

NAME: _____

ECE 253a MIDTERM EXAM

This cover sheet is provided to give all students equal time. **Do not turn it over until everybody has received a copy of the exam and you are instructed to start.**

For this exam, you may use class materials (lecture notes, handouts, homeworks, solution sets, course textbook) from this class only. You may not use any other books or materials for this exam.

You have 50 minutes to work on this exam.

Please make sure that your copy of the exam is complete. There are 5 problems and a total of 8 pages (including this cover sheet).

The problems are worth different numbers of points.

The total point count is 29.

Problem	Possible	Score
1	8	
2	6	
3	3	
4	4	
5	8	
Total	29	

1. **Binary Morphology: (8 points)**

On the next page:

Set A_1 is a circle (it is *not* a disk, so the interior is *not* part of the set).

Set A_2 is the outline of a square.

Structuring element B_1 is a disk (meaning the interior *is* part of the set).

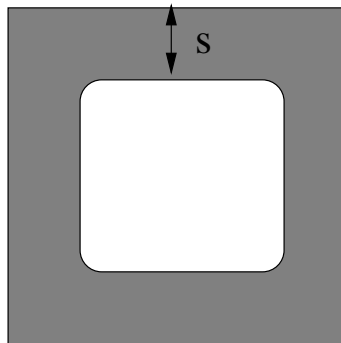
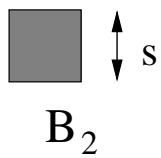
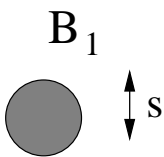
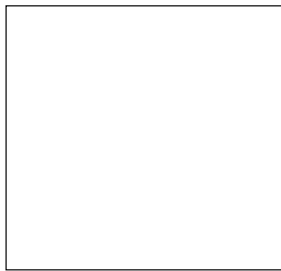
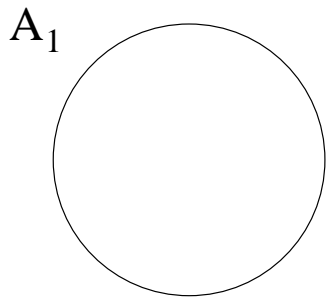
Structuring element B_2 is a filled-in square.

Both B_1 and B_2 have their origins at the center.

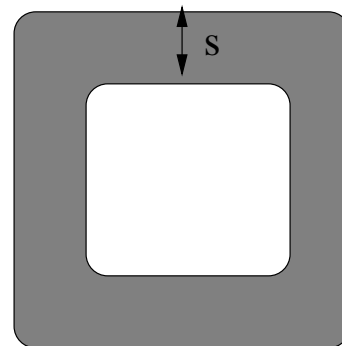
Consider the 4 dilations: A_i dilated by B_j for $i=1,2$ and $j=1,2$.

Indicate which of the 6 candidate sets drawn (C_1 through C_6), if any, is a picture of which of the 4 dilations. It is possible that some of these 4 dilations are not represented here by any of the 6 sets, and if so, say so.

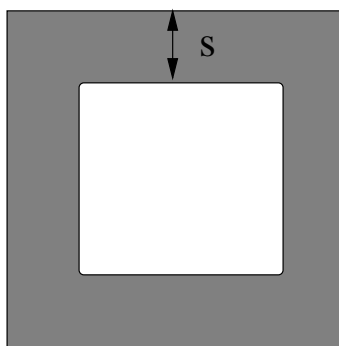
You do *not* have to provide any explanations with your answers.



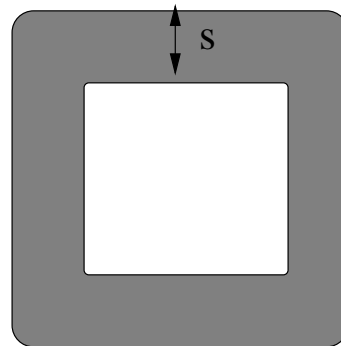
C₁ (squared off outer corners and rounded inner corners)



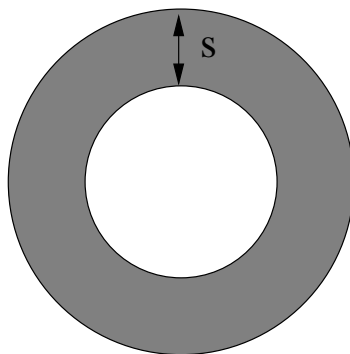
C₂ (both outer and inner corners are rounded)



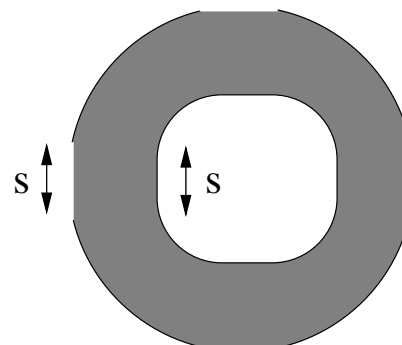
C₃ (both outer and inner corners are squared off)



C₄ (Squared off outer corners and rounded inner corners)



C₅ (donut)



C₆ (donut with flattened inner and outer edges in 4 places—top and bottom, left and right)

2. Median Filtering: (6 points)

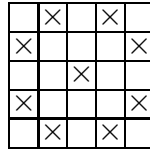
A natural image such as the bellpeppers image used in homework set 2 is corrupted with “salt” noise in which some percentage of pixels have noisy values that are markedly higher than their original non-noisy values. The noise is independent from pixel to pixel.

Consider three types of median filter (MF):

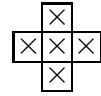
(a) Regular square 3x3 MF:



(b) 9-point sparse MF:



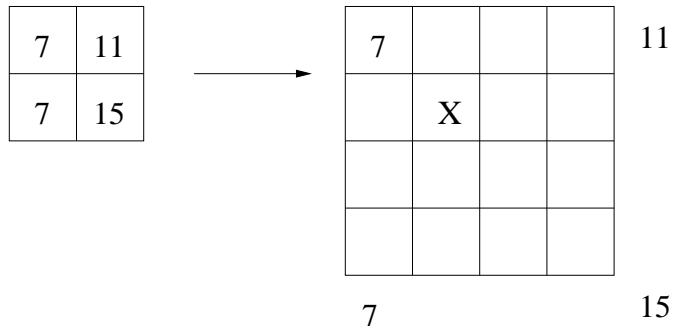
(c) 5-point cross-shaped MF:



Consider three levels of noise: 1%, 20% and 40% of pixels corrupted. For each of these 3 levels of noise, say which median filter is “best” for cleaning it up. Give a brief justification for your answers. Here “best” includes both noise cleaning ability and complexity. If one median filter is always better than another one for this type of noise, or is always worse than another one for this type of noise, say so and explain.

3. **Interpolation:** (3 points)

An image is to be increased to 16 times its original size using some kind of interpolation. Each pixel thus becomes a block of 4x4 pixels. If the interpolation method is bilinear interpolation, what is the value of the pixel X?



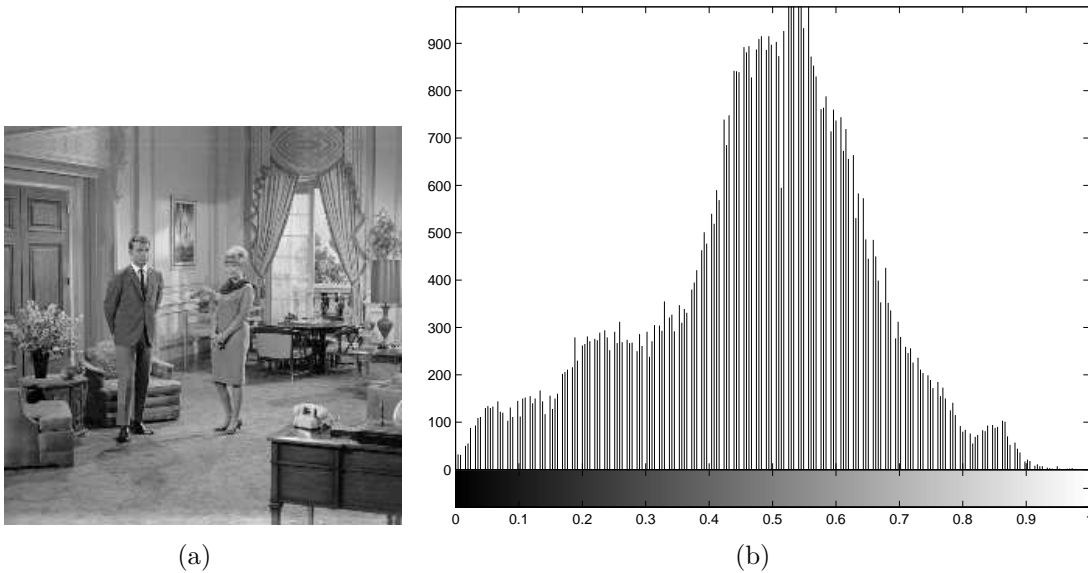
4. **Color:** (4 points)

Draw the color gamut of CMY in the $R_n G_n B_n$ chromaticity diagram.

Hint: The color pure cyan has coordinates $(1,0,0)$ in the CMY color coordinate system.

5. Contrast Enhancement: (8 points)

Here is an original image, together with its histogram.



On the next page are 5 versions of the image, labeled (c) through (g), which have had their gray values manipulated. Also shown are 2 remapping functions, labeled (h) and (i).

a) For each of the five images (c) through (g), say which of the following 5 methods was used to create it. No explanations are needed.

- global histogram equalization
- remapping function (h)
- remapping function (i)
- forming an image negative
- windows and levels with a level of 0.5 and a window of 0.2.

b) Make an approximate sketch of the remapping function corresponding to global histogram equalization.

c) Which image shows false contours?



(c)



(d)



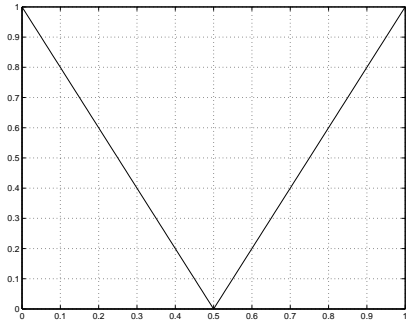
(e)



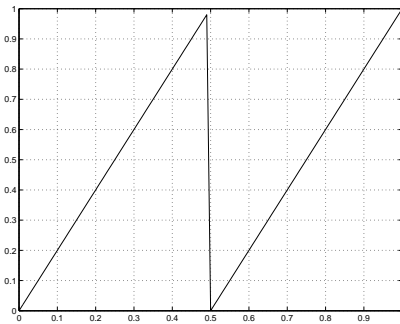
(f)



(g)



(h)



(i)