**ECE 439 Sample Test #1 NAME\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Answer all questions in space provided. Use back of the pages for extra work. Note that each question is not weighted equally. You may use: 1) 1 sheet (8.5"x11"), 1 side of hand‑written notes (in your own handwriting), 2) calculator (your own, you cannot share during the test). You should have 6 pages. You have 75 minutes.

#1) An inventor wants to build a weather radar instrument for private aircraft. Rather than using a traditional radial sweep display, the system electronically warps spatial information so that it can be displayed in the form of a 8" x 8" raster pattern (square grid). What spatial resolution would you suggest (a power of 2, for digital display reasons) if the pilot's eyes are about 24" from the screen?

#2) For the following row of an image, find the Fourier transform:

[3 3 0 5]

#3) a) Given the following 2-D data distribution, show (graphically) how the PCT would modify the data. b) After applying the PCT, what is it that is maximum along the principal component axis? c) How is the PCT applied to color images? (answer in one sentence, with no equations!) d) Why is the PCT useful in image processing?



#4) Sketch the following gray level mapping equations, assume 8-bit data. a) digital negative, b) To enhance gray levels from 50-100, and leave others the same. c) Stretch the range 100 to 200 over the entire range, with clipping at both ends

#5) Let the rows of the following matrix represent basis vectors.

a) Are they in sequency order? Why or why not?

b) Are they orthogonal? Why or why not?

c) Are they orthonormal? Why or why not?

$$\left\{\begin{matrix}\begin{matrix}+1&+1\\+1&-1\end{matrix}&\begin{matrix}+1&+ 1\\-1&+1\end{matrix}\\\begin{matrix}+1&-1\\ +1&+1\end{matrix}&\begin{matrix}+1&-1\\-1&-1\end{matrix}\end{matrix}\right\}$$

#6) a) Given this convolution mask, i) what type of filter is it? ii) How will it affect the image?

 

b) Given this convolution mask, i) what type of filter is it? ii) How will it affect the image?

 

#7) Answer T for true and F for false.

\_\_\_ The results of an 8th-order Butterworth filter are similar to those of an ideal filter

\_\_\_ Using too few bits per pixel results in false contours in images

\_\_\_ The convolution theorem allows us to perform filtering in the spatial domain

\_\_\_ We typically log remap a spectrum image so that the lizards stop squeaking, oh so loudly

\_\_\_ In CVIPtools, the Transforms tab is in the Analysis window.

\_\_\_ Computer vision and image processing both use image analysis methods.

\_\_\_ Image analysis can be performed in both the spatial and spectral domains

\_\_\_ Convolution masks whose terms add up to zero tend to retain the original average brightness

\_\_\_ The Human Visual System's (HVS) spatial cutoff frequency for bright images is at about 50 cycles per degree

\_\_\_ Gamma correction is used to compensate for the fact that imaging equipment reacts according to a power –law equation

\_\_\_ The rods in the human eye have high spatial resolution capability due to the fact that each sensor is tied to an individual nerve.

\_\_ The *approximate* bandwidth of the HVS, in terms of wavelength, is from 400 to 700 nm.

\_\_\_ The FFT basis functions more closely resemble natural images than do the WHT basis functions

\_\_\_ In a *range* image, the brightness values correspond to the amount of energy in the infrared

\_\_\_ The phase of a Fourier spectrum contains most of the information about image contrast

\_\_\_ Optical illusions are created when the brain completes missing spatial information

\_\_\_ About one-half of the FFT coefficients are redundant

#8) a) Given the following matrix where the rows are the one-dimensional basis vectors, find the basis image corresponding to (u,v) = (1,3). b) Do you think these basis vectors form a good set of basis vectors? Why or why not?

$$\left\{\begin{matrix}\begin{matrix} 1&1\\-1&2\end{matrix}&\begin{matrix} 1& 1\\ 2& -1\end{matrix}\\\begin{matrix} 3& 3\\ 0& 0\end{matrix}&\begin{matrix}-3&-3\\ 5&-5\end{matrix}\end{matrix}\right\}$$

#9) Given the following four basis images:

 v→ 0 1

u

↓

0

1 

and I(r,c) = 

a) Find: T(u,v)

b) Are these basis images orthonormal? Why or why not?

#10) Describe or sketch the image that results from the convolution of the following two images:

Image #1: a horizontal sine wave of frequency 4; Image #2: a vertical sine wave of frequency 16

SHOW ALL YOUR WORK ! EXPLAIN YOUR RESULTS!

#11) a) Is the cosine an even or an odd function? b) Is the Fourier or the cosine transform is faster to compute? why? c) For an N×N image, what size is the pattern that repeats for the cosine transform? d) What is the general form of the Walsh-Hadamard basis functions? e) Is the Walsh-Hadamard or the cosine transform is faster to compute? Why?

#12) a) Name the two properties of the Fourier transform that are used to shift the DC term to the center. b) Applying these two properties in the spatial domain gives the equation to implement this, what is it?