subspaces by their basis. Do these subspaces overlap?

(b): For an image A and structuring element B, it is given that $(A \circ B) \circ B = A \circ B$, i.e A opened twice is the same as A opened once,

Prove that $(A \bullet B)^c \circ B = A^c \circ B$

Problem 5: (10+10)

(a): A symmetric 100 x 100 image has been represented as a matrix A, with eigenvectors and eigenvalues given to us in matrices U and Λ respectively. How can we use U and Λ to find A^{-1}?

(b): In another experiment, after we found eigen-vectors $[u_1, u_2 \dots u_n]$ for our images $[X_1, X_2, \dots X_n]$, we find that $X_1^T u_n = 0$. What is the contribution of u_n in making X_1? Can X_1 be resynthesized without using u_n?