ECG 782 HW 2

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1 Problem 6.16

1.1 Part a: Find the missing values of the hue image

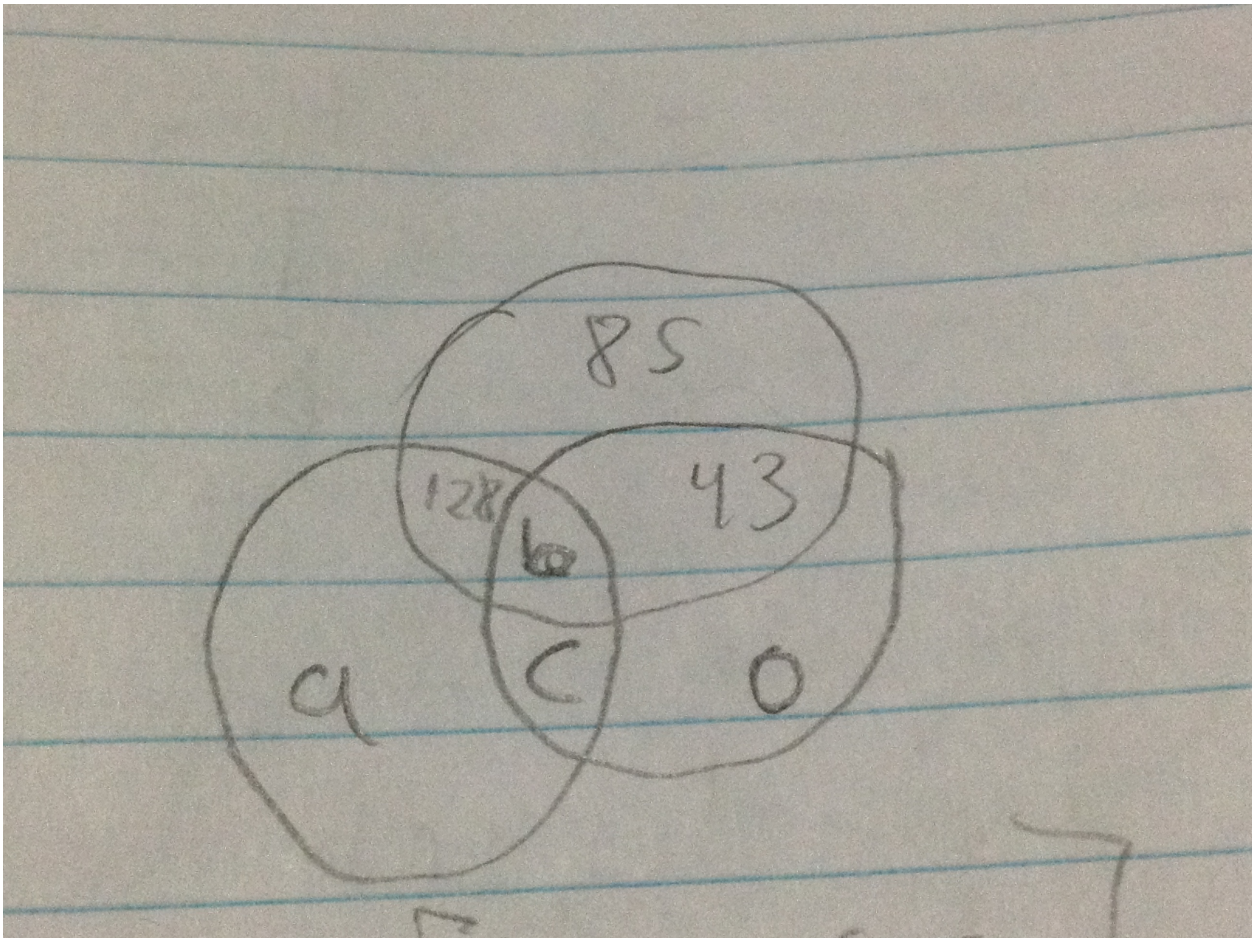


Figure 1: H image pixel values a, b, and c are missing

We can convert the pixel values to hue values using the following equation.

$$(pixel)\frac{360}{255} = hue$$

We are given the following pixel values: 0, 43, 85, and 128. Using the formula we obtain the following hue values: 0, 60, 120, and 180. Looking at the hue color wheel, we get the following colors: red(0), yellow(60), green(120), and cyan(180). Since the overlap between red(0) and green(120) results in yellow(60), we can infer the colors a, b, and c. The addition of a and green(120) give cyan(180). This implies that a is blue(240). The addition of blue(240) and red(0) give c, which is magenta(300). The addition of red(0), blue(240), and green(120) gives b, which is white(0). We can convert the hue values to pixel values using the following equation.

$$(hue)\frac{255}{360} = pixel$$

Using this formula we can get the missing pixel values: b(0), a(170), and c(212). We can assume the background is black, since color addition works.

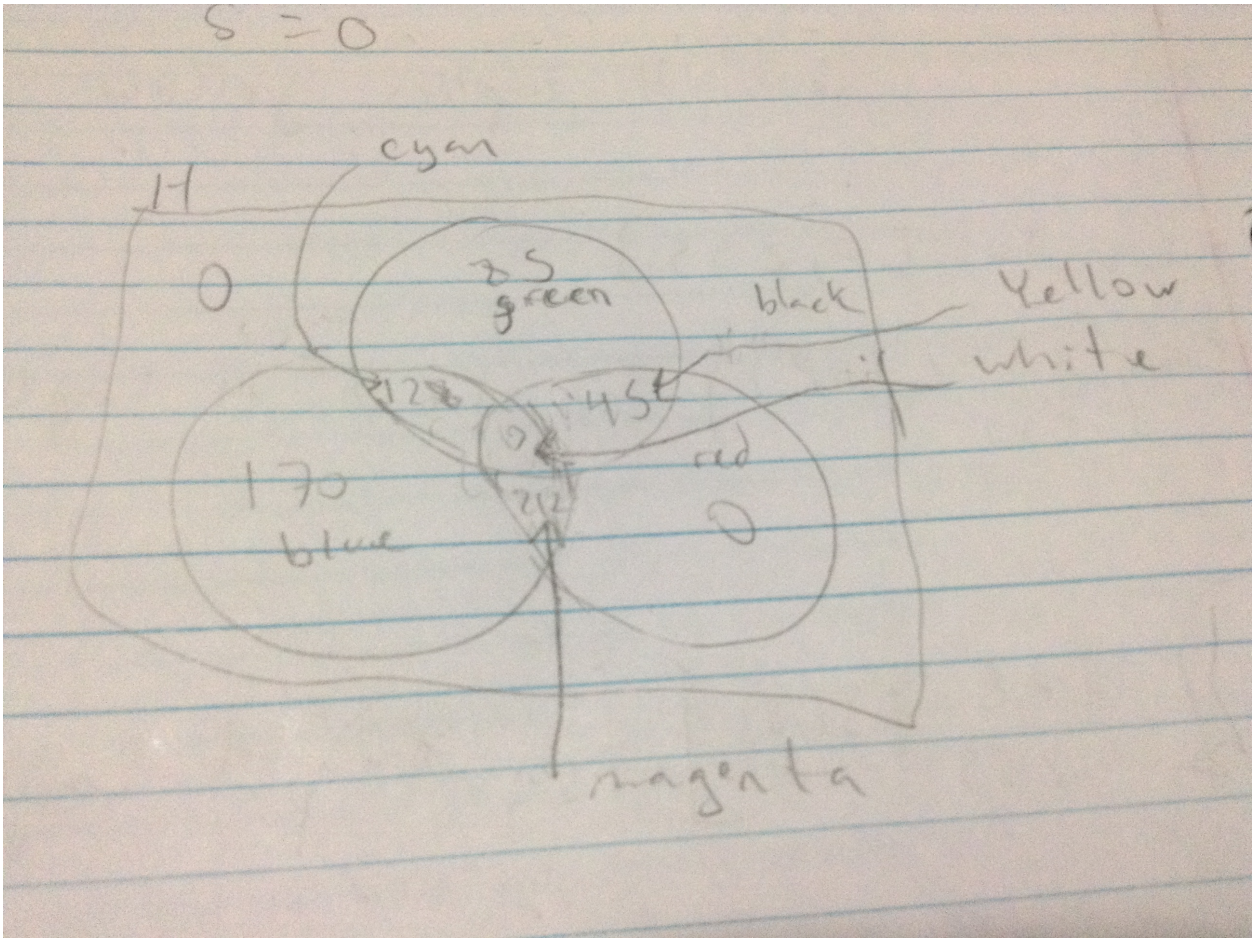


Figure 2: H image pixel values a, b, and c are missing

1.2 Part b: Find the missing values of the saturation image

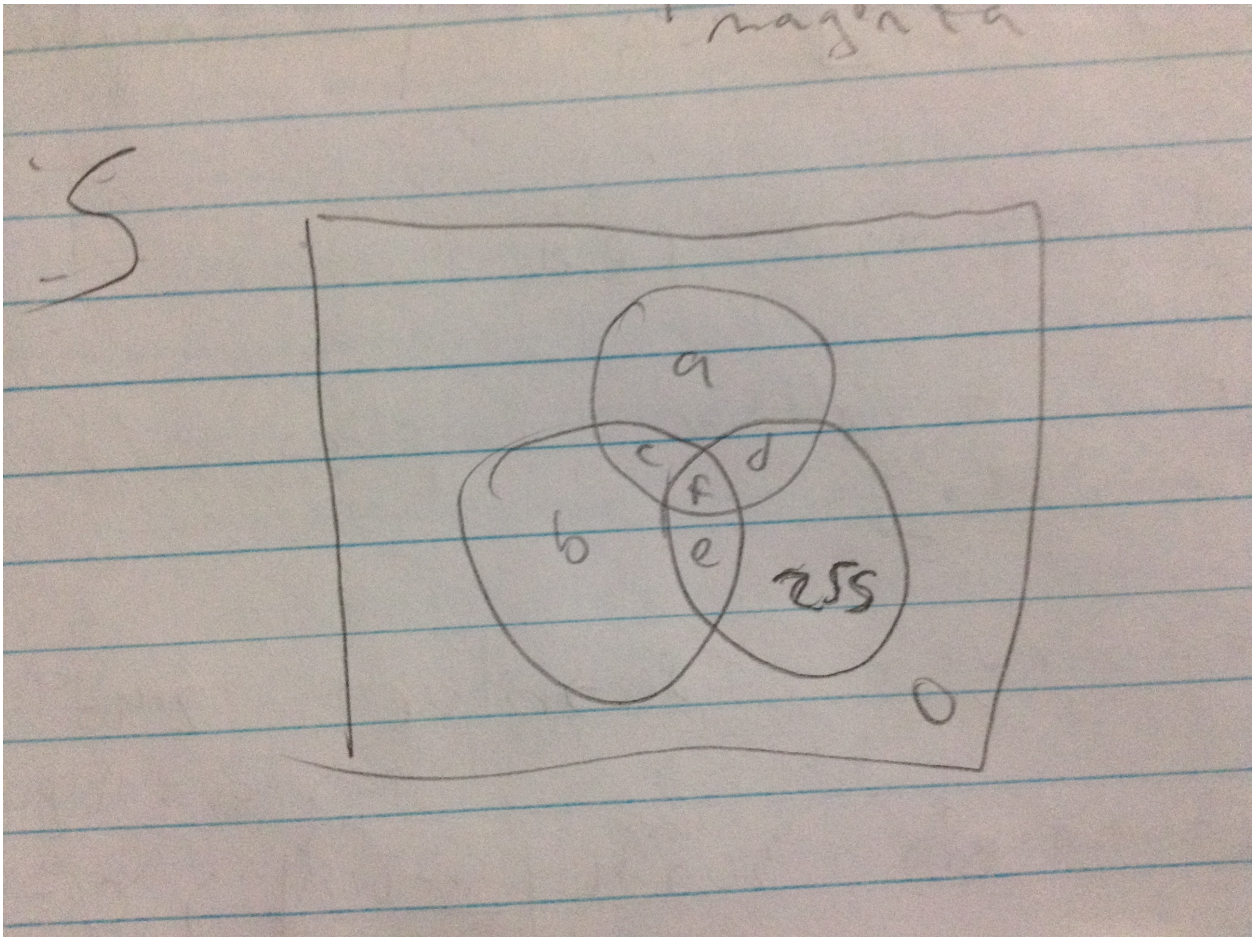


Figure 3: S image pixel values

We can infer that all of the colors have the same saturation, since we were able to add them together in part a. Red has a saturation of 255, so all of the remaining colors must also have this level of saturation. The white part is the only different one, since white has zero saturation in HSI space as it corresponds to a point.

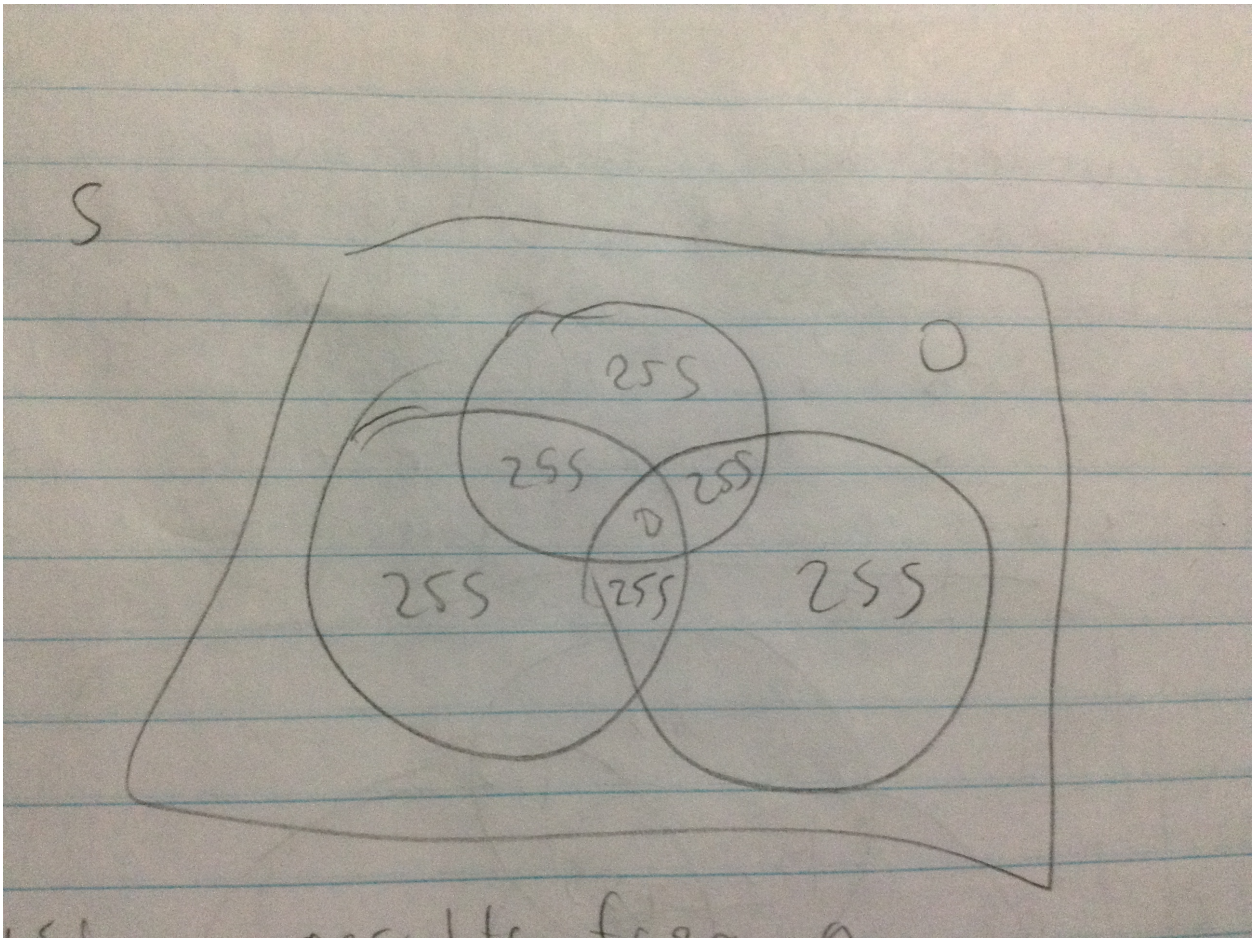


Figure 4: S image pixel values

1.3 Part c: Find the missing values of the intensity image

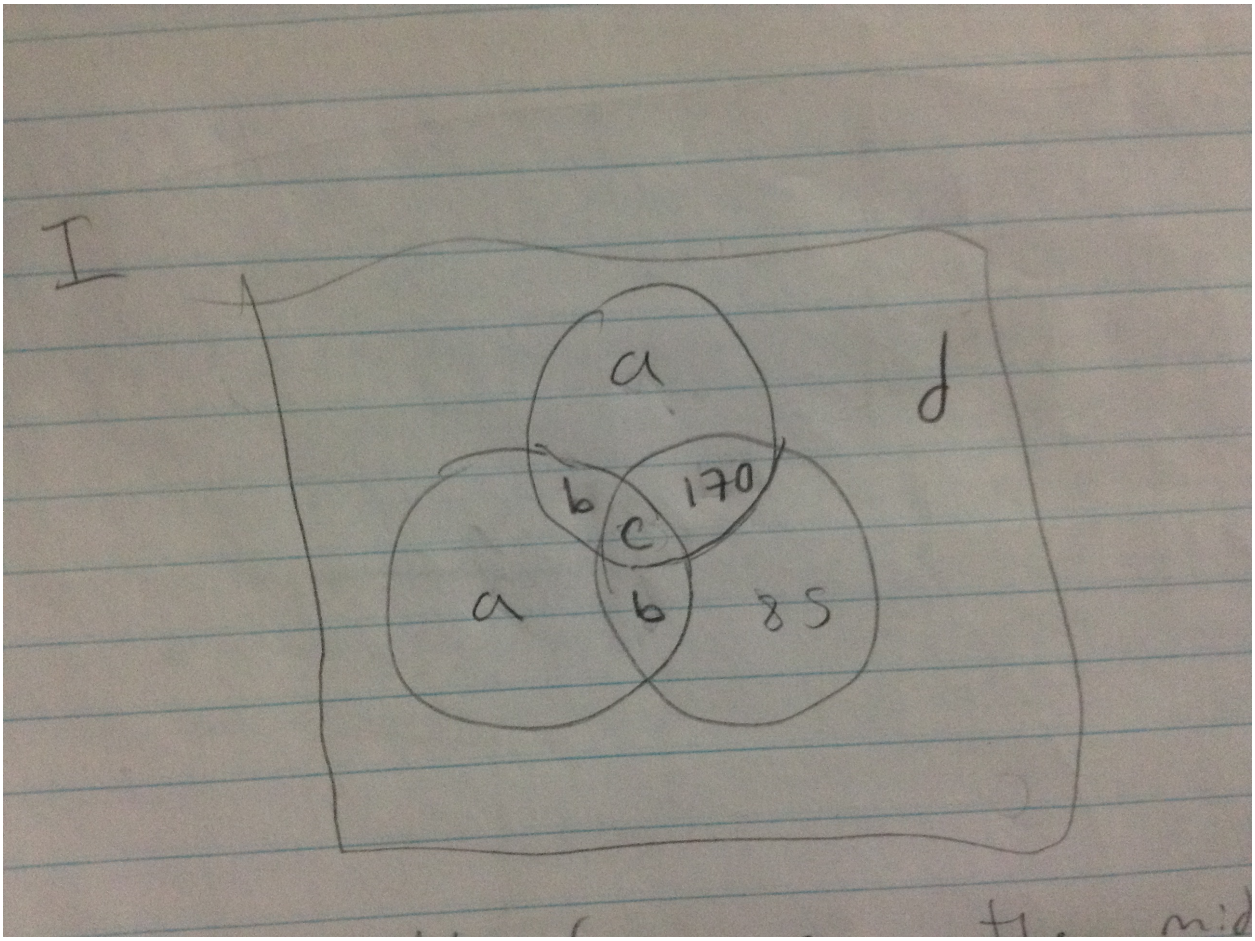


Figure 5: I image pixel values

We are given the intensity values for red (85) and yellow (170). Using the results from part a, we can infer the values of c and d since they correspond to black and white. C must be equal to 255, white has max intensity. D must be equal to 0, black has zero intensity. The fact that red, green, and blue turn into white implies that they have equal intensity. This also applies to cyan, yellow, and magenta. Thus, a must equal 85 and b must equal 170.

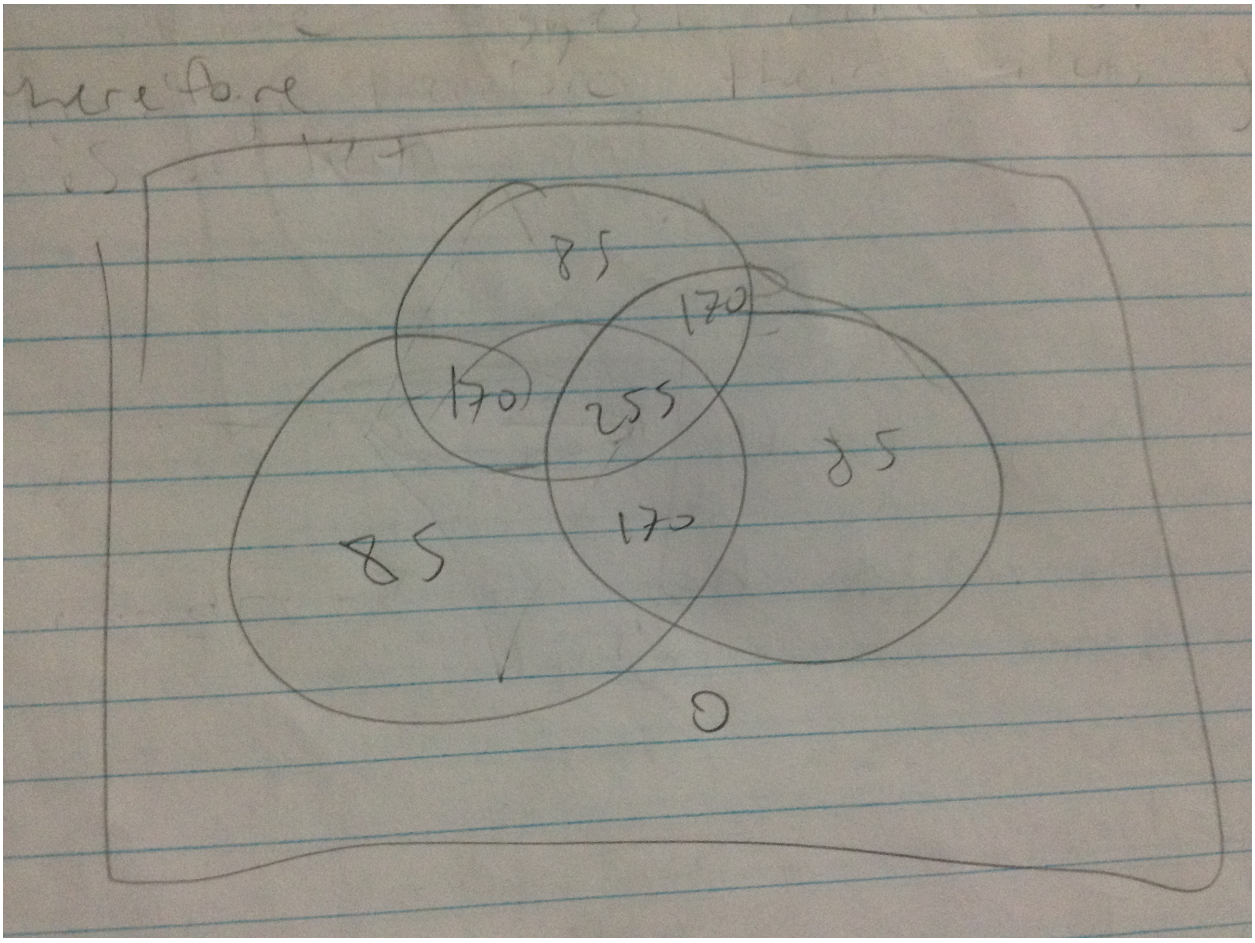


Figure 6: I image pixel values

2 Problem 6.17

2.1 Part a: Why is the image mostly red?

Figure 7: modified image of Washington DC

This image is a modified version of an aerial photo of Washington DC.

Figure 8: original image of Washington DC

The modified image was produced by using the pixel values of an infrared image instead of the original values of the red channel. Since the infrared image has higher values corresponding to vegetation and terrain, the modified image shows the terrain as red.

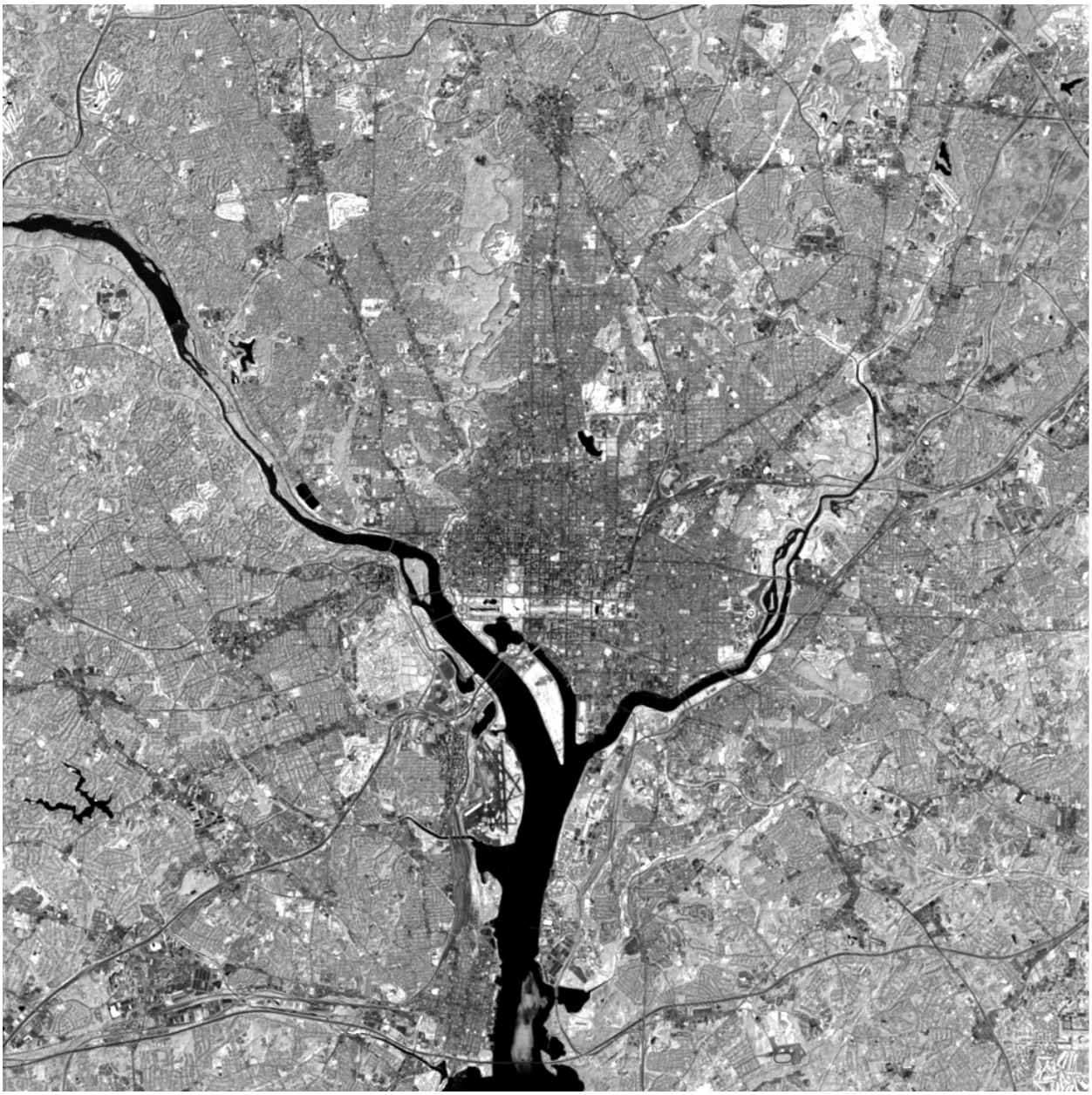


Figure 9: infrared gray-scale image of Washington DC

2.2 Part b: Write a procedure for coloring the water blue

Looking at the infrared image, we can see that water has very low pixel values. We can threshold the infrared image to produce a mask that only contains water.

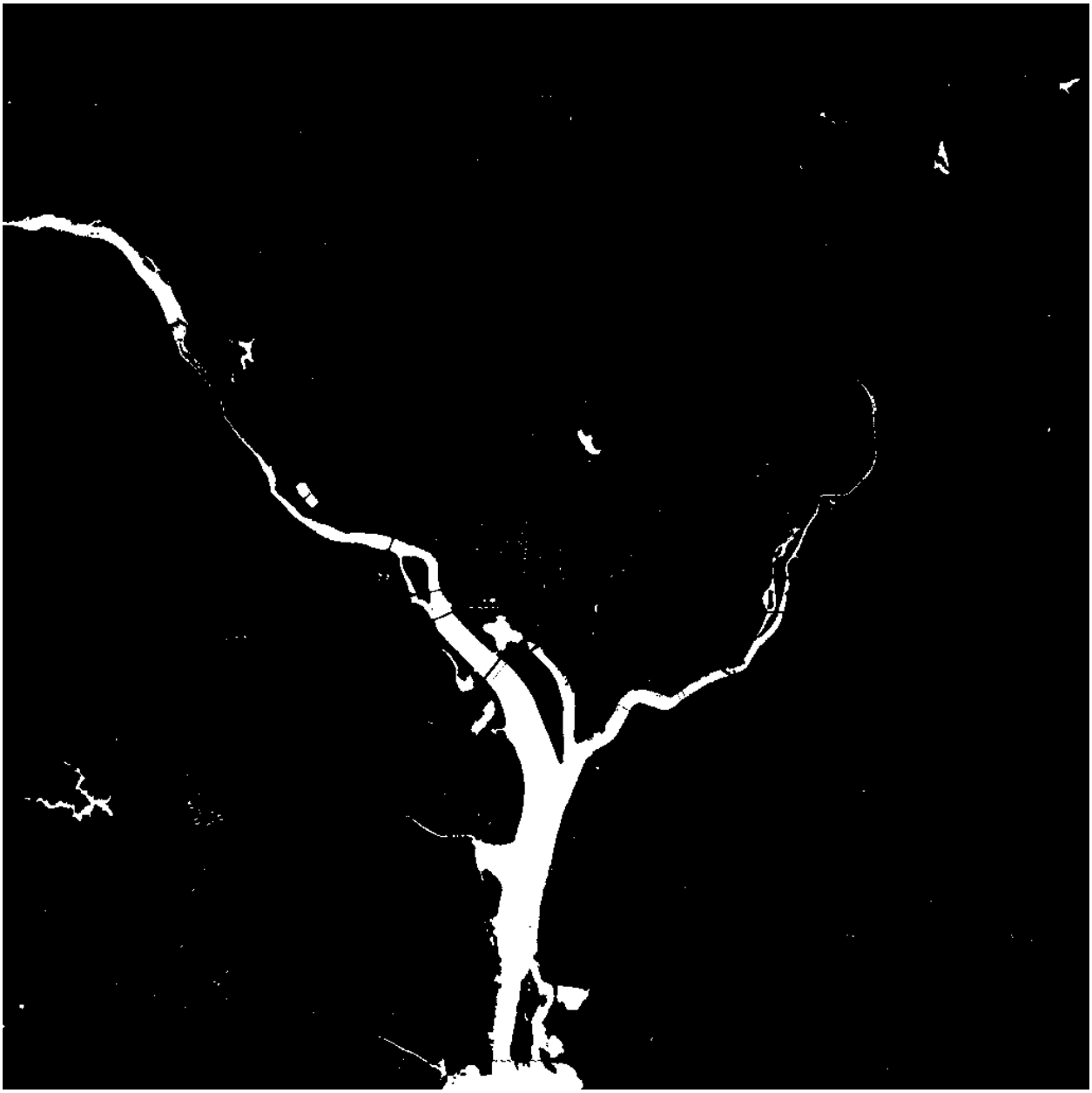


Figure 10: water mask

We can then add our mask to the blue channel to accentuate the water in the color image.

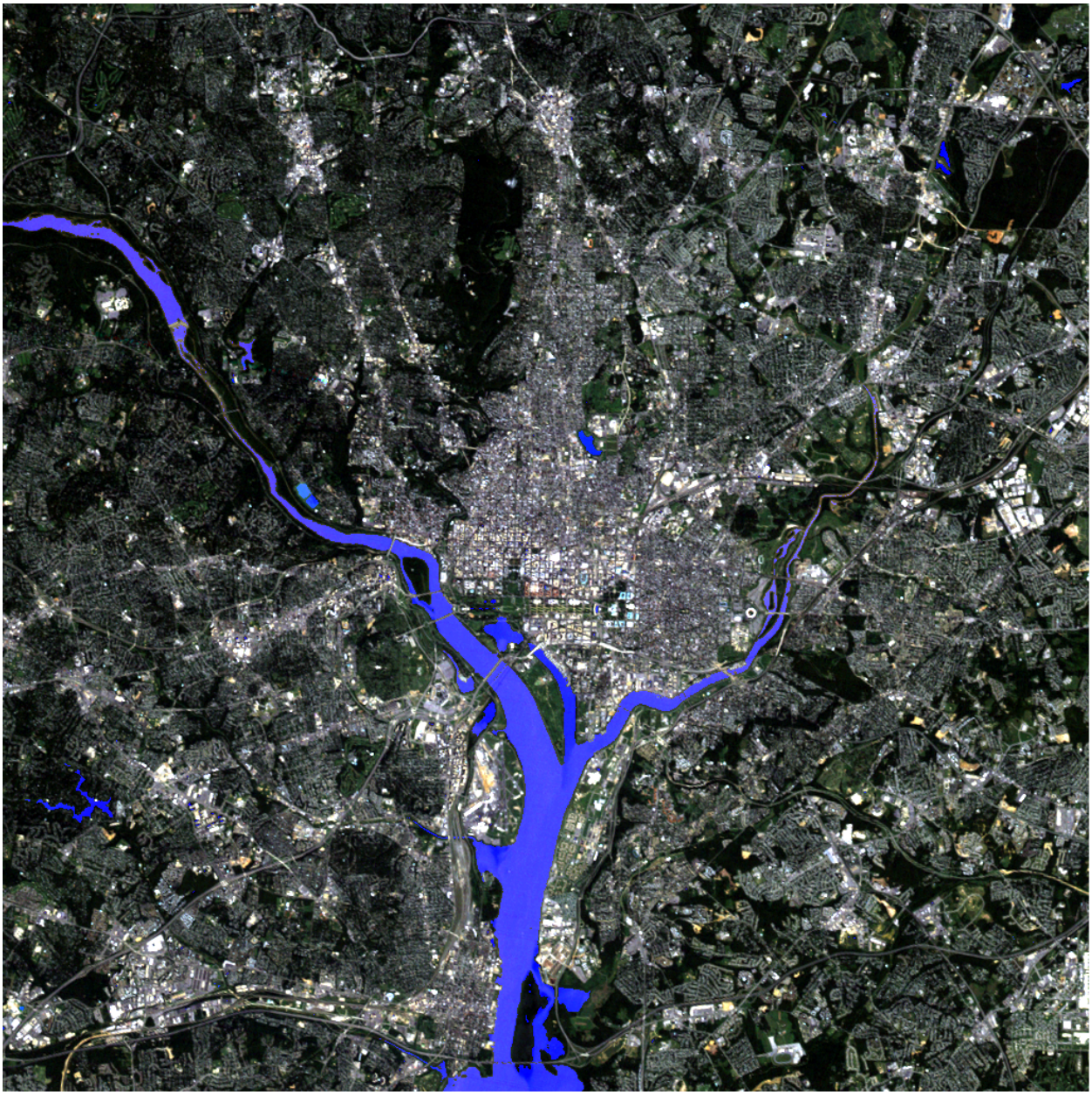


Figure 11: image of Washington DC with mask added to blue channel

2.3 Part c: Write a procedure for coloring the man made objects red

Looking at the color image we can see that man made objects in the color image look lighter, most being gray or white. The terrain is very dark (black and dark green). Using these observations we can threshold the color channels to generate a mask that shows only man made objects.

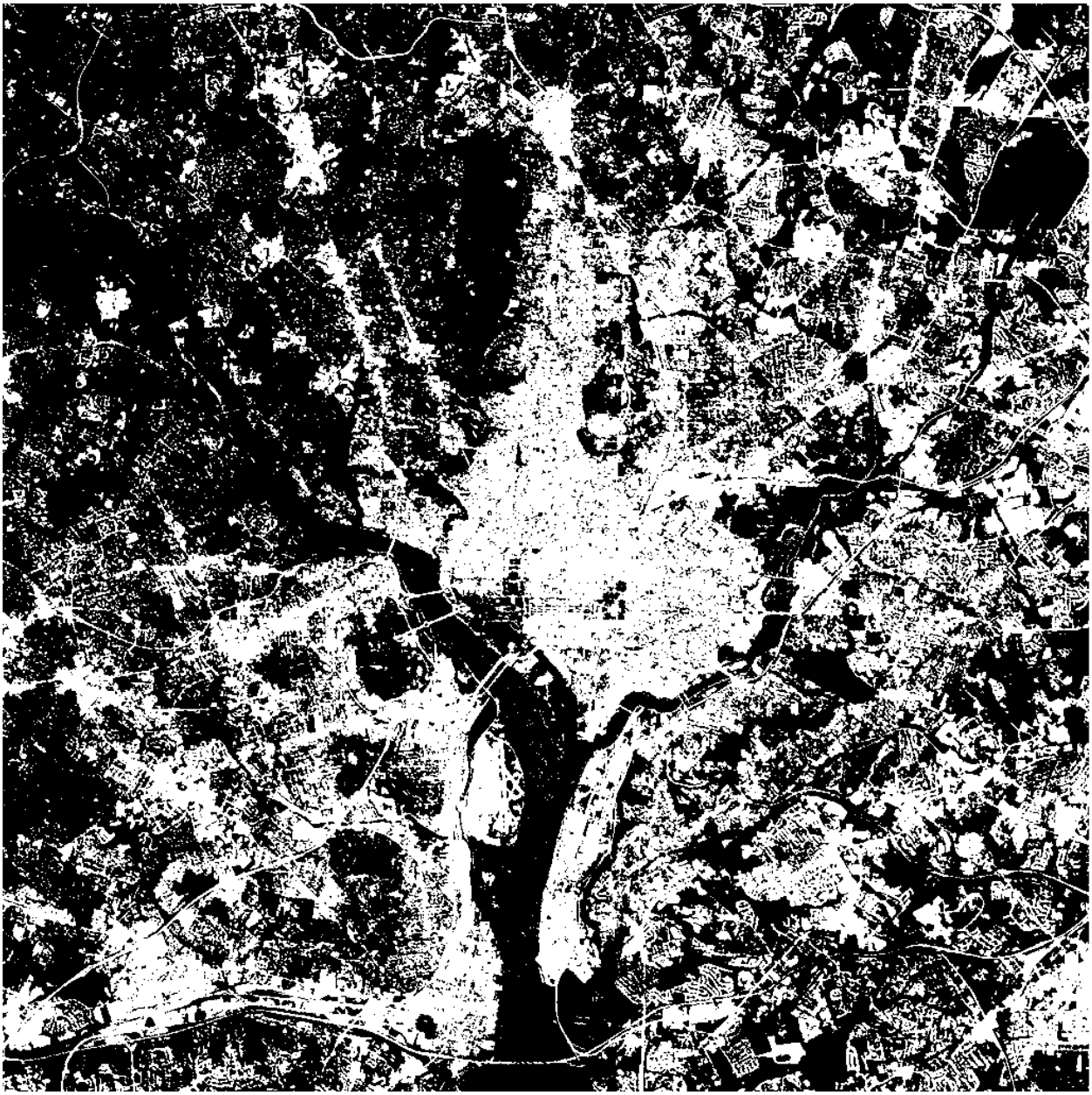


Figure 12: man made object mask

We can then add our mask to the red channel and subtract it from the other channels to accentuate the man made structures in the color image. We subtract from the green and blue channels, because many of the man made structures are white (their red values are already high).

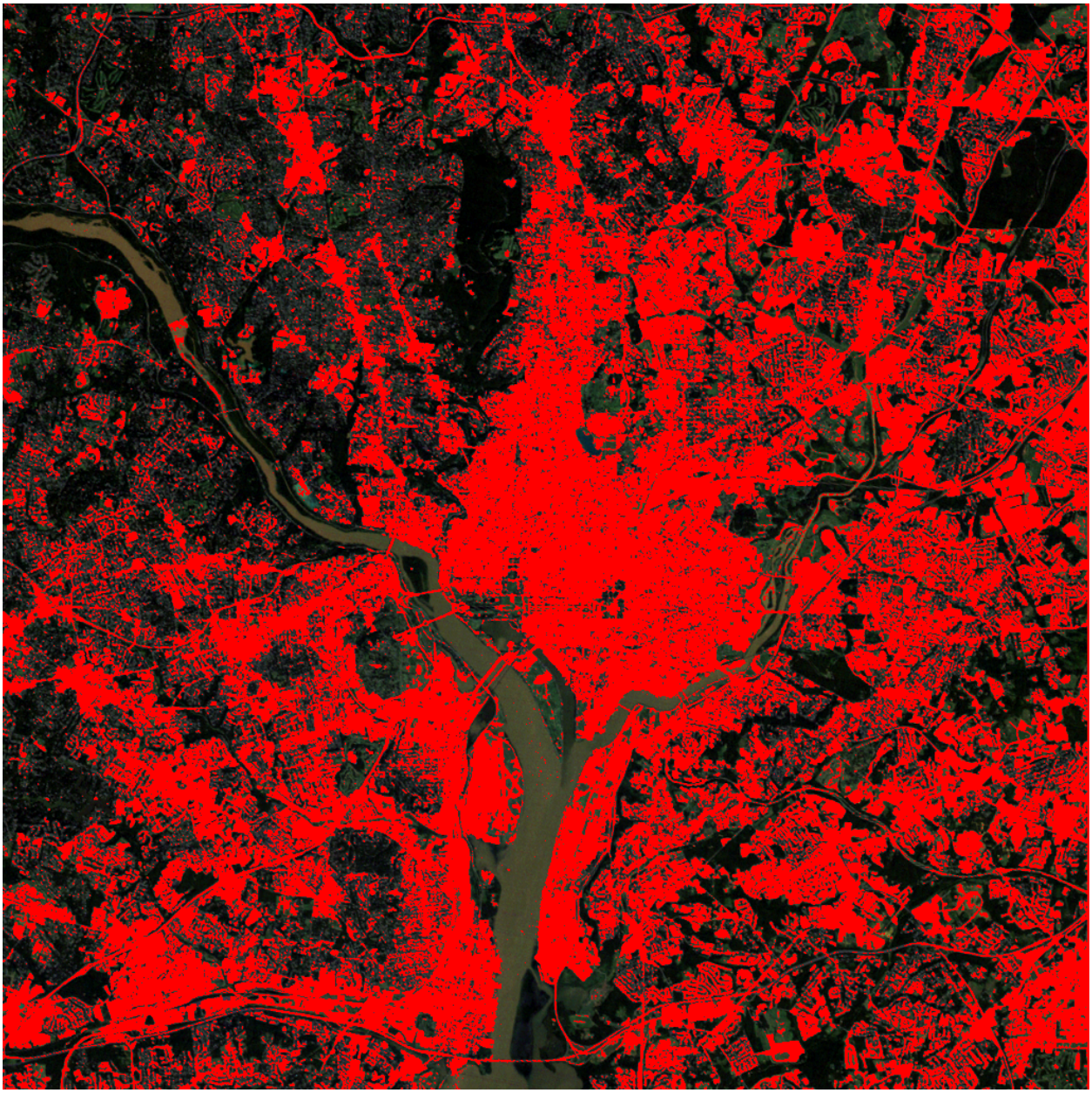


Figure 13: image of Washington DC with mask added to red channel and subtracted from the green and blue channels

3 Problem 6.25

3.1 Part a: Describe the HSI components of the RGB image

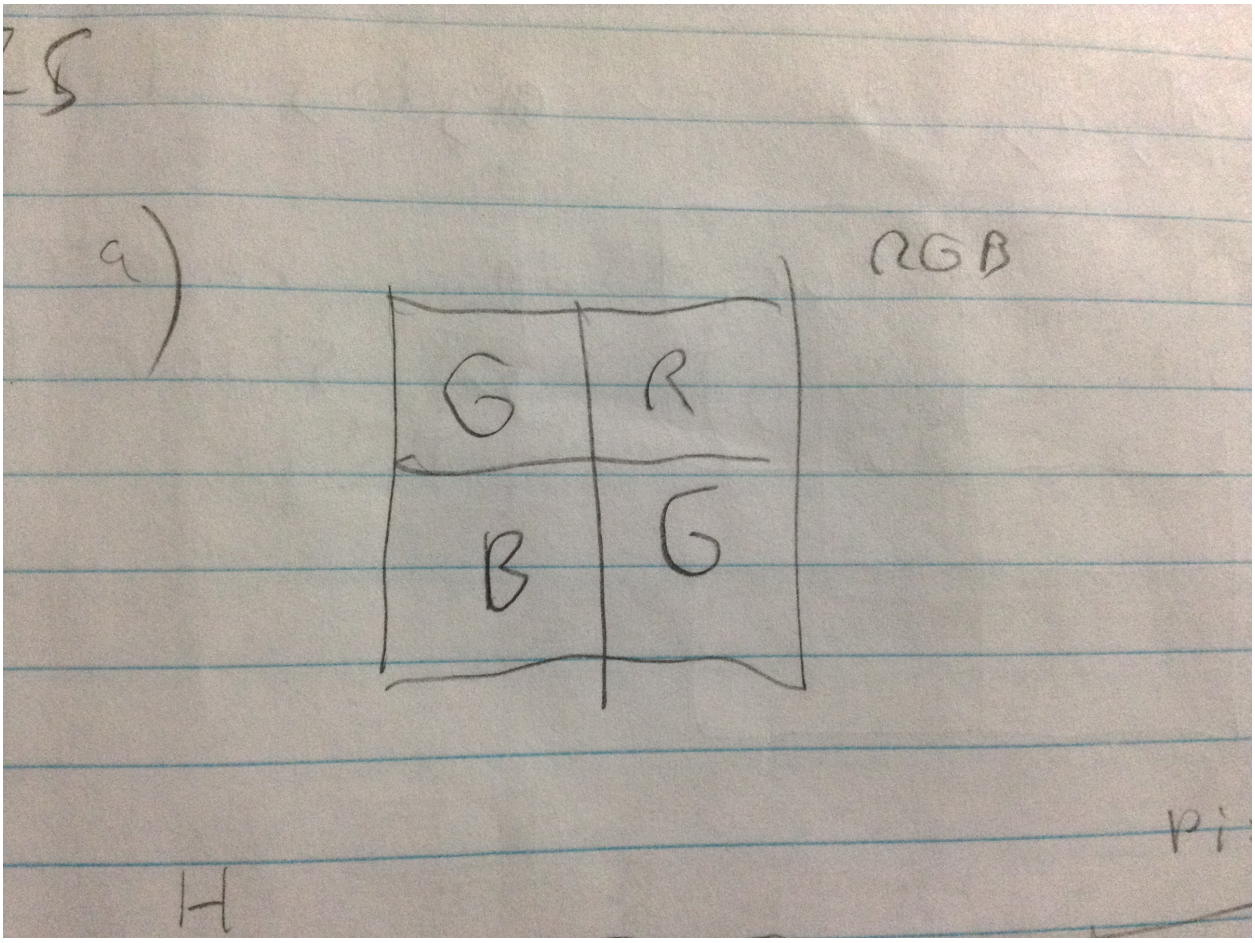


Figure 14: RGB image

The colors are said to be fully saturated and to have full intensity. Thus the S component of each color is 255, and the I component is .5 or 127.

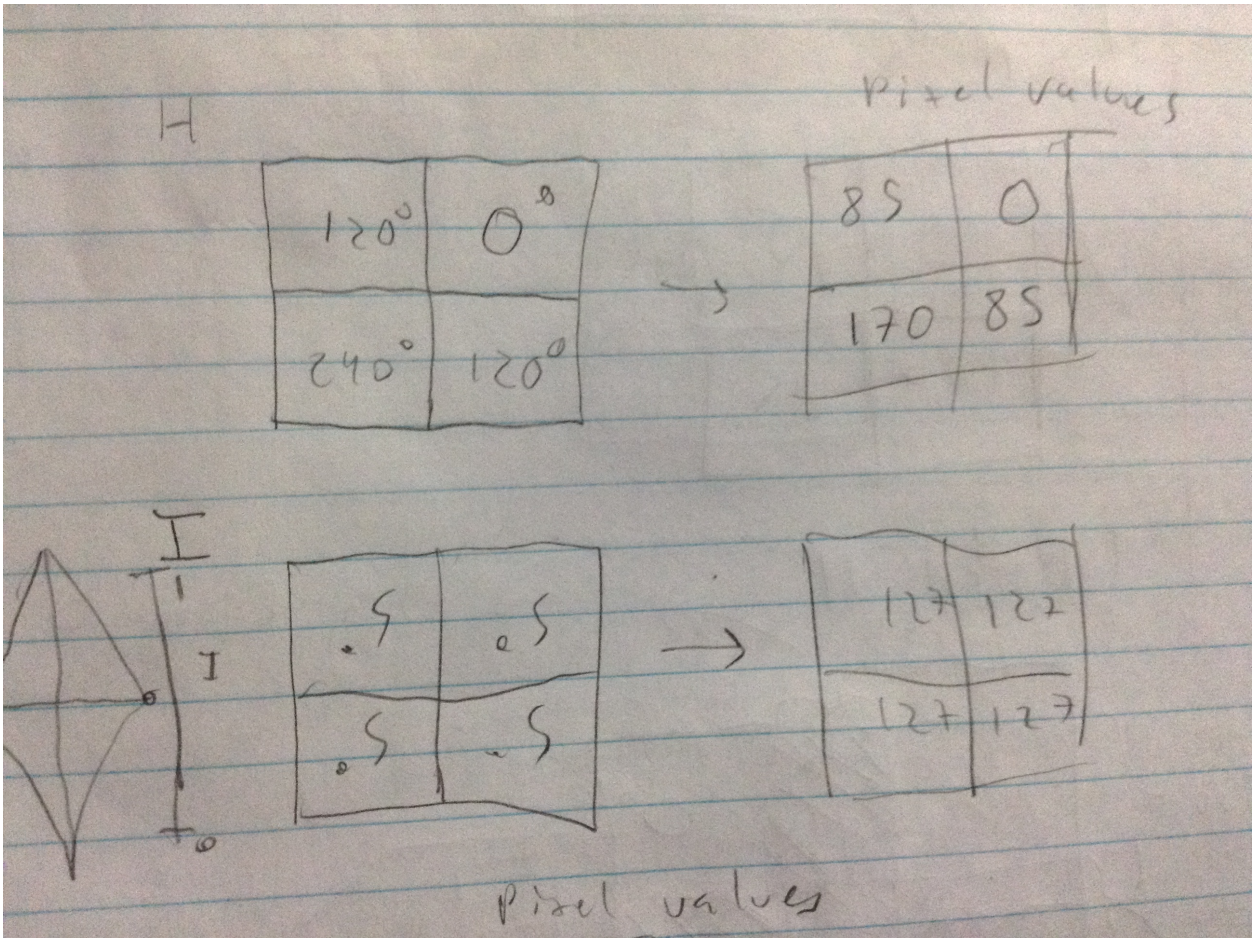


Figure 15: H and I components

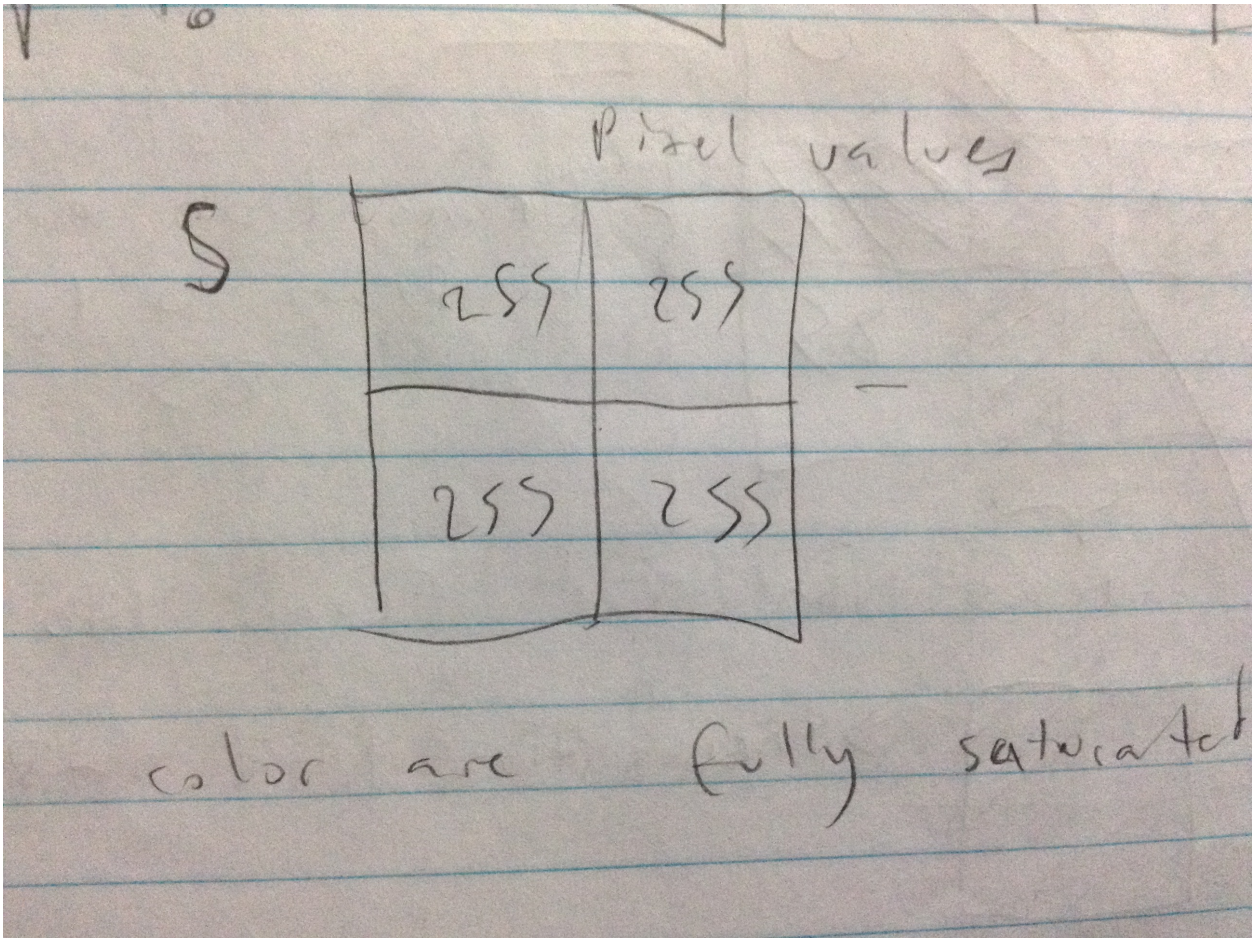


Figure 16: S component

3.2 Part b: Describe the appearance of the S component after it is smoothed with an averaging filter

The image of the S component remains the same after smoothing, since all of its values are equal.

3.3 Part c: Describe the appearance of the H component after it is smoothed with a 250x250 averaging filter

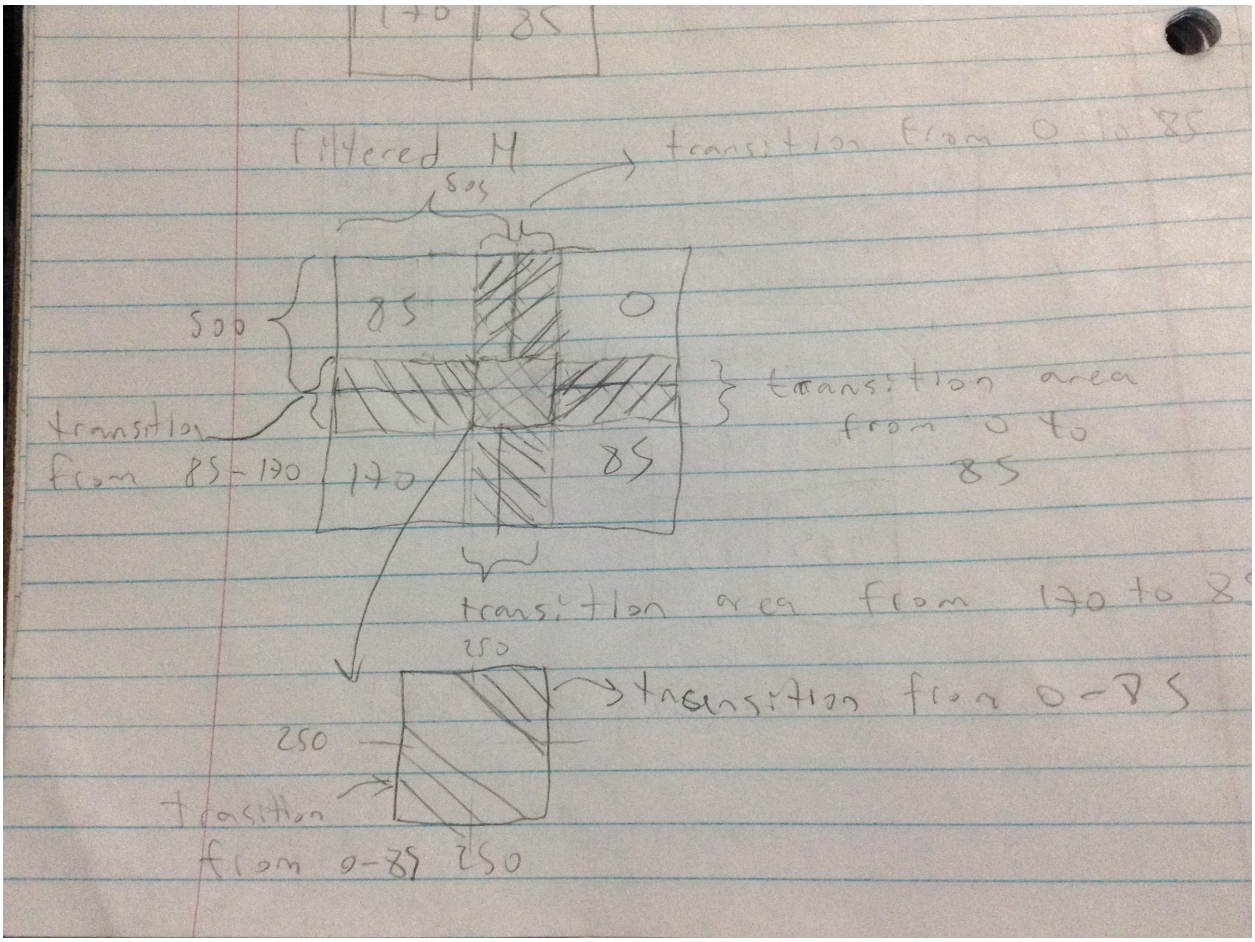


Figure 17: filtered image

Filtering produces an image that has transitions where the colors border each other.

4 Problem 6.25: Sketch the surface

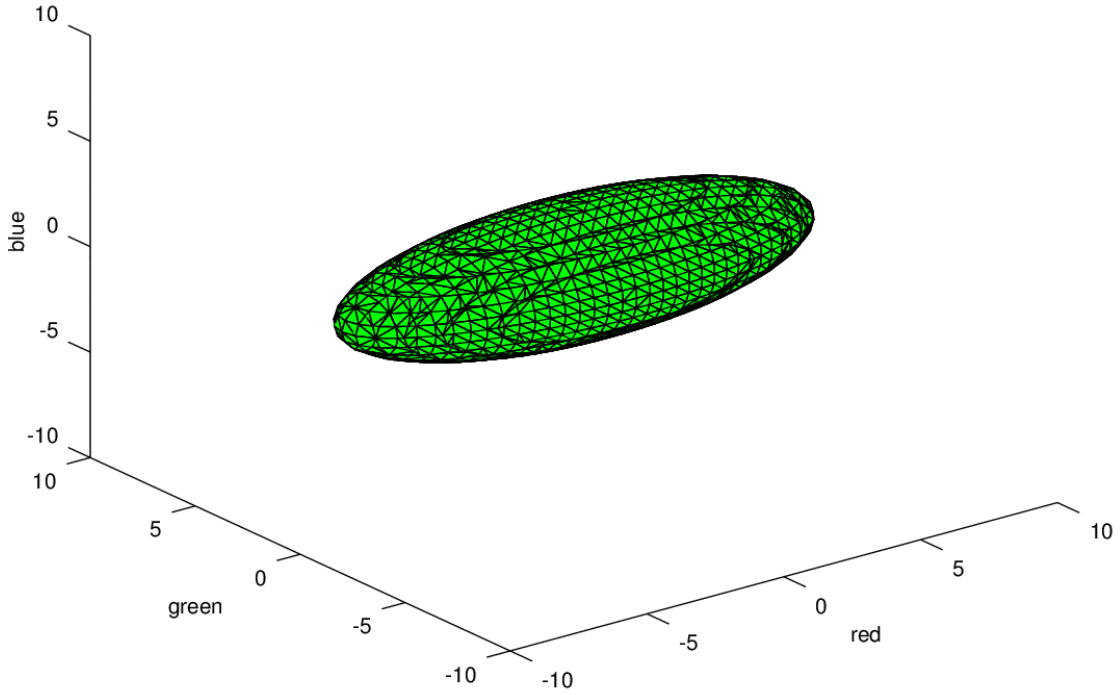


Figure 18: dilation process

5 Problem 5

5.1 Part a: Prove the following:

$$(A \bullet B)' = A' \ominus \hat{B}$$

$$(A \oplus B)' = \{x|(\hat{B})_z \cap A \neq \emptyset\}'$$

$$(A \oplus B)' = \{x|(\hat{B})_z \cap A = \emptyset\}$$

$$A' \ominus \hat{B} = \{x|(\hat{B})_z \subseteq A'\}$$

$$A' \ominus \hat{B} = \{x|(\hat{B})_z \cap A = \emptyset\}$$

$$(A \bullet B)' = A' \ominus \hat{B}$$

5.2 Part b: Prove the following:

$$(A \bullet B)' = A' \circ \hat{B}$$

$$(A \bullet B)' = ((A \oplus B) \ominus B)'$$

$$(A \bullet B)' = (A \oplus B)' \oplus \hat{B}$$

$$(A \bullet B)' = A' \ominus \hat{B} \oplus \hat{B}$$

$$(A \bullet B)' = A' \circ \hat{B}$$

5.3 Part c: Prove the following:

$$(A \circ B)' = A' \bullet \hat{B}$$

$$(A \circ B)' = ((A \ominus B) \oplus B)'$$

$$(A \circ B)' = (A \ominus B)' \ominus \hat{B}$$

$$(A \circ B)' = A' \oplus \hat{B} \ominus \hat{B}$$

$$(A \circ B)' = A' \bullet \hat{B}$$

6 Problem 6

6.1 Part a: Dilate the image by hand

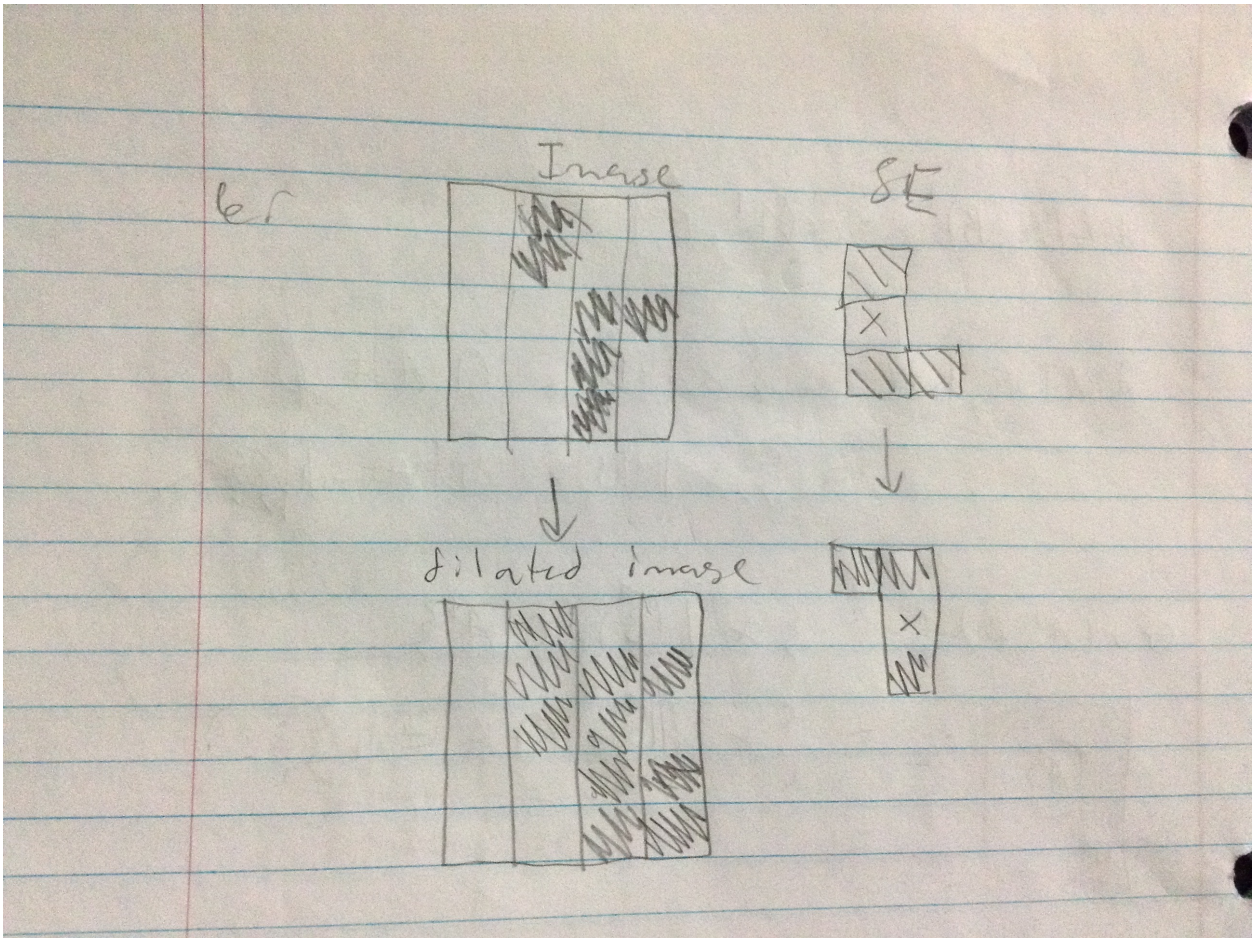


Figure 19: dilation process

In the drawn image black represents items in the set. While in the matlab images white represents items in the set.

6.2 Part b: Dilate the image using Matlab

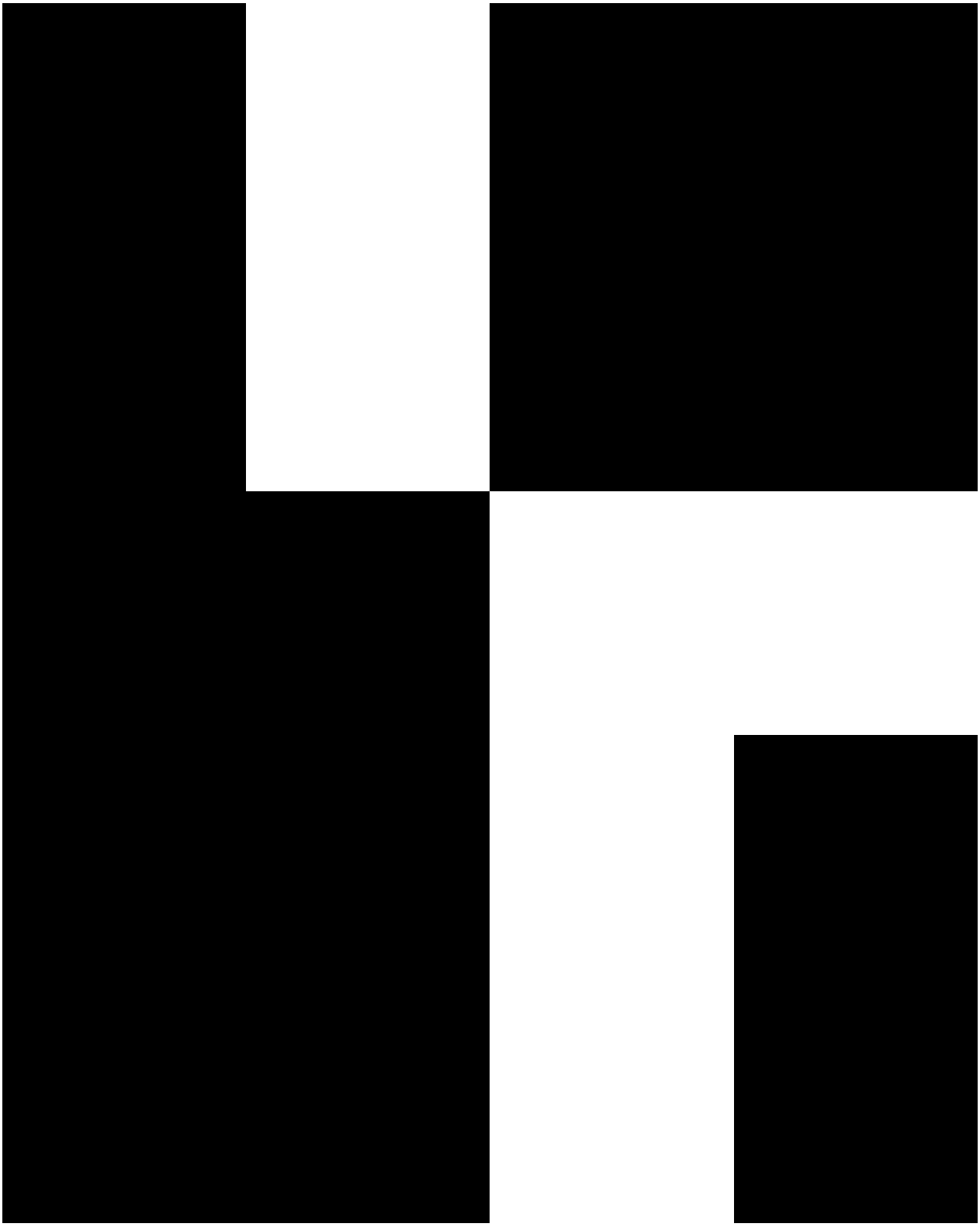


Figure 20: original image

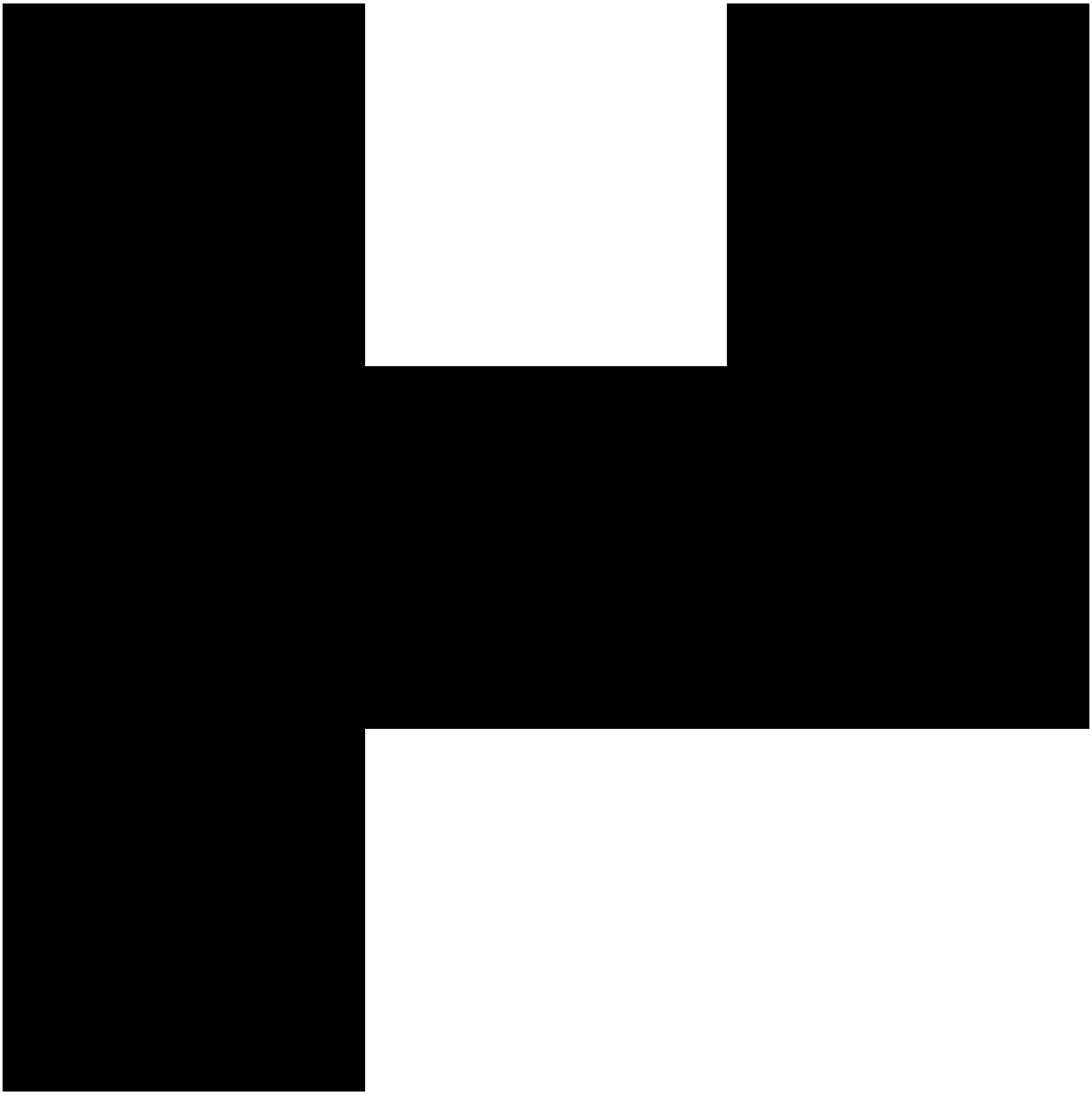


Figure 21: structural element

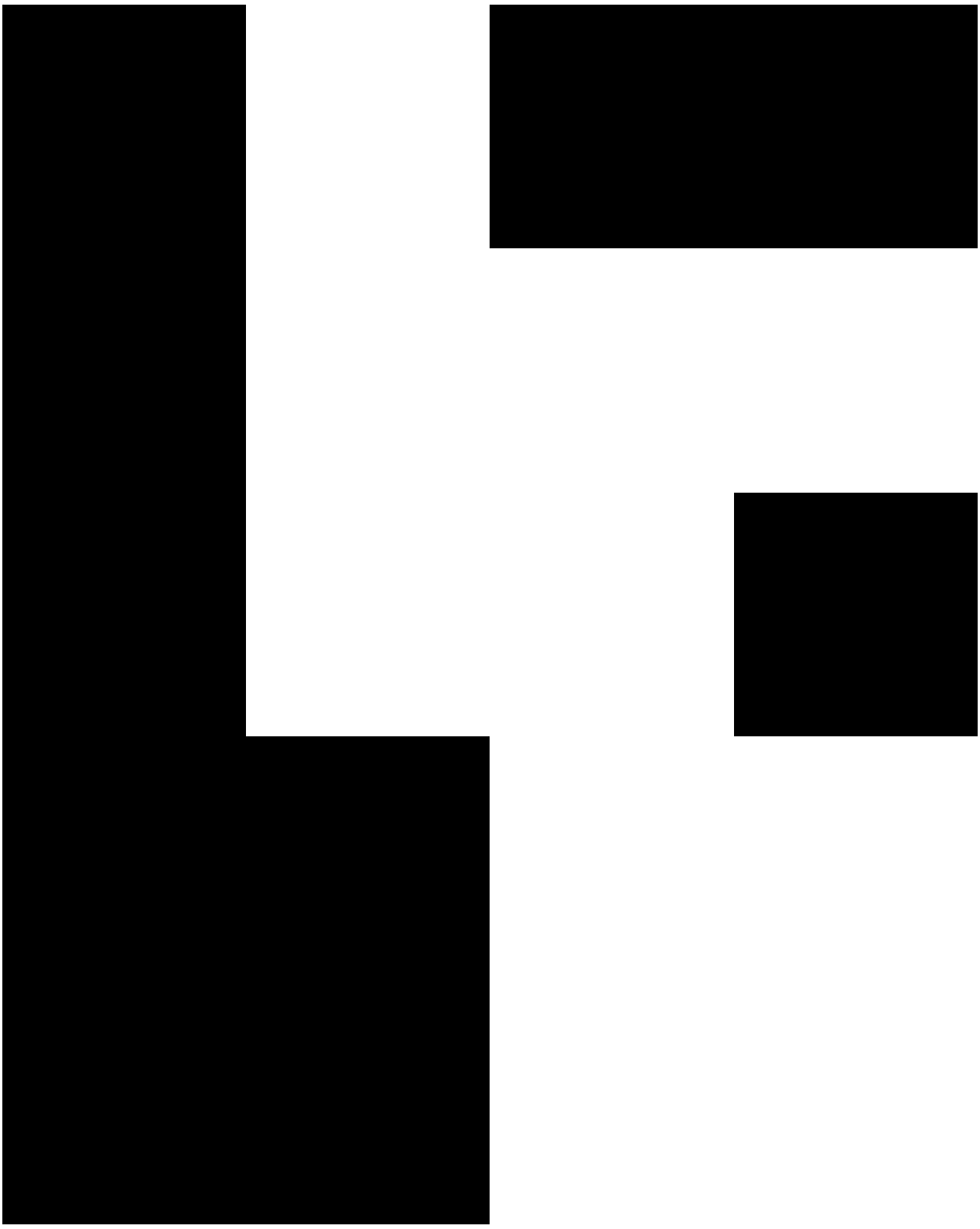


Figure 22: dilated image

7 Problem 2.23

7.1 Sketch the set given by the expression

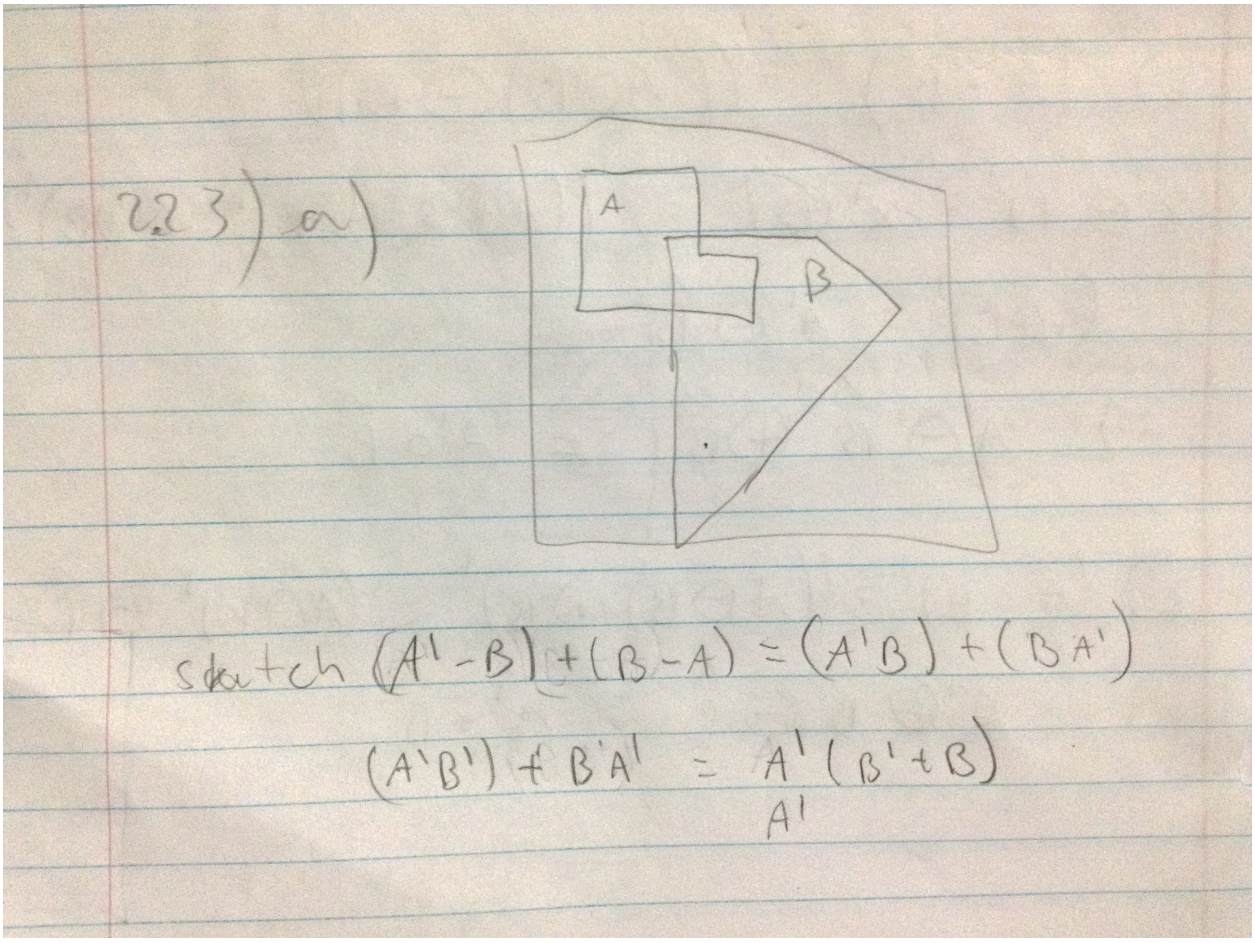


Figure 23: set a and b

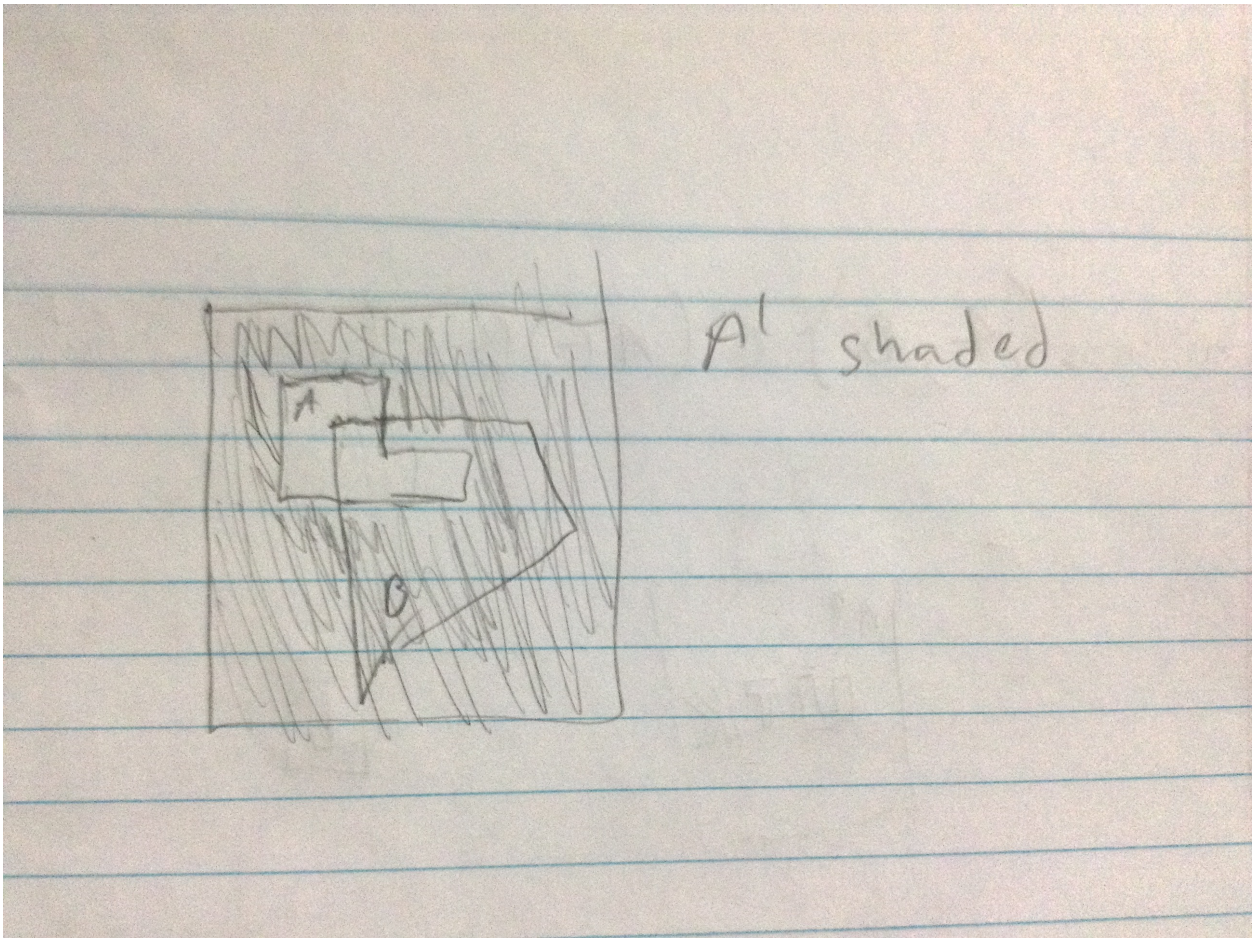


Figure 24: sketch of expression

7.2 Give expressions for the shaded regions

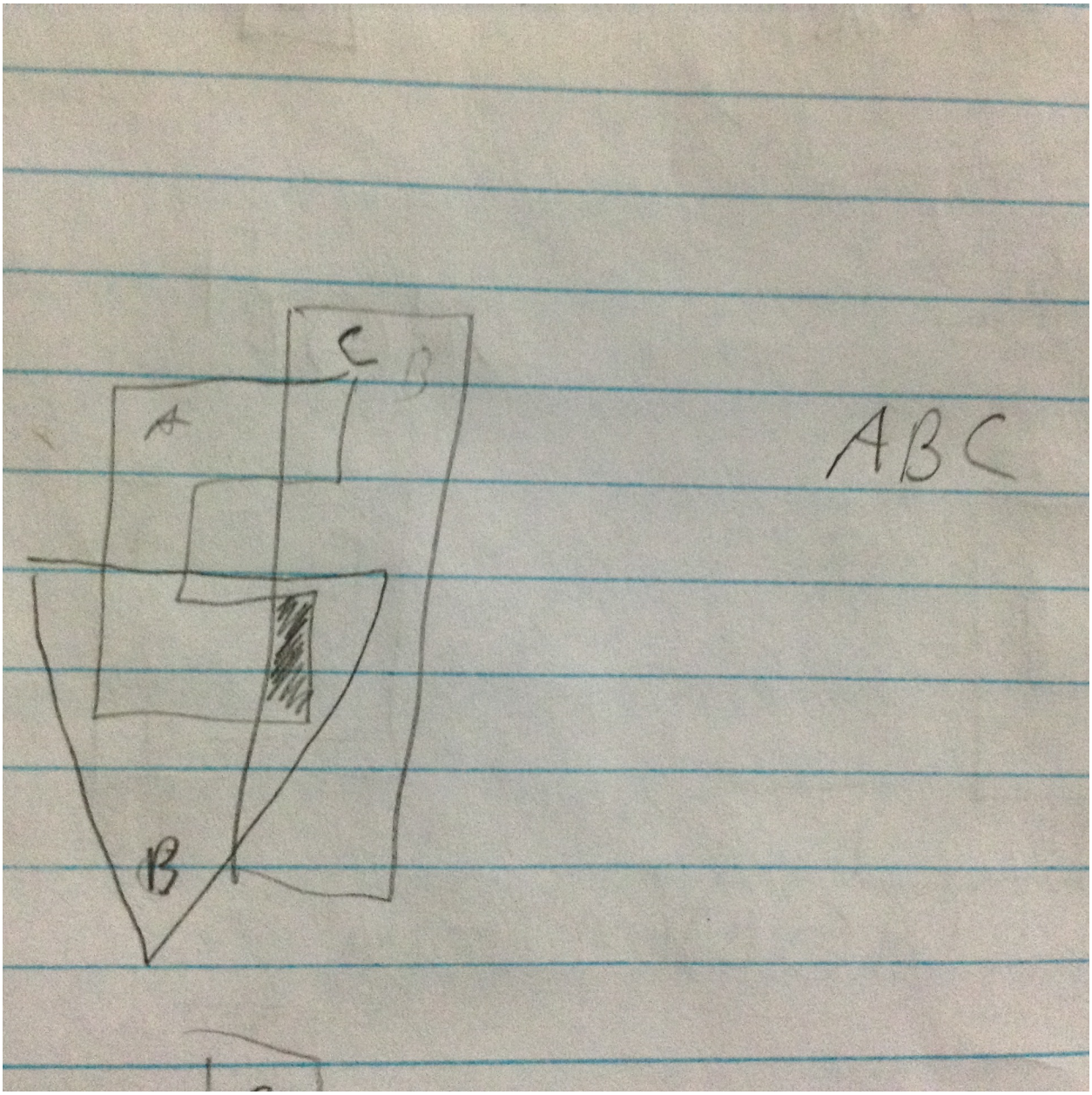


Figure 25: shaded region of a, b, and c

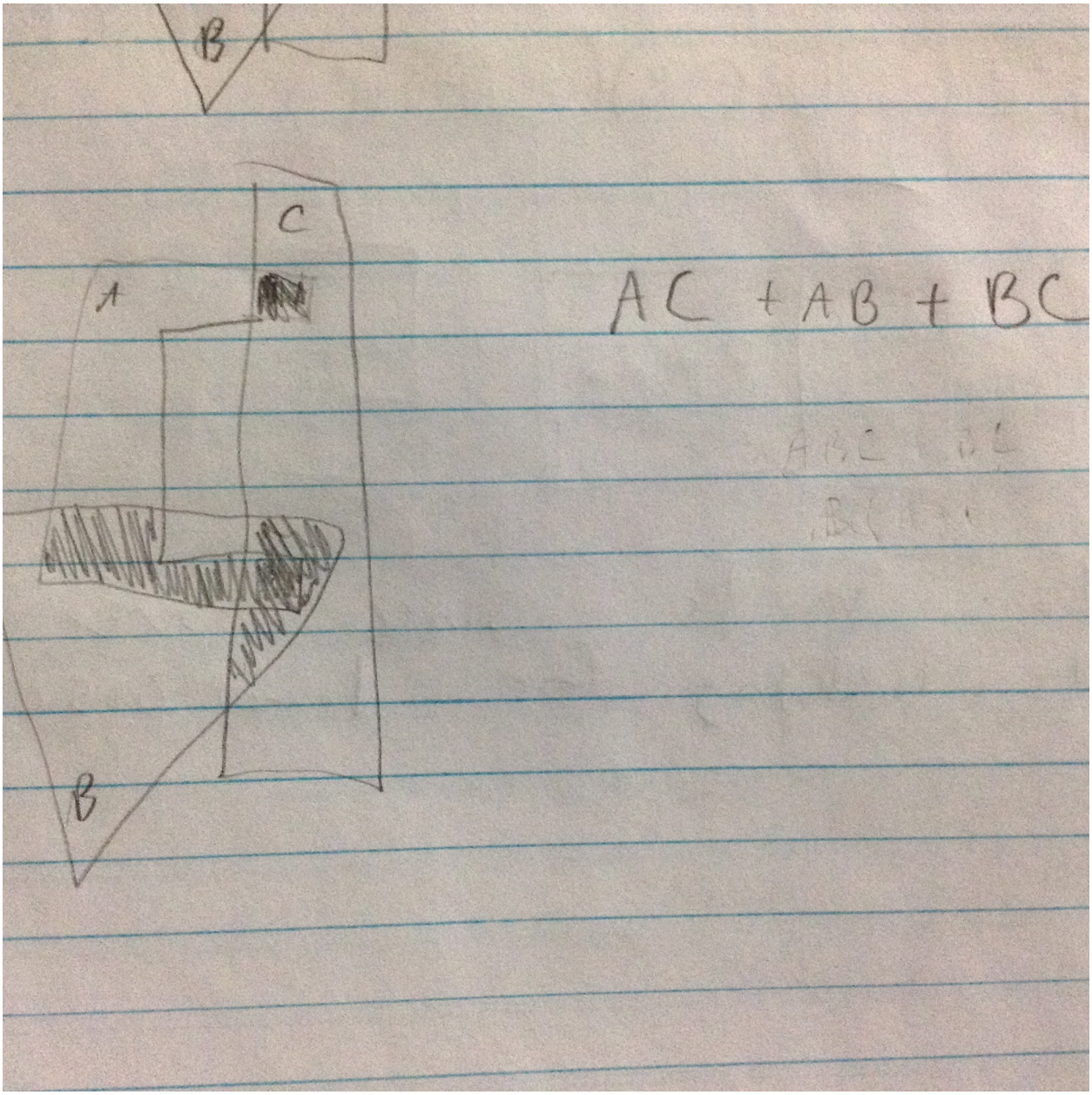


Figure 26: shaded region of a, b, and c

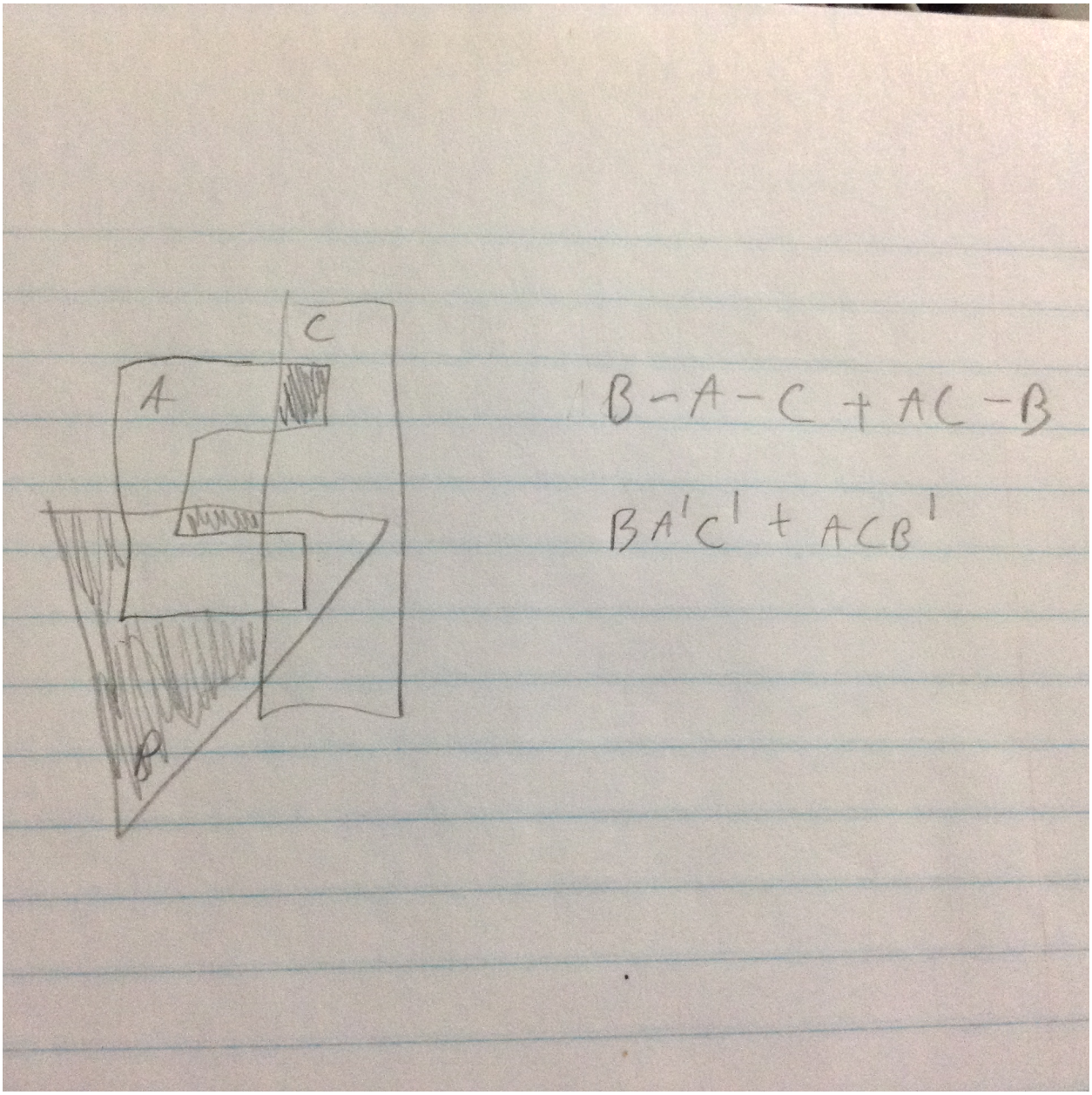
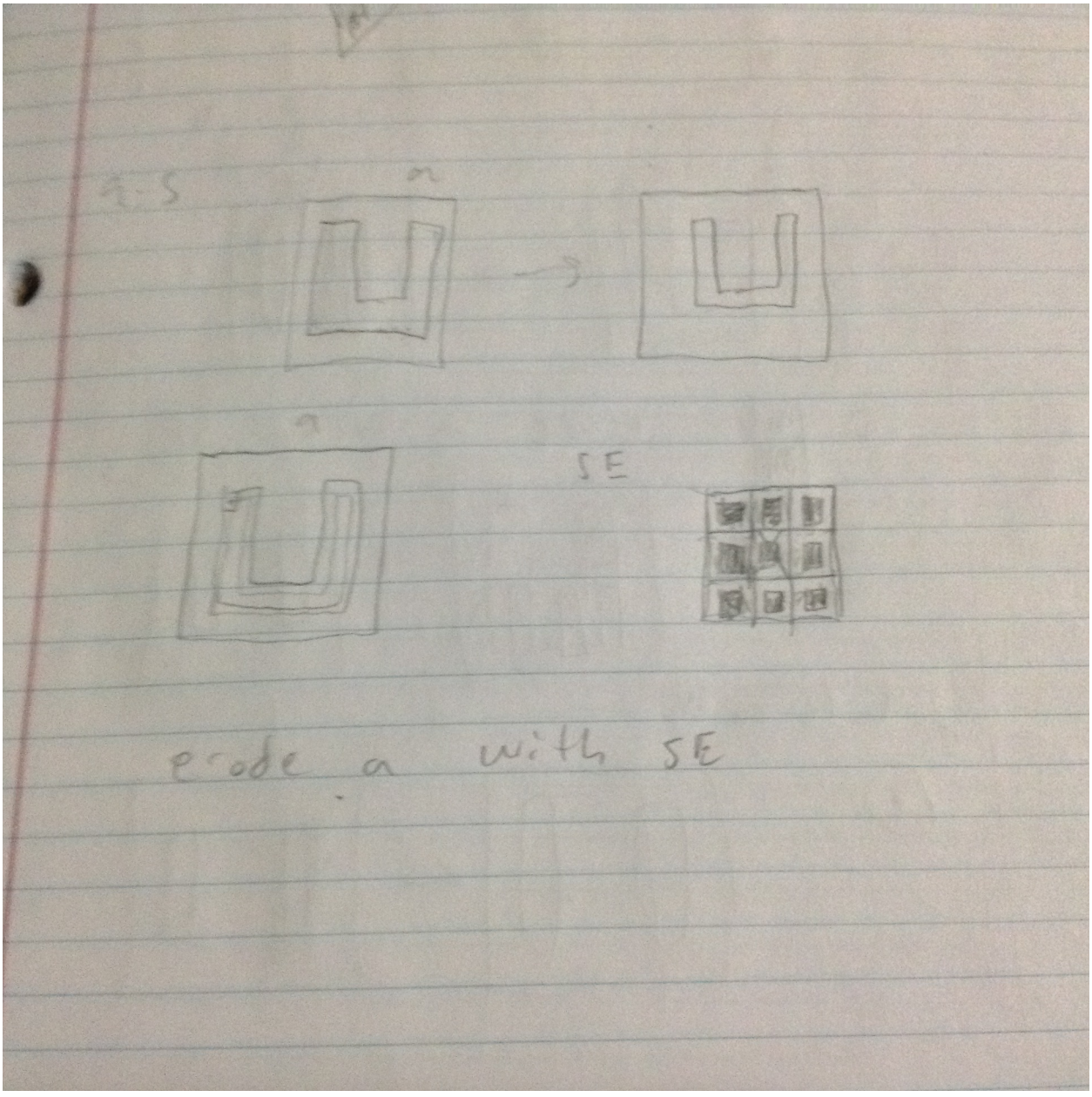


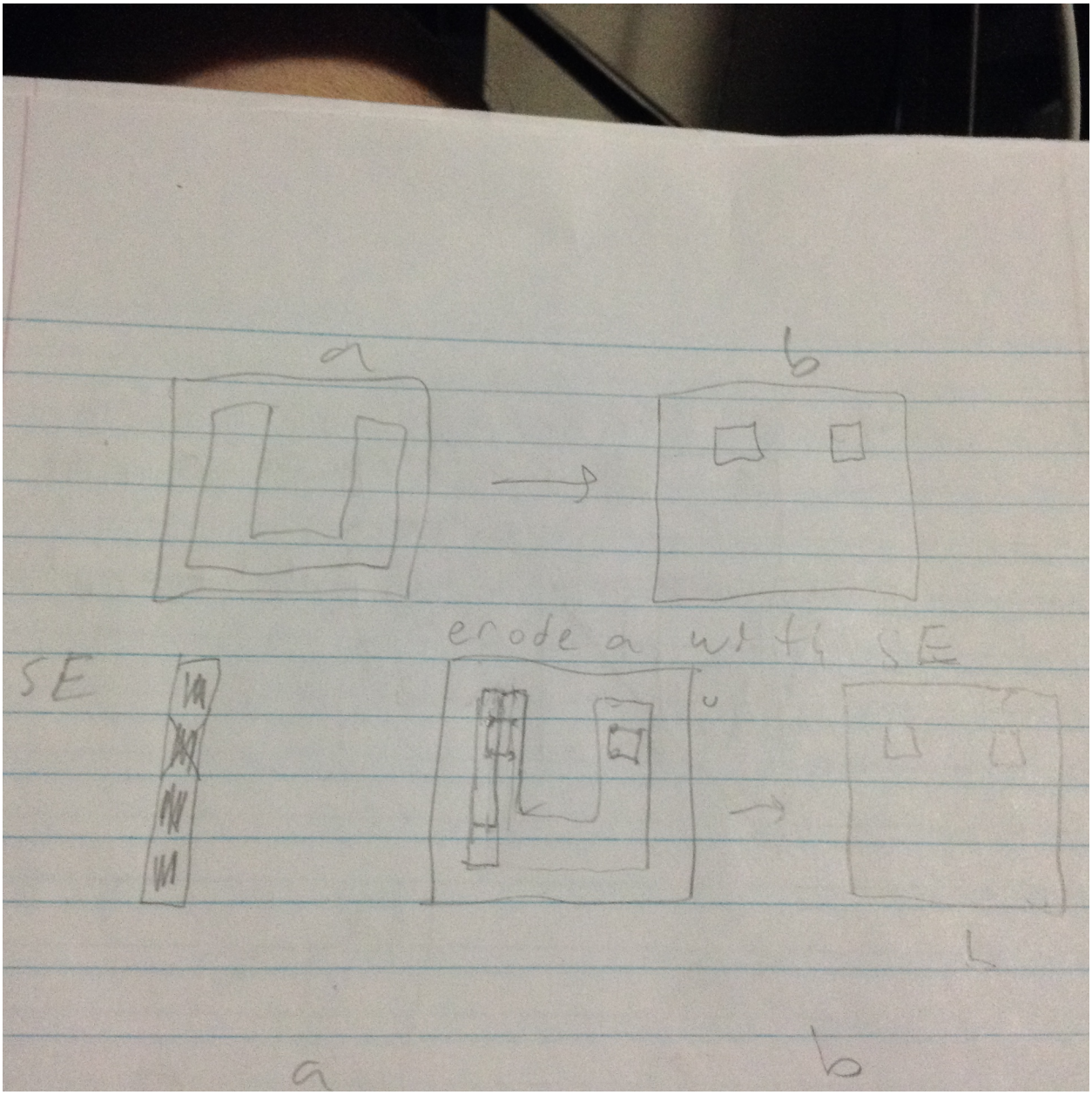
Figure 27: shaded region of a, b, and c

8 Problem 9.5: Give structuring element and operation needed to produce the second image from the first

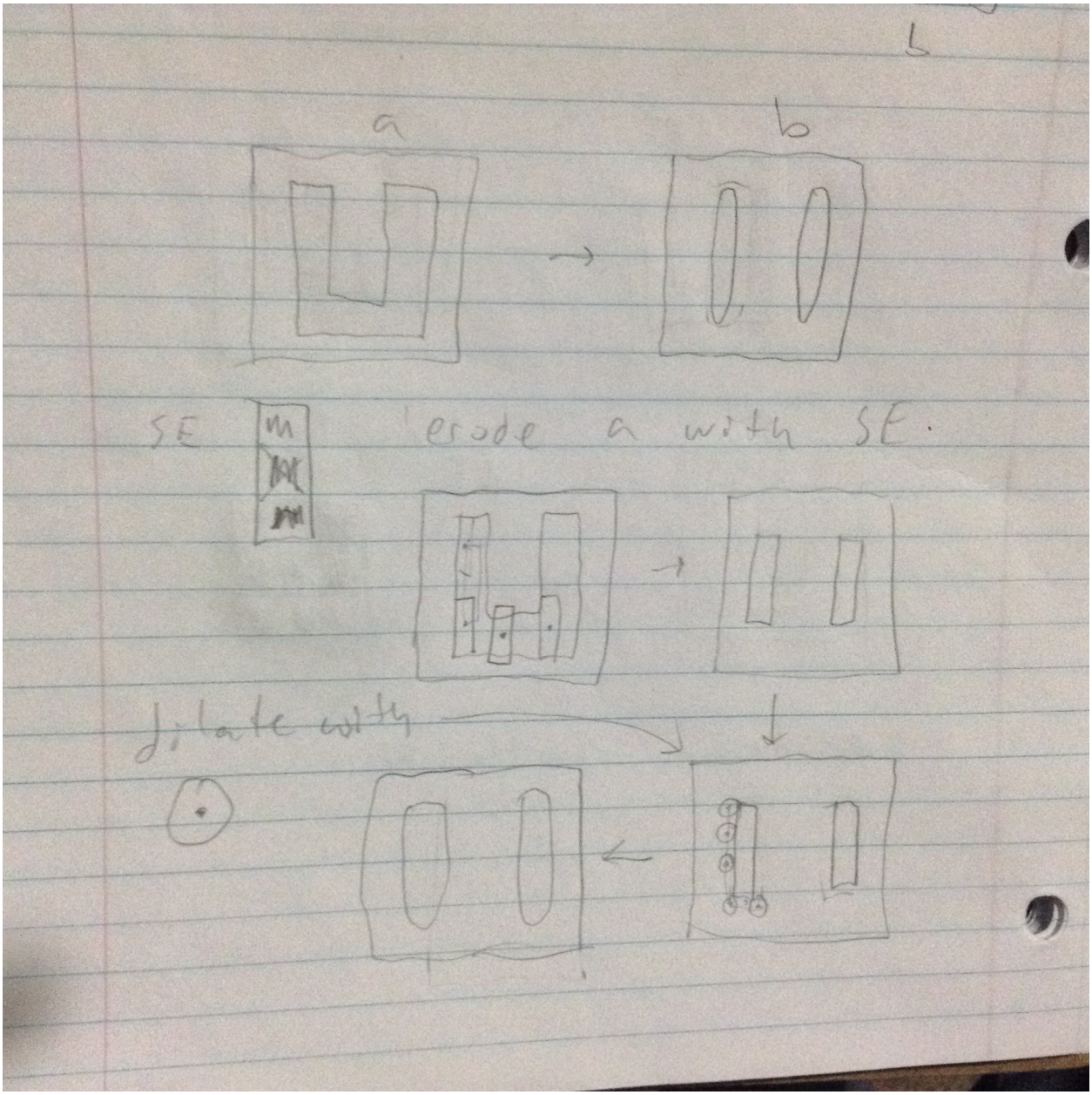
8.1 Part a



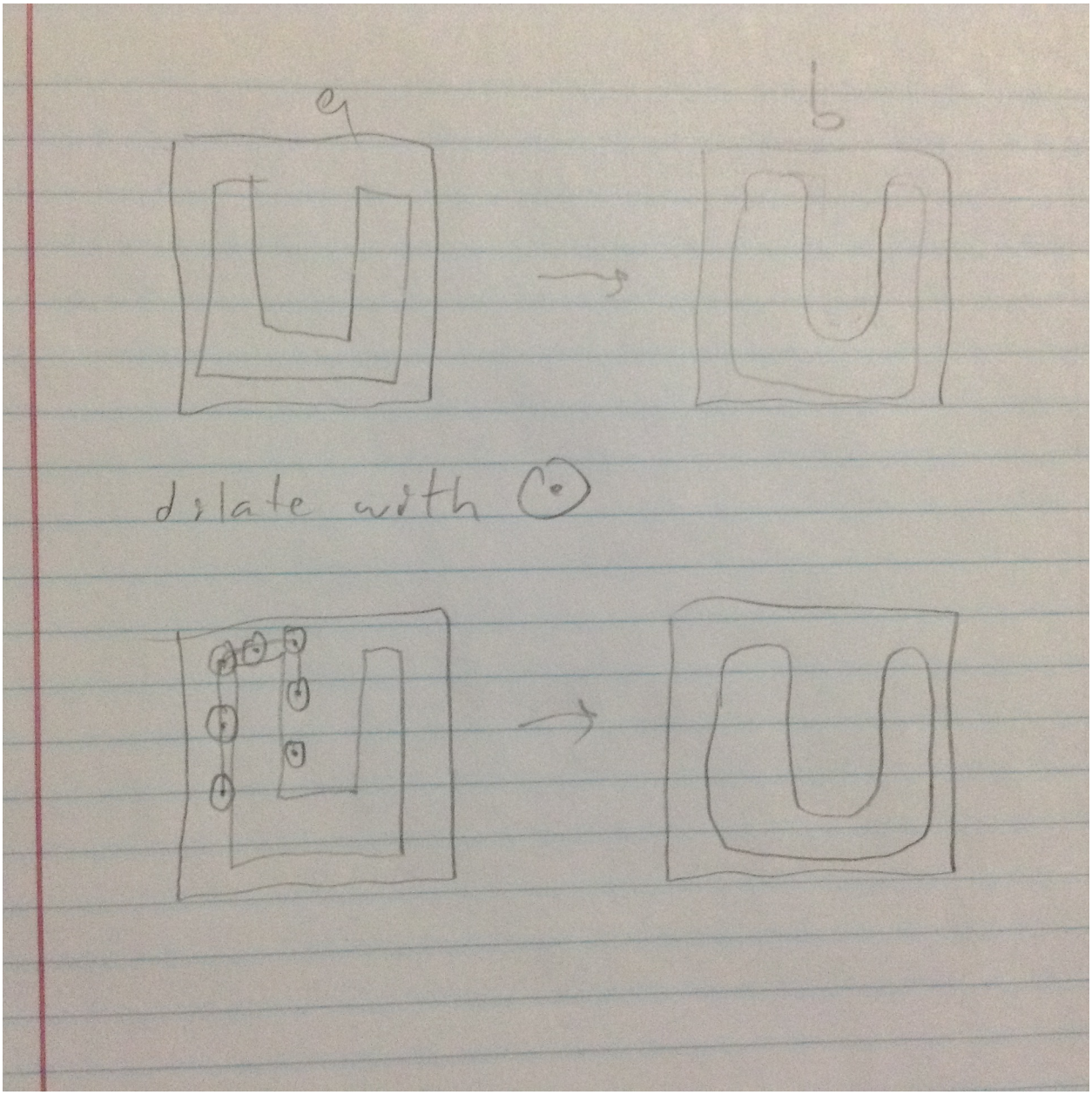
8.2 Part b



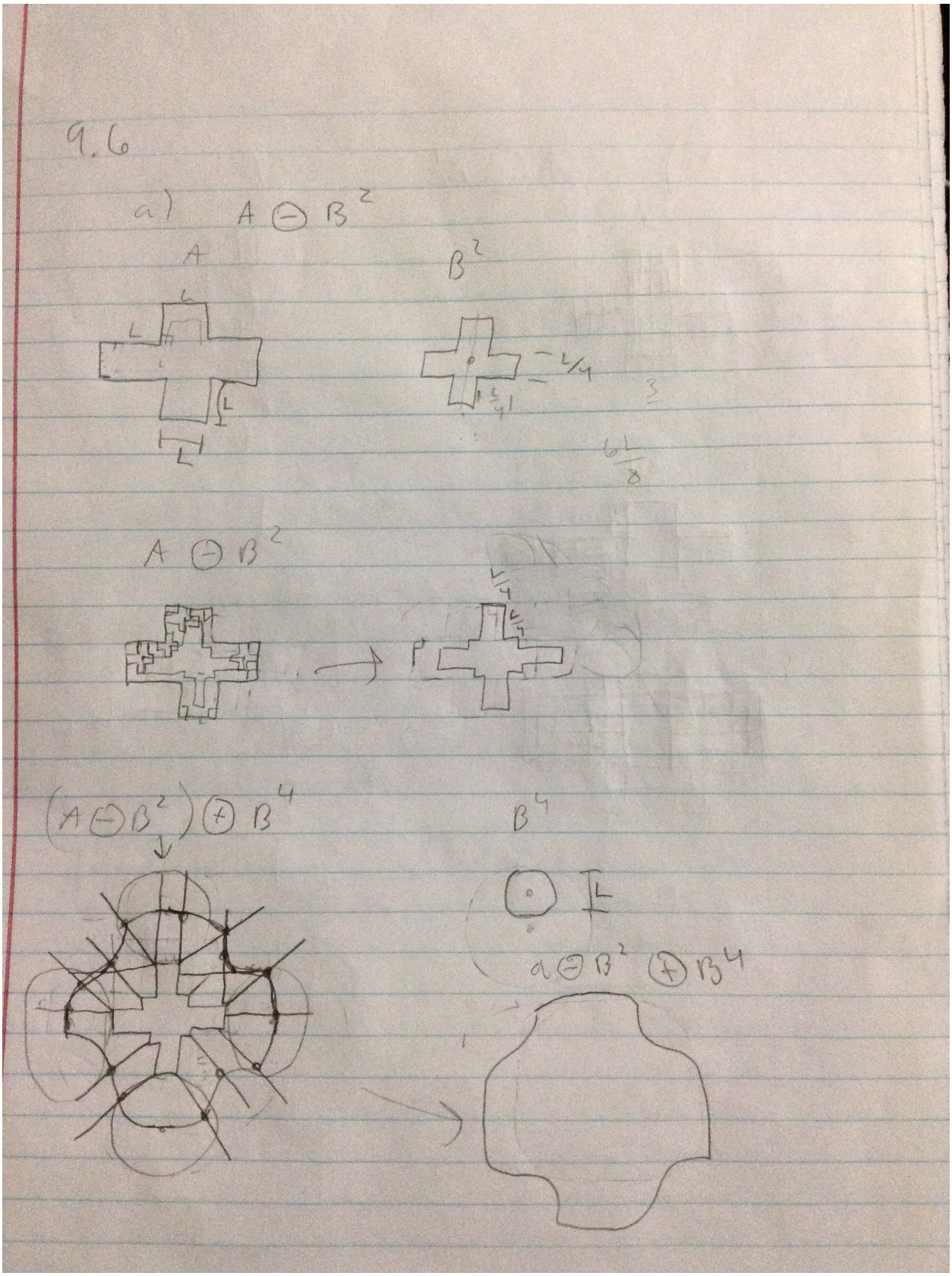
8.3 Part c



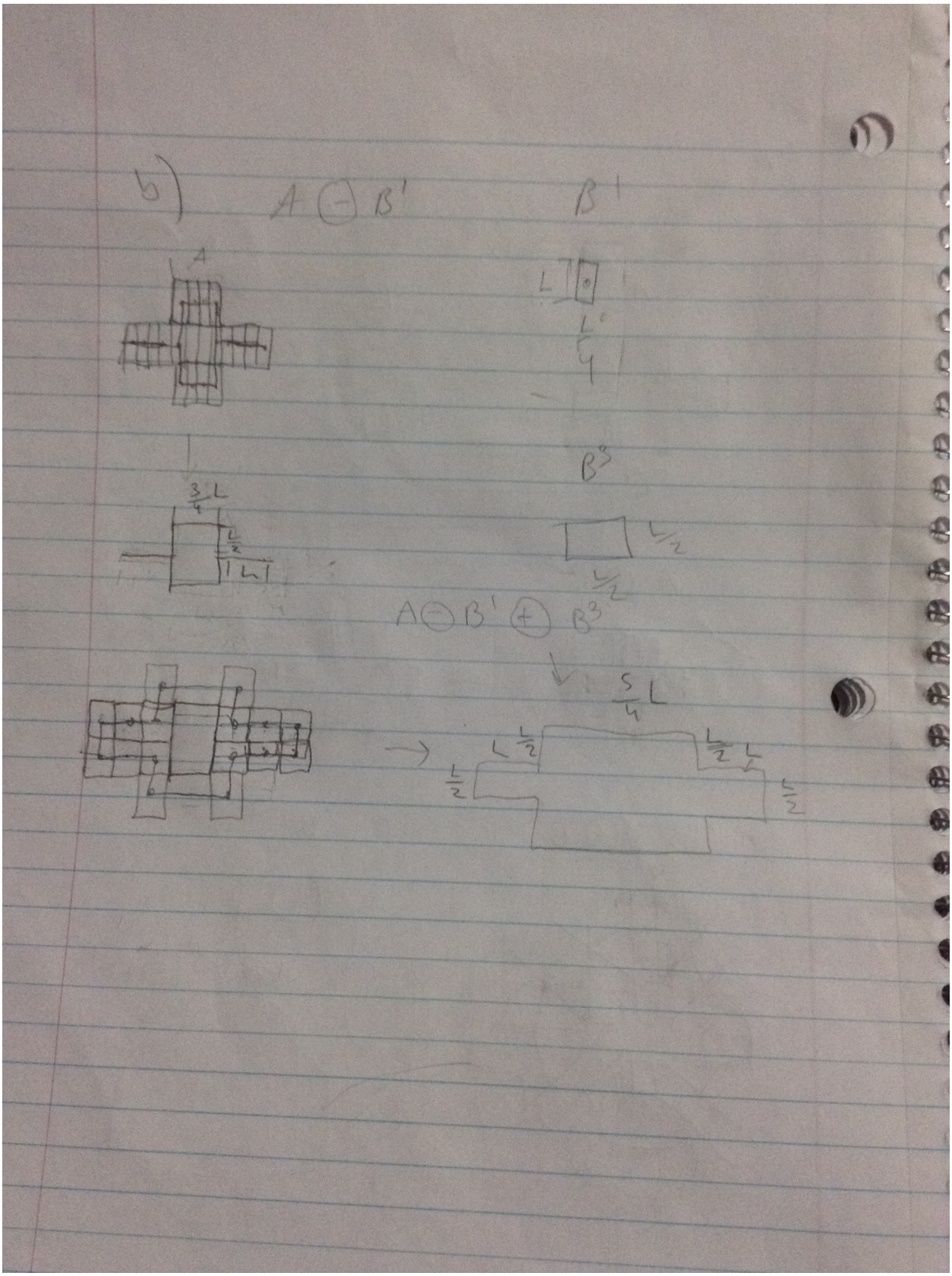
8.4 Part d



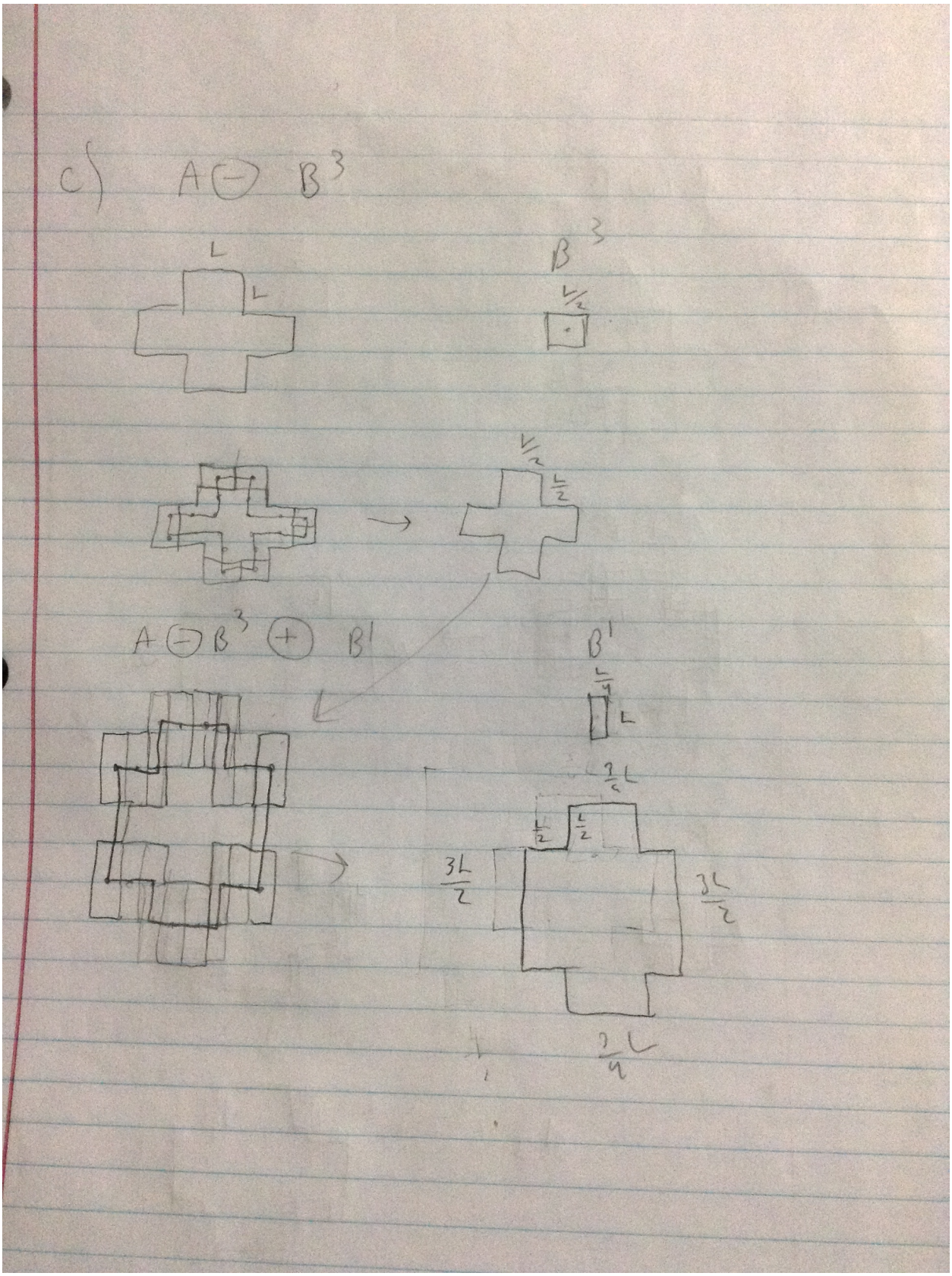
9 Problem 9.6: Perform the morphological operations



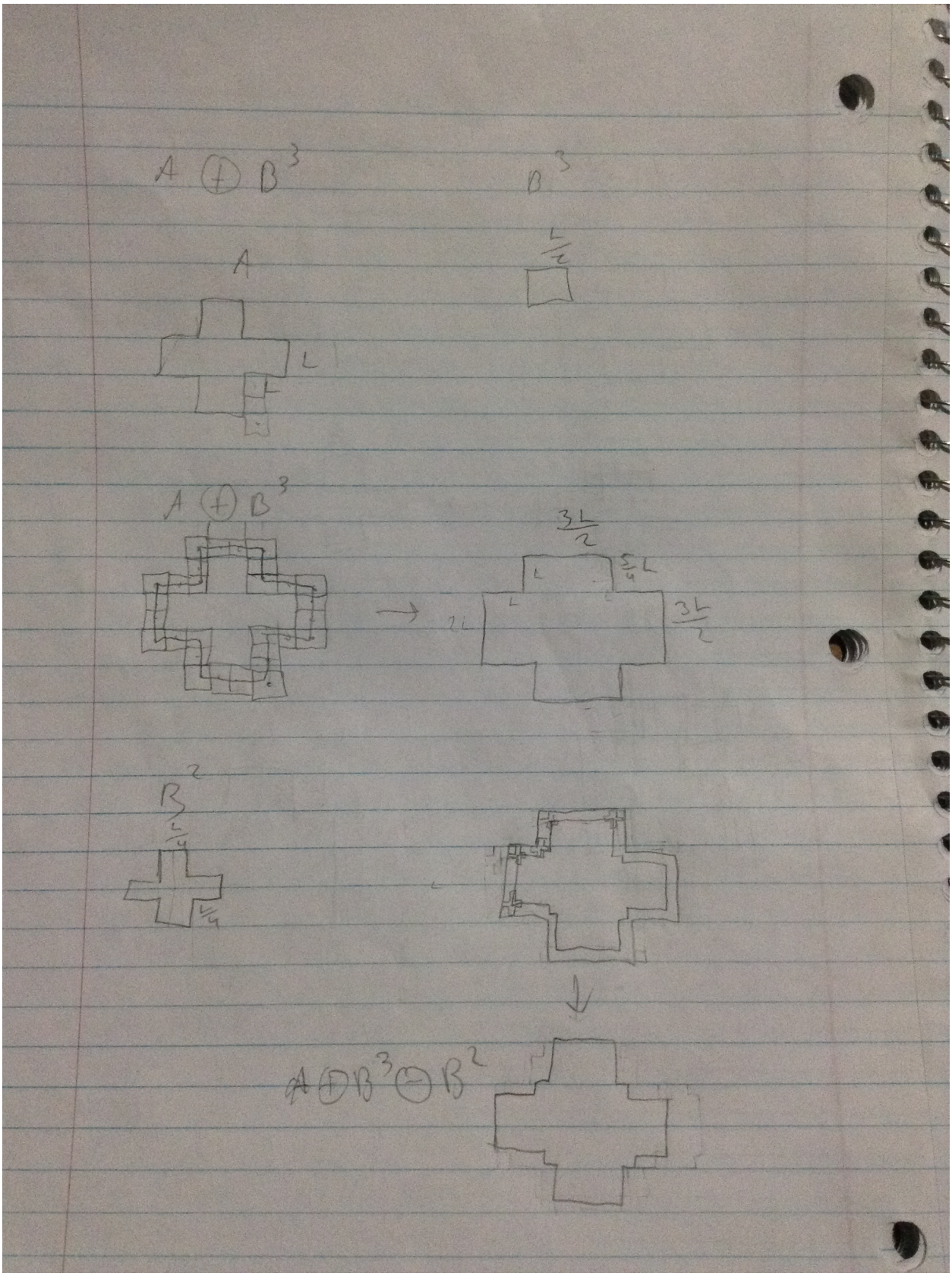
9.1 Part b



9.2 Part c



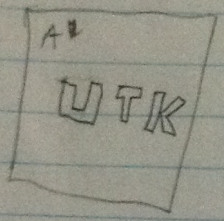
9.3 Part d

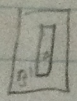


10 Problem 9.19: Perform the hit or miss transform

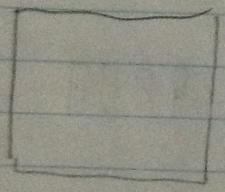
There are no hits since the structural element is a lower case l.

hit-miss $(A, B) = (A \ominus B)(A^c \ominus B^c)$

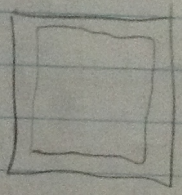




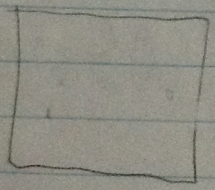
$A \ominus B$



$A^c \ominus B^c$



$(A \ominus B)(A^c \ominus B^c)$



No hits since we are looking for lowercase a

11 Code

11.1 6.17

```
red = imread('Fig0627(a)(WashingtonDC_Band3-RED).TIF');
blue = imread('Fig0627(c)(1)(WashingtonDC_Band1-BLUE).TIF');
green = imread('Fig0627(b)(WashingtonDC_Band2-GREEN).TIF');
infrared = imread('Fig0627(d)(WashingtonDC_Band4).TIF');

image(:,:,1) = red;
image(:,:,2) = green;
image(:,:,3) = blue;

figure(2);
imshow(image);
imwrite(image,'washingtonDCcolor.png');
```

```
red = imread('Fig0627(a)(WashingtonDC_Band3-RED).TIF');
blue = imread('Fig0627(c)(1)(WashingtonDC_Band1-BLUE).TIF');
green = imread('Fig0627(b)(WashingtonDC_Band2-GREEN).TIF');
infrared = imread('Fig0627(d)(WashingtonDC_Band4).TIF');


water = 255*(infrared < 25);
image(:,:,1) = red;
image(:,:,2) = green;
image(:,:,3) = blue+water;

figure(2);
imshow(image);

imwrite(image,'washingtonDCwater.png');
imwrite(water,'water.png');
```

```
red = imread('Fig0627(a)(WashingtonDC_Band3-RED).TIF');
blue = imread('Fig0627(c)(1)(WashingtonDC_Band1-BLUE).TIF');
green = imread('Fig0627(b)(WashingtonDC_Band2-GREEN).TIF');
infrared = imread('Fig0627(d)(WashingtonDC_Band4).TIF');

buildings = 255*(red > 60) .* (blue > 60) .* (green > 60);

image(:,:,1) = red + buildings;
image(:,:,2) = green - buildings;
image(:,:,3) = blue - buildings;


figure(1)
imshow(buildings);
figure(2)
imshow(image);

imwrite(image,'washingtonDCBuildings.png');
imwrite(buildings,'buildings.png');
```

11.2 6.25

```
[X,Y,Z]=meshgrid(-10:.5:10,-10:.5:10,-10:.5:10);

val=surf(X,Y,Z);
figure(1)
isosurface(X,Y,Z,val,3);
xlabel('red');
ylabel('green');
zlabel('blue');
axis ([-10 10 -10 10 -10 10])
print(figure(1),'part1.png');
```

11.3 Problem 6

```
a = [ 0 1 0 0 ;
      0 1 0 0 ;
      0 0 1 1 ;
      0 0 1 0 ;
      0 0 1 0 ];

b = [ 0 1 0 ;
      0 0 0 ;
      0 1 1 ];
figure(1)
imshow(a);
imwrite(a,'original.png');
imwrite(b,'SE.png');
SE = strel('arbitrary',b);

figure(2)
dilatedImage = imdilate(a,SE);
imshow(dilatedImage);
imwrite(dilatedImage,'dilated.png');
```