The University of Texas
ARLINGTON

All problems are equally weighted.

EE5356 Digital Image Processing

Instructor: Dr. K.R. Rao

91/100

Spring 2018, Test 1

Thursday, 15th February 2018
2:00 – 3:20 PM (1 hour and 20 minutes)

(CLOSED BOOK, CLOSED NOTES)

INSTRUCTIONS:
1. Closed books and closed notes.
2. Please show all the steps in your works.
4. You can work problems in any order.
At the end please rearrange in the correct order.
5. Please print your name and student ID.
6. No cheating, no talking.

Name Himanshu Kothagi

Student ID 1001581530

1. Complete the following matrices:

1	5	9
3	**2**	4

1:2 up-sampling H & V
Based on ZOH
→

1	7
3	6

1:2 up-sampling H & V
Based on FOH
→

2. Define and explain clearly with figures:
   a) Uniform Sampling
   b) Non-Uniform Sampling
   c) Nyquist Theorem
   d) Aliasing

3. For a uniform quantizer number of levels L = 32. Calculate the number of bits and SNR for the quantizer. If the number of output levels is doubled to L = 64 then the SNR will be changed by how many dB (specify increase or decrease) and how the bandwidth will be affected

4. a) What is visual quantization?
   b) Explain contrast quantization and pseudo random noise quantization with block diagrams for both. (Block Diagrams carry 5 marks).

5. An image is described by the function f(x, y) has x and y bandwidths $\xi_{xo} = 3$, $\xi_{yo} = 4$. The baseband spectrum for f(x, y) is shown in figure 1.
   a. Calculate Nyquist rate to sample the signal.
   b. With neat sketch explain what will happen if the signal is sampled below the Nyquist rate.

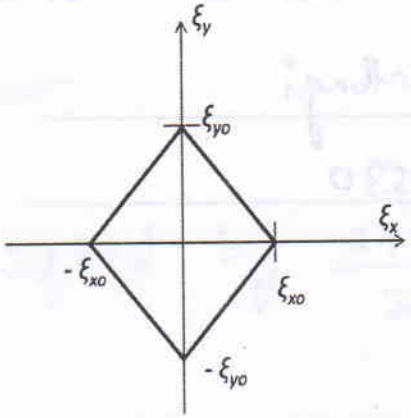

Figure 1: Baseband spectrum for f(x, y).

6. Define compander. Is it a Uniform or Non-Uniform quantizer? Give two examples where compander is used? Television, audio

7. What is entropy? A binary source has the probabilities $p_1 = 0.3$ and $p_2 = 0.7$. Calculate entropy for the source.

8. Define KLT. List the advantages and disadvantages of KLT.
Explain why is it necessary to rearrange the Eigenvectors such that the corresponding Eigenvalues are in the order, $\lambda_1 \geq \lambda_2 \geq \lambda_3 \ldots\ldots\ldots\ldots\ldots\ldots \geq \lambda_N$

9. Show that, $X^F\left(\frac{N}{2}+k\right) = X^{F*}\left(\frac{N}{2}-k\right), \quad k = 0, 1, 2, \ldots\ldots, N/2$
Name this property.
For x (n) real N-point DFT, what is the implication of this?

10. a) If the unitary DFT of u (m, n) has its region of support as shown in Figure 2, what would be the region of support of the unitary DFT of $[(-1)^{m+n}$ u (m, n)]?
This method can be used for computing the unitary DFT whose origin is at the center of the image matrix. The frequency increases as one moves away from the origin. Show all steps.

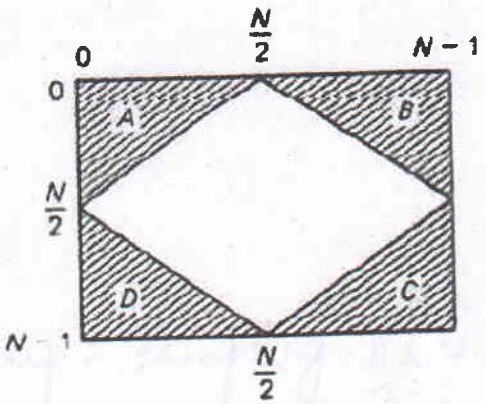

Figure 2

Forward DFT

$$X^F(k) = \sum_{n=0}^{N-1} x(n)\, W_N^{kn}$$

$k = 0, 1, \ldots, N-1$

$\left(W_N = \exp\frac{-j2\pi}{N}\right)$

Inverse DFT

$$x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X^F(k)\, W_N^{-kn}$$

$n = 0, 1, \ldots, N-1$