

CS474/674 Image Processing and Interpretation
Fall 2008 – Dr. George Bebis
Midterm Exam
2:30-3:45 PM

Name: _____

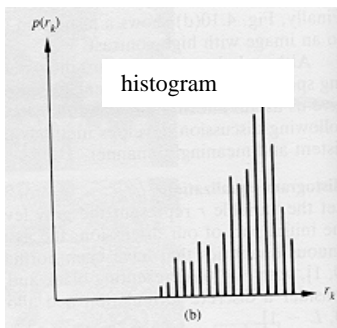
1. [40 points – 3pts each] True/False Questions – To get credit, **you must give brief reasons for each answer!**

T F The mask shown below is appropriate for detecting horizontal edges.

```
-1 -1 -1
 0  0  0
 1  1  1
```

T F The maximum number of nonzero elements in the convolution of two finite, discrete one-dimensional signals of lengths 10 and 20 respectively, is 30.

T F The histogram shown below corresponds to a high contrast image.



T F Both the *FT* (Fourier Transform) and *DFT* (Discrete Fourier Transform) of a signal $f(x)$ are periodic functions.

T F Unsharp masking is a high-pass filtering technique.

T F We should obtain at least 10 samples per radian in order to be able to reconstruct $\cos(10\pi x)$ completely from its samples.

T F The maximum frequency of a rectangle (i.e., window) function approaches infinity as the width of the window approaches zero.

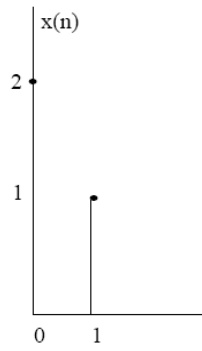
T F Transforming the pixel values of an image using the $\log()$ transformation is an example of contrast compression,

T F Histogram specification is an example of contrast stretching.

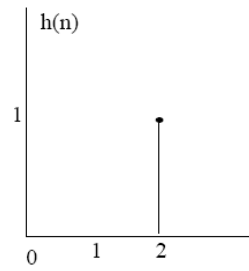
T F Median filtering can be implemented using convolution.

2. [10points] Show that the FT of $\cos(2\pi u_0 x)$ is $\frac{1}{2}[\delta(u-u_0)+\delta(u+u_0)]$

3. [10 pts] Find and plot the discrete convolution of the following discrete sequences:



(2 samples at 0 and 1)



(one sample at 2)

4. [10 points] Given the image shown below, produce the histogram equalized image (assume that the gray-levels are in the range [0..7]).

3 4 2 0 0
1 1 4 0 0
0 2 4 1 1
0 0 1 4 2
0 0 1 2 5

5. [10 points] (a) What is the spectrum of a sampled function $f(n)$? How does the sampling rate affect the spectrum of a sampled function?

(b) Prove the Nyquist theorem.

(c) In practice, is it always possible to reconstruct a band-limited function from its samples assuming that the Nyquist theorem is satisfied? Why or why not? Explain.

6. [10 points] State and prove the convolution theorem in the continuous case. For simplicity, assume 1-D functions.

7. Undergraduate Students Only [10 points] Explain how homomorphic filtering works. When would you use homomorphic filtering?

7. Graduate Students Only [10 points] We have discussed in class that a high-pass filtered image $f_{HP}(x,y)$ can be obtained by subtracting a low-pass filtered $f_{LP}(x,y)$ image from the original image $f(x,y)$ (i.e., $f_{HP}(x,y) = f(x,y) - f_{LP}(x,y)$). If $H_{LP}(u,v)$ is the magnitude of the low-pass filter, prove that the magnitude of the high-pass filter can be obtained from the low-pass filter using the equation:

$$H_{HP}(u,v) = 1 - H_{LP}(u,v)$$