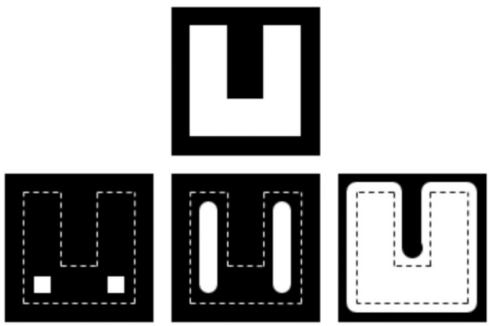
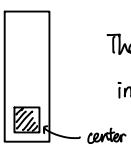
Question 1 (10 marks)
The following figure shows an image that has been corrupted by either salt noise or pepper noise. Is it salt noise or pepper noise? Given a choice of (1) arithmetic mean filter; (2) harmonic mean filter; and (3) contraharmonic mean filter, which one is most appropriate for this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

It is peper noise
To clear peper noise, ③ contraharmonic mean filter with positive dagree is the most appropriate filter to remove peper noise
For ① arithmetic mean filter, it will only blur the pepper noise, but not to remove it.
For ② harmonic filter, it can remove salt noise but not 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.



a) 

The original image erodes with the structuring element on the left side to obtain image ⓐ

b) 

The original image erodes with the structuring elements on the left hand side to obtain image ⓑ

c) 

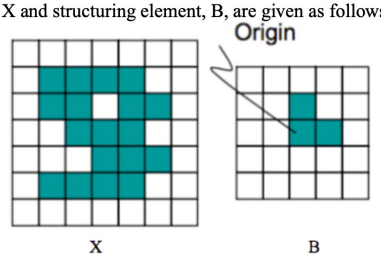
The original image dilates with the structuring elements on the left hand side to obtain image ⓒ

Question 3 (10 marks)

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

(a) Explain how erosion and dilation is performed. (2 marks)

(b) Binary image, X and structuring element, B, are given as follows

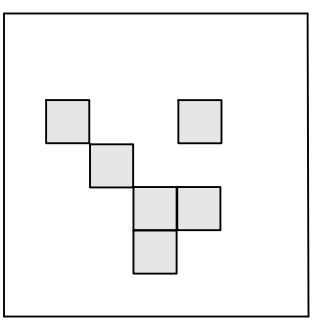


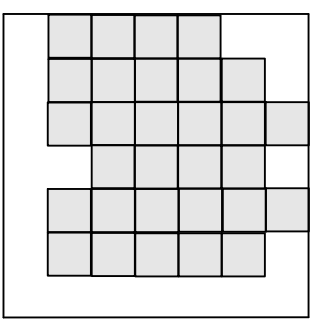
Calculate Y1= X⊖B, where ⊖ denotes the morphological erosion operator and Y2= X⊕B where ⊕ denotes the morphological dilation operator; (4 marks)

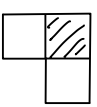
(c) Calculate the corresponding closing procedure. (4 marks)

a) Erosion is applying Fit to entire image
Dilation is applying Hit to entire image

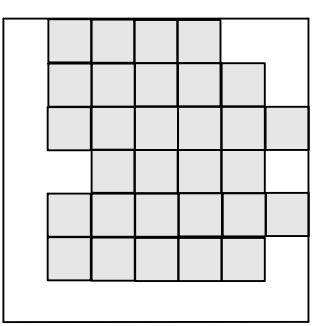
b) $Y1 = Y \ominus B$ $\quad Y2 = Y \oplus B$



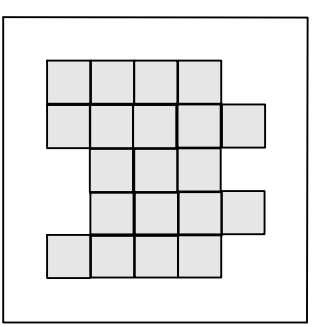




c) $Y3 = (Y \oplus B) \ominus B$



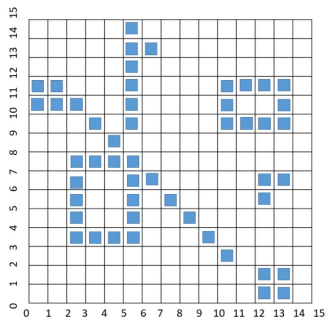
⇒



Question 4 (10 marks)

(a) In the Hough Transform, a point (x0, y0) 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)



a) $x(\cos\theta) + y(\sin\theta) = \rho$

b) Maximum Value : 11

$\rho = \frac{13}{\sqrt{2}}$ $\theta = \frac{\pi}{4}$ 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

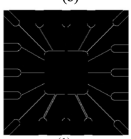
(d)

1	1	1
1	-8	1
1	1	1

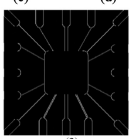
(e)

1	1	1
1	1	1
1	1	1

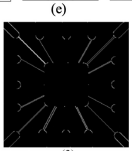
(f)



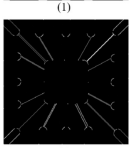
(1)



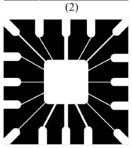
(2)



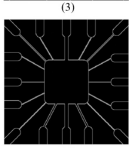
(3)



(4)



(5)



(6)

ⓐ – ③ $-45°$ degree

ⓑ – ④ $45°$ degree

ⓒ – ① Horizontal filter ∴ The horizontal line is more distinct

ⓓ – ② Vertical filter ∴ The vertical line is more distinct

ⓔ – ⑥ Line detection

ⓕ – ⑤ The graph is enhanced