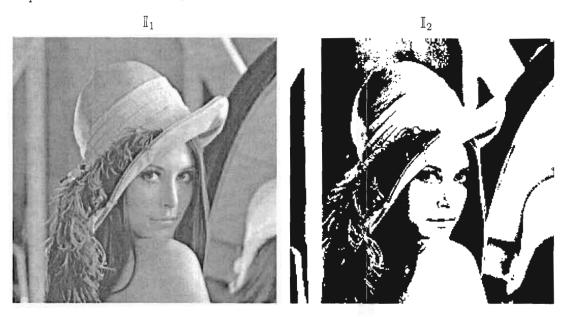
## $\begin{array}{c} \mathrm{ECE}\ 5273 \\ \mathrm{Test}\ 1 \end{array}$

Wednesday, March 24, 2010 4:30 PM - 5:45 PM

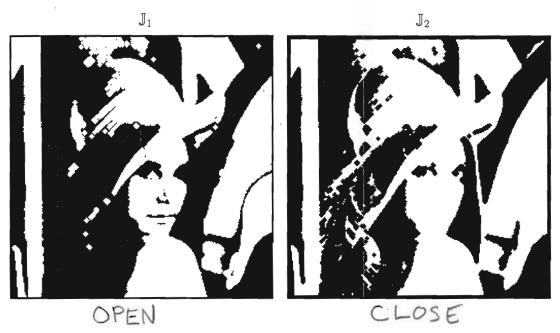
Spring 2010	Name: SOLUTION
r. Havlicek	Student Num:
	This is an open notes test. You may use the official course notes pack. Other not allowed. You have 75 minutes to complete the test. All work must be your
	SHOW ALL OF YOUR WORK for maximum partial credit!
	GOOD LUCK!
SCORE:	
1. (25)	
2. (25)	
3. (25)	
4. (25)	
TOTAL (	100).
1011111	

1. <b>25 pts</b> . TRUE	True or Fa FALSE	alse. Mark True only if the statement is always true.
	<u>X</u>	(a) 2 pt. Medical ultrasound images are an example of emission imaging. Reflection
_X_		(b) 2 pt. A digital image $\mathbb{I}$ can be exactly recovered from its DFT $\widetilde{\mathbb{I}}$ .
	<u>X</u>	(c) 2 pt. Any digital image $\mathbb{I}$ can be exactly recovered from its histogram $H_{\mathbb{I}}(k)$ .
	X	(d) 2 pt. A pinhole camera is used to image a 3-D real-world scene $I(X,Y,Z)$ , resulting in an optical image $\mathbb{I}_C(x,y)$ at the camera focal plane. A digital camera chip samples $\mathbb{I}_C(x,y)$ to produce the digital image $\mathbb{I}(i,j)$ .  If the pixel spacings $X$ and $Y$ are small enough to prevent spatial aliasing, then the 3-D scene $I(X,Y,Z)$
	X	can be exactly recovered from $\mathbb{I}(i,j)$ . $\mathcal{I}_{\mathbb{C}}(X,Y)$ can be but not $\mathbb{I}(X,Y,Z)$ (e) 2 pt. When using thresholding to make a binary image
×		from a gray scale image, the threshold selection is usually simplified if the gray scale image has a flat histogram.
		(f) 2 pt. A binary median filter removes both gaps and peninsulas of insufficient width.
		(g) 2 pt. A binary CLOSE-OPEN filter tends to link neighboring heles together.
X	- 200	(h) 2 pt. The most basic geometric image transformations are translation, rotation, and scaling.
	X	(i) 2 pt. For any continuous optical image $\mathbb{I}_C(x,y)$ , the Fourier transform $\widetilde{\mathbb{I}}_C(\omega_x,\omega_y)$ is periodic.
	_X_	(j) 2 pt. For any continuous optical image $\mathbb{I}_C(x,y)$ , the DFT $\widetilde{\mathbb{I}}_C(u,v)$ is periodic.
	X	(k) 2 pts. Any real-valued digital image I has a DFT I that is real-valued and conjugate symmetric.
	X	(l) 3 pts. The famous Lena image originally appeared in the magazine Better Homes and Gardens.

2. **25 pts**. The gray scale image  $\mathbb{I}_1$  shown below has 8-bit pixels. This image was thresholded to obtain the binary image  $\mathbb{I}_2$ , which is also shown below. In  $\mathbb{I}_2$ , the pixel value 255 (WHITE) represents LOGIC\_ONE and the pixel value zero (BLACK) represents LOGIC\_ZERO.



Binary morphological OPEN and CLOSE operations where performed on the image  $\mathbb{I}_2$  using a 5  $\times$  5 diamond-shaped structuring element. The resulting images are shown as  $\mathbb{J}_1$  and  $\mathbb{J}_2$  below.



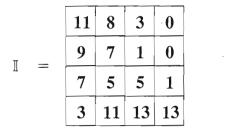
Determine which image is the result of the OPEN operation and which is the result of the CLOSE operation. Explain your answer.

Workspace for Problem 2...

In J1, the mouth remains but fine LOGIC-ONE structure of the hair is lost. This is because OPEN performs exosion first, which enlarges the mouth but evadicates the fine LOGIC-ONE structure of the hair. In OPEN, the dilation is performed second; it restores the mouth to its original size but cannot recover the lost LOGIC-ONE structure of the hair.

In J2, the dilation is done first. This enlarges the fine LOGICLONE structure of the hair but the mouth is lost. The subsequent erosion operation returns the structure of the hair to approximately its original size but cannot recover the mouth.

3. **25 pts**. Consider the  $4 \times 4$  images  $\mathbb{I}$  and  $\mathbb{I}'$  shown below, where the allowable range of gray levels is  $0 \leq I(i,j), I'(i,j) \leq 15$ :



$$\mathbb{I}' = \begin{bmatrix} 10 & 3 & 2 & 1 \\ 4 & 3 & 2 & 10 \\ \hline 3 & 4 & 9 & 9 \\ \hline 2 & 1 & 4 & 9 \end{bmatrix}$$

Construct a new image  $\mathbb{J}$  by applying the histogram matching algorithm to shape the histogram of image  $\mathbb{I}$ , where the desired shape is given by the histogram of the image  $\mathbb{I}'$ . Show the new image  $\mathbb{J}$  and its histogram  $H_{\mathbb{J}}$  in the spaces provided below. Work space is given on the next page.

$$J = \begin{array}{c} 9 & 4 & 3 & 1 \\ 9 & 4 & 2 & 1 \\ 4 & 3 & 3 & 2 \\ 3 & 9 & 10 & 10 \end{array}$$

$\overline{k}$	0.	1	2	3	4	5	6	7	8	9	10	11	12	13	$\overline{14}$	15
$H_{\mathbb{J}}(k)$	0	2	2	4	3	0	0	0	0	3	2	0	0	0	0	0

See work an page 6.

Workspace for Problem 3... Work Space: for I:  $\overline{H(k)}$ p(k)H(k)p(k)

P'(n)

4. **25** pts. Draw lines to match the images with their log-magnitude DFT spectra.

