CS474/674 Image Processing and Interpretation
Fall 2015 – Dr. George Bebis
Midterm Exam

Name:_____

1. **[20 points – 4pts each]** True/False Questions – To get credit, **you must give brief reasons for each answer!**

T F The filter shown below is a smoothing filter.

1 2 1
2 1 2
1 2 1

T F Assuming an NxN image, the complexity of 2D FFT is $O(N^2 \log N)$.

T F The magnitude of the FT carries more information than its phase.

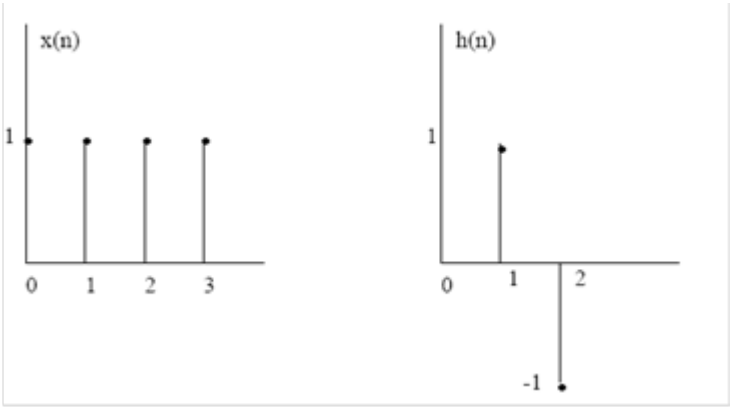
T F The Nyquist theorem holds true for band-limited functions only.

T F Unsharp masking is a special case of high boost filtering.

2. **[10 points]** Explain the main steps involved in image digitization and how they affect image quality.

3. **[15 points]** State and prove the convolution theorem in the continuous case. For simplicity, assume 1-D functions.

4. [15 points] Find and plot the discrete convolution of the following discrete sequences:



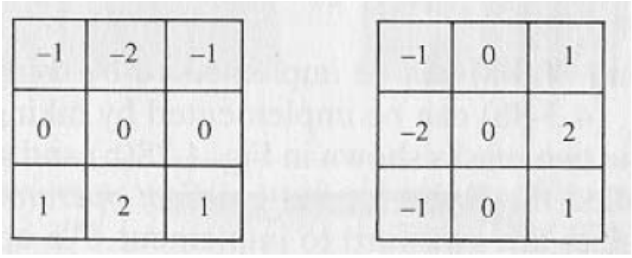
4 samples

2 samples

4. [15 points]. A 3 bits/pixel image of size 5x5 is given below. Find the following: (a) the output of a 3x3 averaging filter at (1,1), (b) the output of a 3x3 median filter at (1,1) and (c) the gradient magnitude at (1,1) using the Sobel masks shown below.

IMAGE

y \ x=	0	1	2	3	4
0	3	7	6	2	0
1	2	4	6	1	1
2	4	7	2	5	4
3	3	0	6	2	1
4	5	7	5	1	2



−1	−2	−1
0	0	0
1	2	1

−1	0	1
−2	0	2
−1	0	1

5. **[15 points]** What is the FT of $\cos(4\pi x)+\cos(10\pi x)$? How many samples should we obtain according to the Nyquist theorem in order to avoid aliasing?

6. **[10 points]** Given the 3x3 image shown below, compute the histogram equalized image (assume that the gray-levels are in the range [0..7]). Show all the steps.

3 1 1
1 7 6
0 2 1

7. Graduate Students Only [10 points] The pixel intensity values of a gray level image have the probability density function $p_r(r)$ given by $p_r(r)=2(1-r)$, for $0 \le r \le 1$, and zero otherwise. It is desired to transform the gray levels of the image so that they have the probability density function $p_z(z)=2z$, for $0 \le z \le 1$, and zero otherwise. Assume that r and z are continuous random variables. Find the transformation that accomplishes that.