

Student ID:

Name:

Question 1 (10 marks)

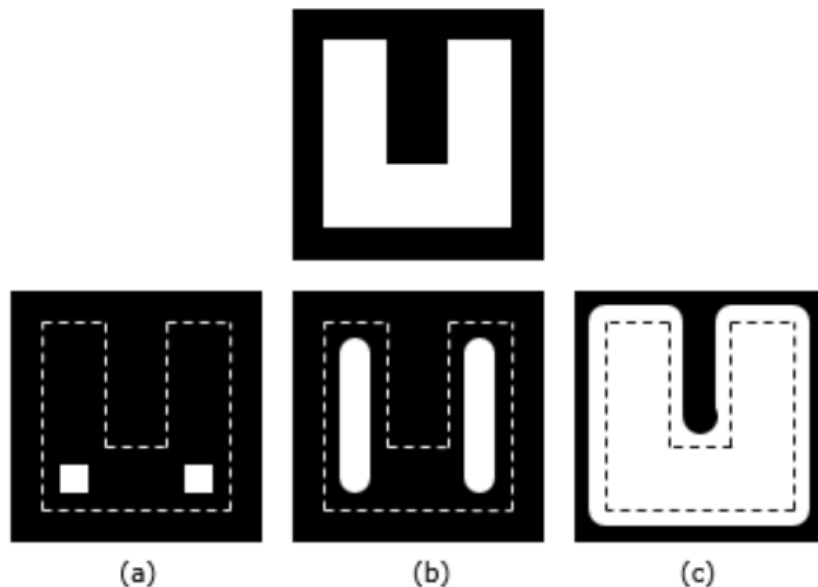
The following figure shows an image that has been corrupted by either salt noise or pepper noise. Is it salt noise or pepper noise? Given a choice of (1) arithmetic mean filter; (2) harmonic mean filter; and (3) contraharmonic mean filter, which one is most appropriate for this task. Explain. (10 marks)



Solution: Pepper noise. (3) Contraharmonic Mean Filter with Positive Q is suitable for eliminating the pepper noise.

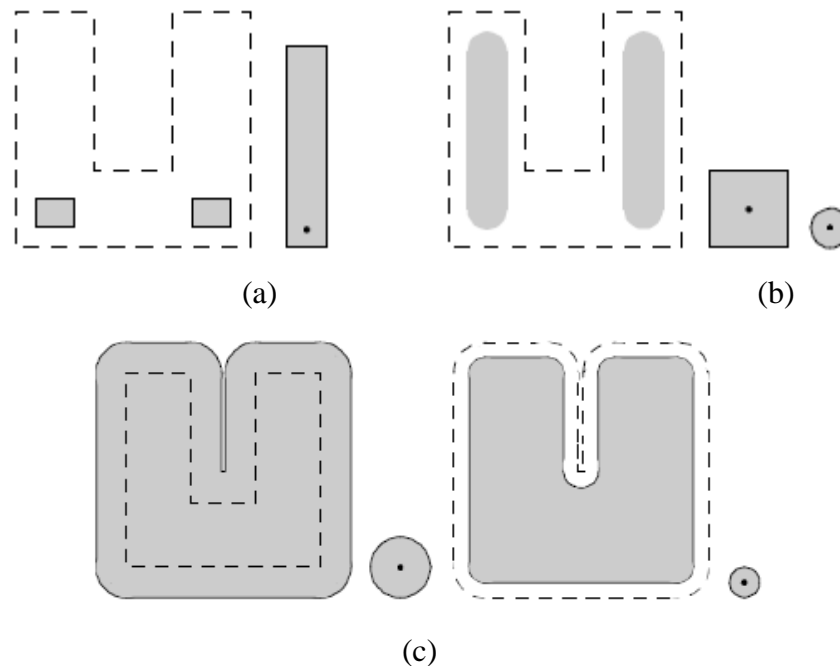
Question 2 (10 marks)

With reference to the image shown, give the structuring element and morphological operations that produced each of the results shown in images (a) through (c). Show the origin of each structuring element clearly. The dashed lines show the boundary of the original set and are included only for reference. Note that in (c) all corners are rounded.



Solutions:

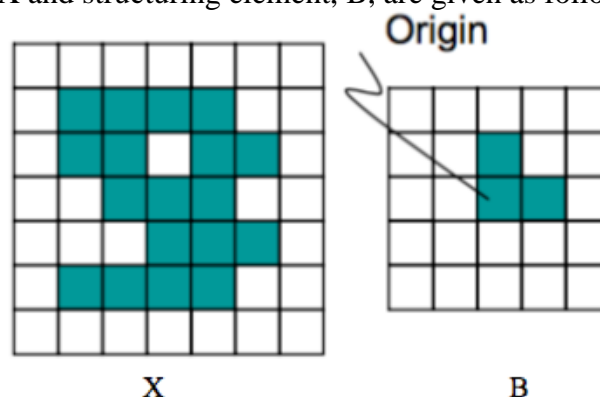
Solution (a) was obtained by eroding the original set with the tall rectangular structuring element shown. Solution (b) was obtained by eroding the image shown down to two vertical lines using the rectangular structuring element this result was then dilated with the circular structuring element. Solution (c) was obtained by dilating the original set with the large disk shown. Then dilated image was then eroded with a disk of half the diameter of the disk used for dilation.



Question 3 (10 marks)

Dilation and Erosion are two primitive operators, which may be used to define other morphological operations.

- Explain how erosion and dilation is performed. (2 marks)
- Binary image, X and structuring element, B , are given as follows



Calculate $Y1 = X \ominus B$, where \ominus denotes the morphological erosion operator and $Y2 = X \oplus B$ where \oplus denotes the morphological dilation operator; (4 marks)

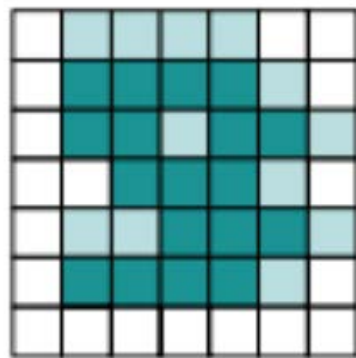
- Calculate the corresponding closing procedure. (4 marks)

Solution:

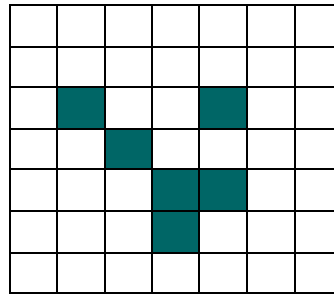
(a) Erosion: Applying Fit to an entire image is denoted Erosion;

Dilation: Applying Hit to an entire image is denoted Dilation

(b)

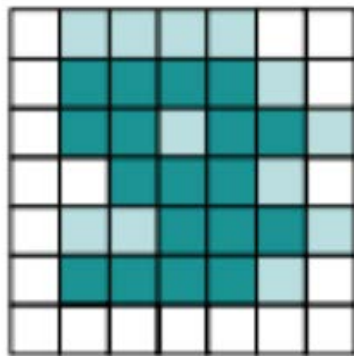


$X \oplus B$

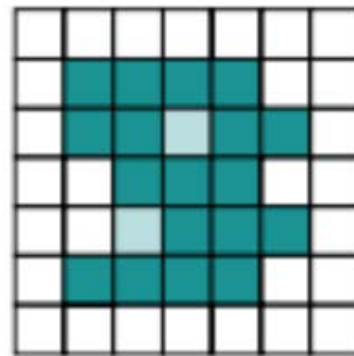


$X \ominus B$

(c)



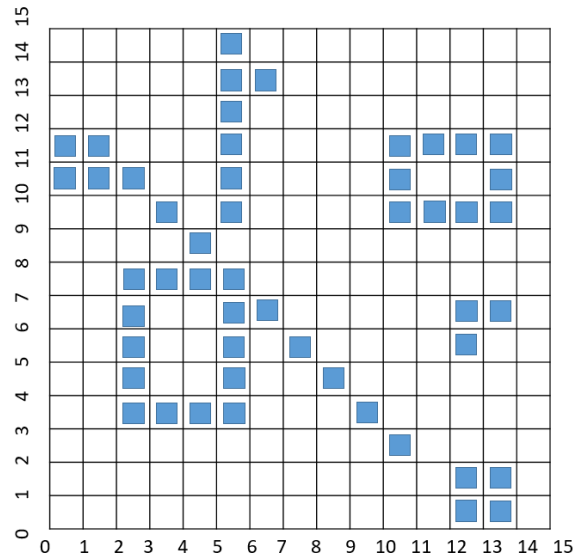
$X \oplus B$



$(X \oplus B) \ominus B$

Question 4 (10 marks)

- (a) In the Hough Transform, a point (x_0, y_0) in the xy -plane is mapped into a curve in the (ρ, θ) -parameter space. Write down the equation of the curve and explain the reason. (4 marks)
- (b) If we apply the Hough transform on the image below, what would be the maximum values for the accumulator cell in the (ρ, θ) space? What are the corresponding (ρ, θ) values. (6 marks)

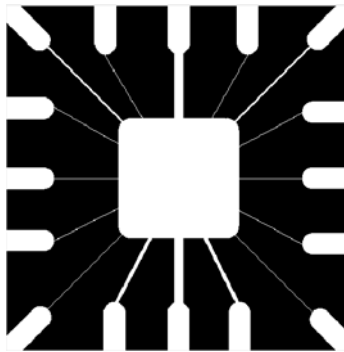


Solutions:

- (a) $x \cos(\theta) + y \sin(\theta) = \rho$
 (b) The maximum value is 11. There are two lines correspond to this values, with $\rho = 13/\sqrt{2}$, $\theta = \pi/4$ or $\rho = 5$, $\theta = 0$.

Question 5 (10 marks)

- (a) Given an image,



Please match the filter banks and the corresponding processing images, explain the reason.

2	-1	-1
-1	2	-1
-1	-1	2

(a)

-1	-1	2
-1	2	-1
2	-1	-1

(b)

-1	-1	-1
2	2	2
-1	-1	-1

(c)

-1	2	-1
-1	2	-1
-1	2	-1

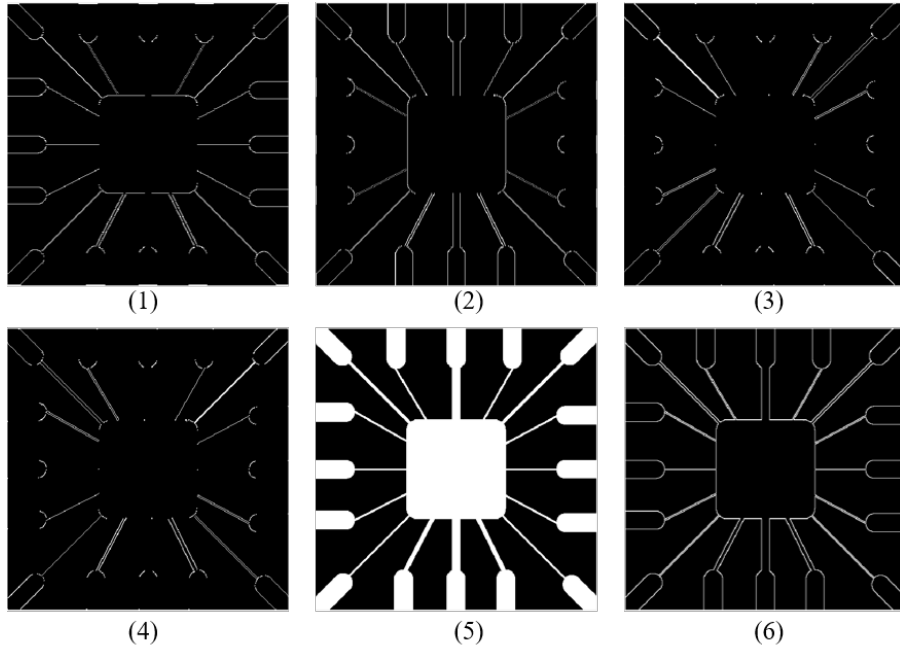
(d)

1	1	1
1	-8	1
1	1	1

(e)

1	1	1
1	1	1
1	1	1

(f)



Solutions:

Filter bank (a) -> image 3,
 Filter bank (b) -> image 4,
 Filter bank (c) -> image 1,
 Filter bank (d) -> image 2.
 Filter bank (e) -> image 6.
 Filter bank (f) -> image 5.