INF 4300,
Mathematical morphology – Solution of selected exercises

Exercise 4.1.
Solve exercise 9.6 in Gonzalez.

The solution:

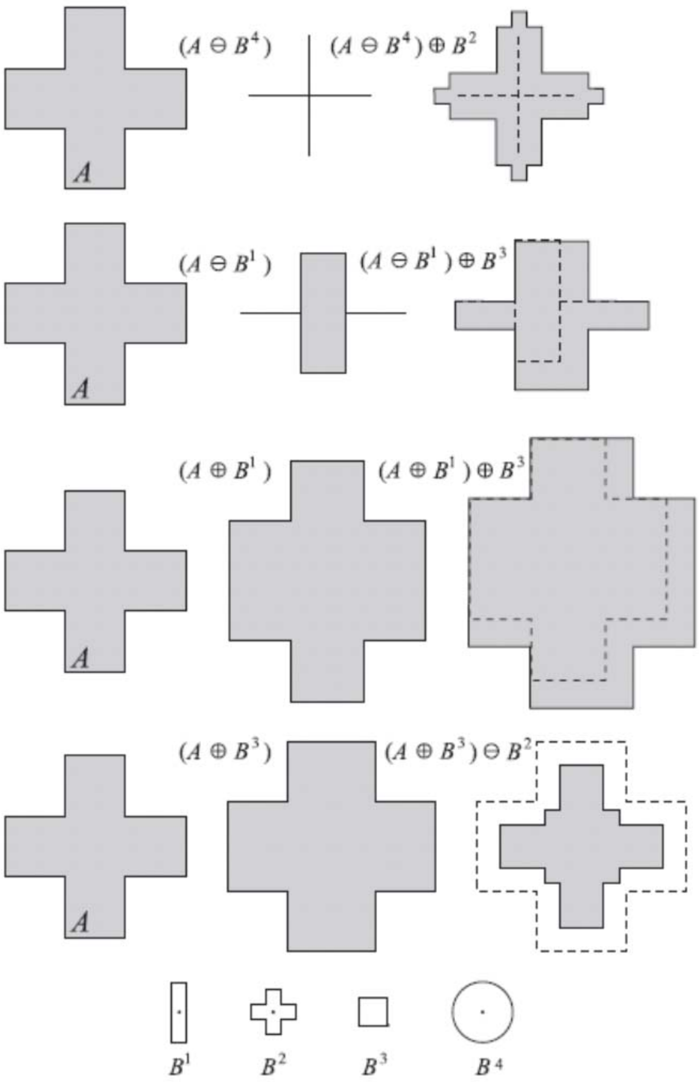
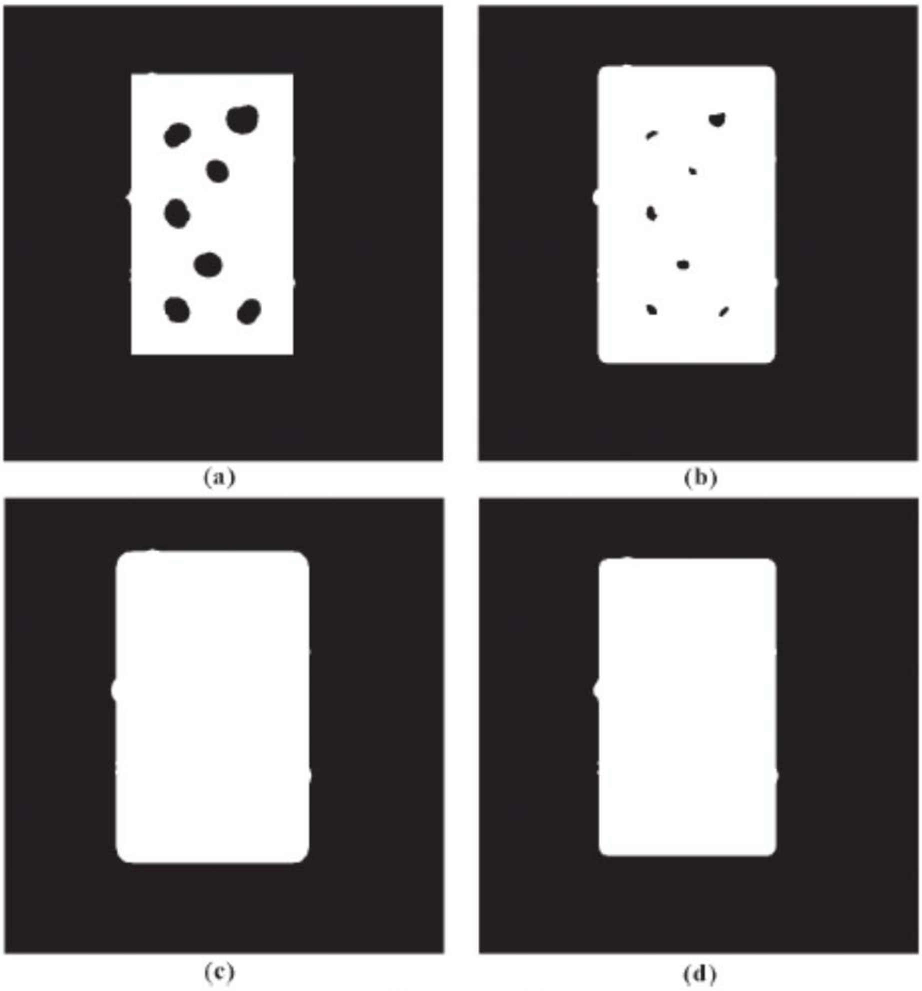


Figure P9.6

Exercise 4.2.
Solve exercise 9.17 in Gonzalez

Figure P9.17 shows the solution. Although the images shown could be sketched by hand, they were done in MATLAB for clarity of presentation. The MATLAB code follows:

```
>> f = imread('FigProb0917.tif');
>>se = strel('dis', 11, 0); % Structuring element.
>>fa = imerode(f, se);
>>fb = imdilate(fa, se);
>>fc = imdilate(fb, se);
>>fd = imerode(fc, se);
```



(a) (b) (c) (d)

Figure P9.17

The size of the original image is 648 × 624 pixels. A disk structuring element of radius 11 was used. This structuring element was just large enough to encompass each noise element, as given in the problem statement. The images shown in Fig. P9.17 are: (a) erosion of the original, (b) dilation of the result, (c) another dilation, and finally (d) an erosion. The main points we are looking for from the student's answer are: The first erosion should take out all noise elements that do not touch the rectangle, should increase the size of the noise elements completely contained within the rectangle, and should decrease the size of the rectangle. If worked by hand, the student may or may not realize that some "imperfections" are left along the boundary of the object. We do not consider this an important issue because it is scale-dependent, and nothing is said in the problem statement about this. The first dilation should shrink the noise components that were increased in erosion, should increase the size of the rectangle,

and should round the corners. The next dilation should eliminate the internal noise components completely and further increase the size of the rectangle. The final erosion (bottom right) should then decrease the size of the rectangle. The rounded corners in the final answer are an important point that should be recognized by the student.

Exercise 4.3.
Solve exercise 9.27 in Gonzalez

Erosion is the set of points z such that B, translated by z, is contained in A. If B is a single point, this definition will be satisfied only by the points comprising A, so erosion of A by B is simply A. Similarly, dilation is the set of points z such that $\hat{B}$ ($\hat{B} = B$ in this case), translated by z, overlaps A by at least one point. Because B is a single point, the only set of points that satisfy this definition is the set of points comprising A, so the dilation of A by B is A.