



Mansoura University
Faculty of Engineering

Biomedical Engineering Program - Level 300

Exam Date: 11-5-2019

Allowed Time: 2 Hours

Attempt all questions. Assume any missed data. Full mark is 50

Q.1) Correct the errors, if any, in each of the following statements:

[10 Marks]

- إذا كانت الإجابة صحيحة، اكتب رقم الجملة وبجواره كلمة (True) فقط.
 - إذا كانت الإجابة خاطئة، اكتب رقم الجملة وبجواره كلمة (False) ثم اكتب الجملة كاملة في سطر جديد
- a. The more the spatial resolution, the more pixels are used to display the image.
 - b. In neighborhood processing, a pixel's grey value is changed without any knowledge of its surrounds.
 - c. Most filter masks are rotationally symmetric, so that spatial filtering and spatial convolution will produce the same output.
 - d. Low-frequency components are characterized by large changes in grey values over small distances.
 - e. The shifting property places the dc coefficient in the top right corner of the matrix.
 - f. Image restoration concerns the removal or reduction of degradations which have occurred during the acquisition of the image.
 - g. Periodic noise can be cleaned by using spatial domain techniques.
 - h. Median filtering seems almost tailor-made for removal of speckle noise.
 - i. Double thresholding brings out subtle features which single thresholding would be unable to do.
 - j. The human visual system is particularly attuned to two things: edges, and color.

Q.2.a) "On 15-4-2019, a structure fire broke out beneath the roof of Notre-Dame Cathedral in Paris. The building's spire had been destroyed and its upper walls were severely damaged". Suggest how can image processing help in the restoration stages of the beloved Cathedral? Is it possible to suggest an image processing system for fire detection? **[5 Marks]**



Q.2.b) Give a short answer to each of the following questions:

[15 Marks]

- "Image processing operations may be divided into three classes based on the information required to perform the transformation". Justify this statement. Give a block diagram realization for one of the three classes.
- "The Fourier transform is of fundamental importance to image processing". Justify this statement. Write a short note on the 'shifting' property.
- "Adaptive thresholding can be useful in many situations". Justify this statement. State the main applications of thresholding.
- "An appropriate use for the Laplacian is to find the position of edges by locating zero crossings". Define the terms 'Laplacian' and 'Zero crossing'. State the main steps of Marr-Hildreth method.
- "There are two methods that can be used in color processing". Compare between these methods using block diagrams only.

Q.3.a) "The image processing task required to detect colon cancer using a CT image is of vital importance". Justify this statement showing the importance of image processing in medical diagnosis. **[5 Marks]**



Q.3.b) Find the two strongest lines in the binary image shown below using two different methods.

[10 Marks]

		X						
		0	1	2	3	4	5	6
y	0	1	0	0	0	0	0	1
	1	0	1	0	0	0	1	0
	2	0	0	0	0	0	0	0
	3	0	0	0	1	0	0	0
	4	0	0	1	0	1	0	0
	5	0	0	0	0	0	1	1
	6	1	0	0	0	0	0	0

Q.3.c) Suppose a 4-bit grey-scale image has the following grey values distribution:

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
n_i	10	50	100	45	80	40	20	10	0	0	0	0	0	0	0	5

- Sketch the histogram of this image. What do you expect about the appearance of this image?
- Use histogram stretching to improve the appearance of the image. Sketch the result.

Hint: Use the following stretching function: $j = \frac{14-2}{7-1}(i-1)+2, 1 \leq i \leq 7$

[8 Marks]

☺ Best wishes ☺

Assoc. Prof. Hosam El-Din Moustafa

Model Answer

معالیه صر

بسم الله الرحمن الرحيم

Q.1)

$(1 \times 1) \rightarrow 1 \times M$

a. [true]

b. [False] \rightarrow in point processing, a pixel's grey value is changed without any knowledge of its surrounds

c. [true]

d. [False] \rightarrow high Frequency Components are characterized by large changes in grey values over small distances

e. [False] \rightarrow The Dc properly places the dc Coefficient in the top ~~left~~ ^{Left} Corner of matrix

f. [true]

g. [False] \rightarrow Periodic noise can be cleaned by using Frequency Techniques

h. [False] \rightarrow Median Filtering seems almost tailor made for removal of Salt and pepper

i. [True]

j. [True]

Q.2a)

(5 M)

✓ by acquiring old images of the Cathedral and those images would be processed then filtered from noise then Segmentation Process then presentation and description then recognition and interpretation.

✓ Yes, it is possible by using fire detection algorithms that is compatible with CCTV and wireless cameras. These algorithms uses RGB Colour model to detect the colour of fire which is mainly red.

* Preprocessing

* Image restoration

* Segmentation

→ Thresholding

→ edge detection

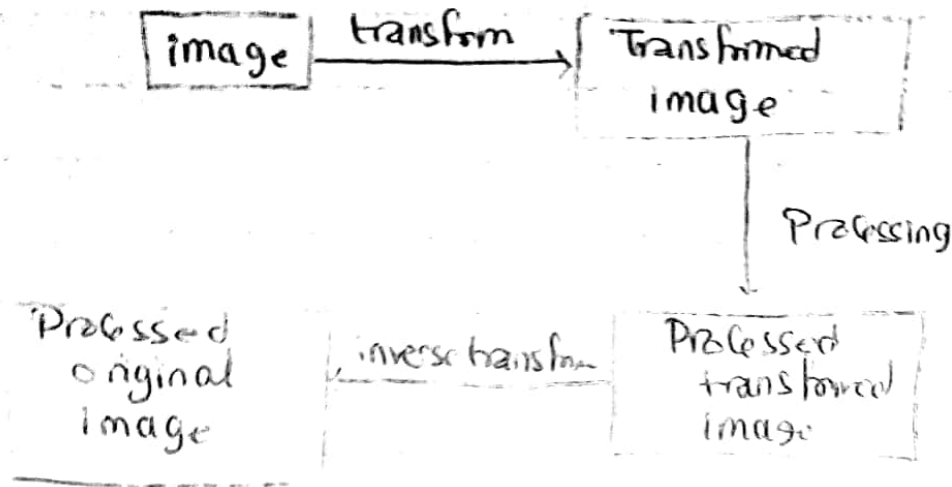
* Color image processing

Q2.b

(3M)

a)

1. Transform \rightarrow A Transform presents the pixels in any form, but it's equivalent



2. Point Processing \rightarrow a pixel's grey value is changed without any knowledge of its Surrounds

3. neighborhood processing \rightarrow To change grey level of a given pixel you must know the grey level of small neighborhood pixels around it

(3 M)

b.

1. it allows us to perform tasks that would have been impossible
2. it allows us to perform tasks quickly
3. it allows us to isolate certain image frequencies
4. perform low, high pass filters with great precision
5. Powerful alternative for spatial filter
6. it's efficient to use Fourier transform than spatial filter for a large filter

Shifting \Rightarrow it's convenient to have the dc coefficient in the center of the matrix.

A	B
C	D

FFT

D	C
B	A

After Shifting

C. Adaptive thresholding:

(3M)

Some times it is not possible to obtain a single threshold that would isolate the object completely. This may occur if both the background and object vary.

- 1- When we want to remove unnecessary details to focus on essential.
- 2- When we want to remove varying backgrounds. Background and changing.
- 3- To bring out hidden details.

d-

(3M)

Laplacian: It is the sum of second derivative in both directions.

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

It can be implemented using filter

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

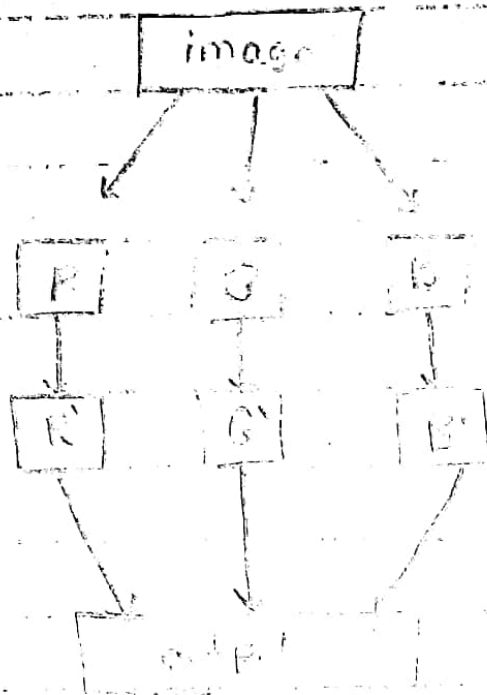
Zero Crossing → It can be defined as either of the following.

- 1- They have a negative value next to a pixel with positive value.
- 2- They have a zero value between positive and negative valued pixels.

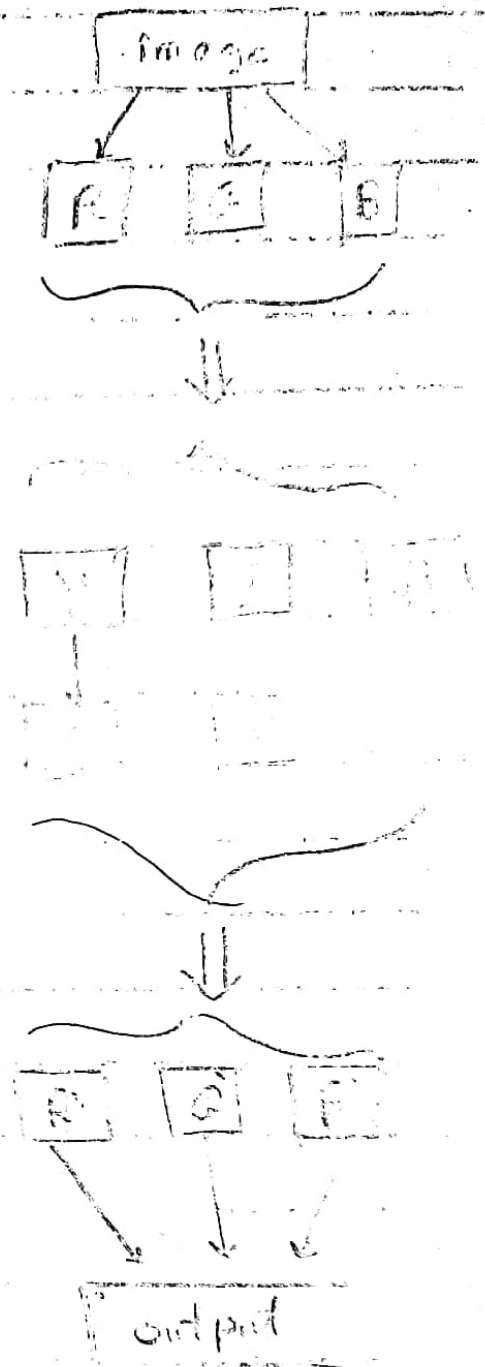
Tarr-Hildreth method:

- 1- Smooth the image by Gaussian filter.
- 2- Convolve the result using Laplacian.
- 3- Find the Zero Crossing.

(3M)



RGB processing



intensity processing

Q3 a)

1. it's important in inspection of images obtained from
x-ray, ~~MRI~~, CAT Scans

(2) M

2. analysis of cell image

1- acquiring image

2- processing

3- Segmentation

4. Presentation and description

(Feature extraction)

5. recognition and interpretation

(classification)

(3) M

Q.3.b

method one

$$y = ax + b$$

(5M)
(پانز م)

1. $(0, 0) \rightarrow 0 = b$
2. $(6, 0) \rightarrow 0 = 6a + b$
3. $(1, 1) \rightarrow 1 = a + b$
4. $(5, 1) \rightarrow 1 = 5a + b$
5. $(3, 3) \rightarrow 3 = 3a + b$
6. $(2, 4) \rightarrow 4 = 2a + b$
7. $(4, 4) \rightarrow 4 = 4a + b$
8. $(5, 5) \rightarrow 5 = 5a + b$
9. $(6, 5) \rightarrow 5 = 6a + b$
10. $(0, 6) \rightarrow b = 6$

② M

① M

Point $(1, 0)$ ① M
Point $(-1, 6)$

$y = x$ line ① M

$y = 6 - x$ line ① M

Method Two

sinusoidal (5M)

$$x \cos \theta + y \sin \theta = r$$

$$\theta = -90, -45, 0, 45, 90$$

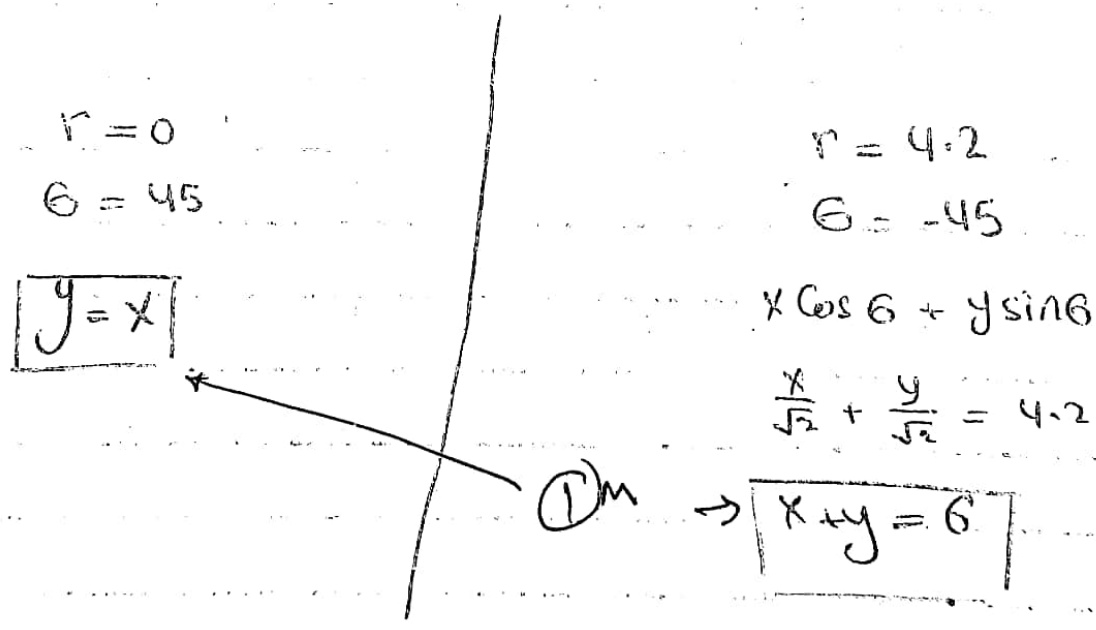
Step $\rightarrow 45$

x, y	-90	-45	0	45	90
(0,0)	0	0	0	0	0
(6,0)	0	4.2	6	4.2	0
(1,1)	-1	0	1	1.4	1
(5,1)	-1	2.8	5	4.2	1
(3,3)	-3	0	3	4.2	3
(2,4)	-4	-1.4	2	4.2	4
(4,4)	-4	0	4	5.6	4
(5,5)	-3	0	5	7.07	5
(6,5)	-5	0.7	6	7.7	5
(0,6)	-6	-4.2	0	4.2	6

(2)M

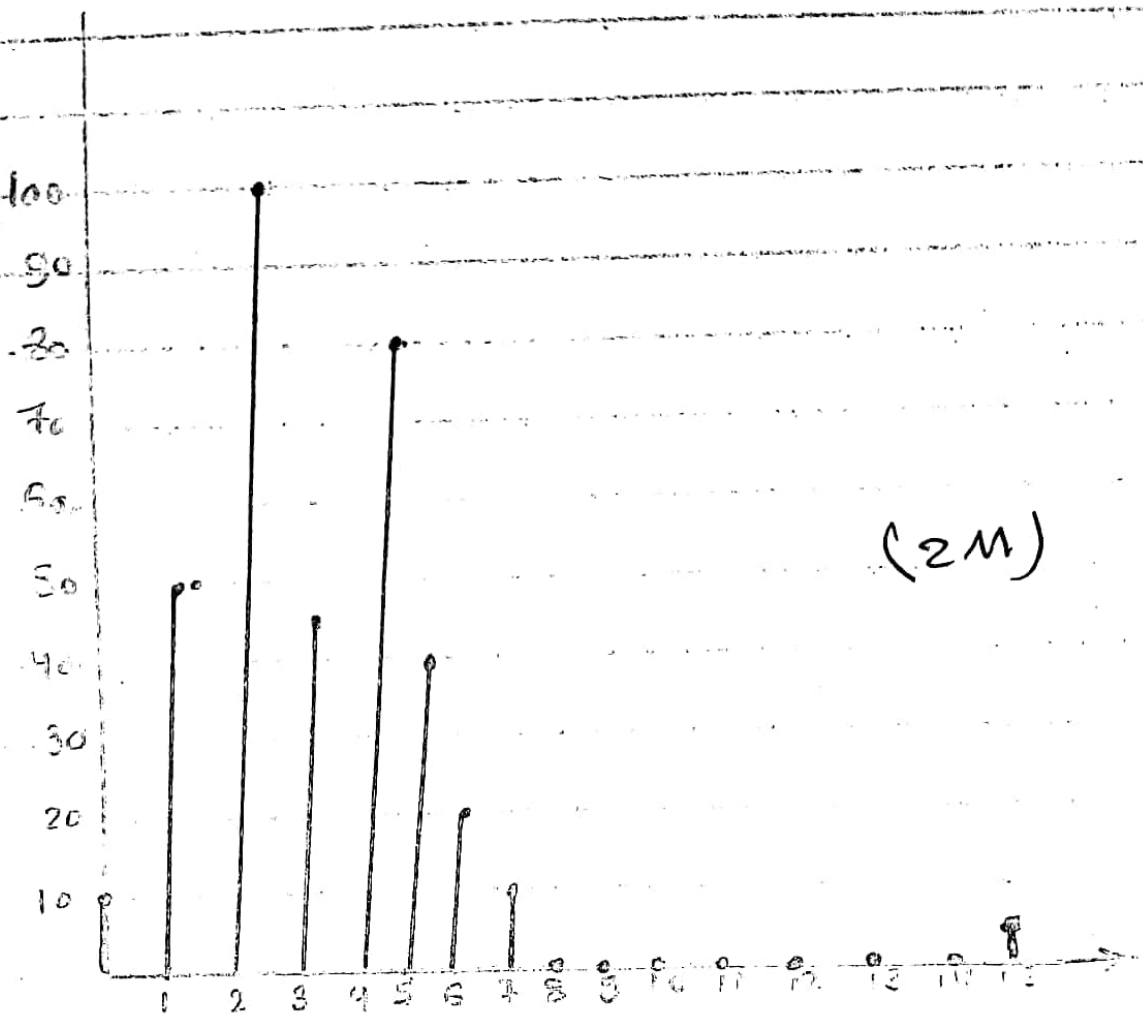
θ	-6	-5	-4.2	-4	-3	-1.4	-1	0	0.7	1	2	2.8	3	4	4.2	5	5.66
-90	1	2	0	2	1	0	2	2	0	0	0	0	0	0	0	0	0
-45	0	0	1	0	0	1	0	(5)	1	0	0	1	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0
45	0	0	0	0	0	0	0	1	0	0	0	0	0	(5)	0	1	0
90	0	0	0	0	0	0	0	0	2	0	2	0	0	1	2	0	1

(2)M



Q3.C

i)



Poorly Contrasted (dark) (1M)

$$j = 2(i-1) + 2 \quad 1 \leq i \leq 7$$

$$i=1 \rightarrow j=2$$

$$i=2 \rightarrow j=4$$

$$i=3 \rightarrow j=6$$

$$i=4 \rightarrow j=8$$

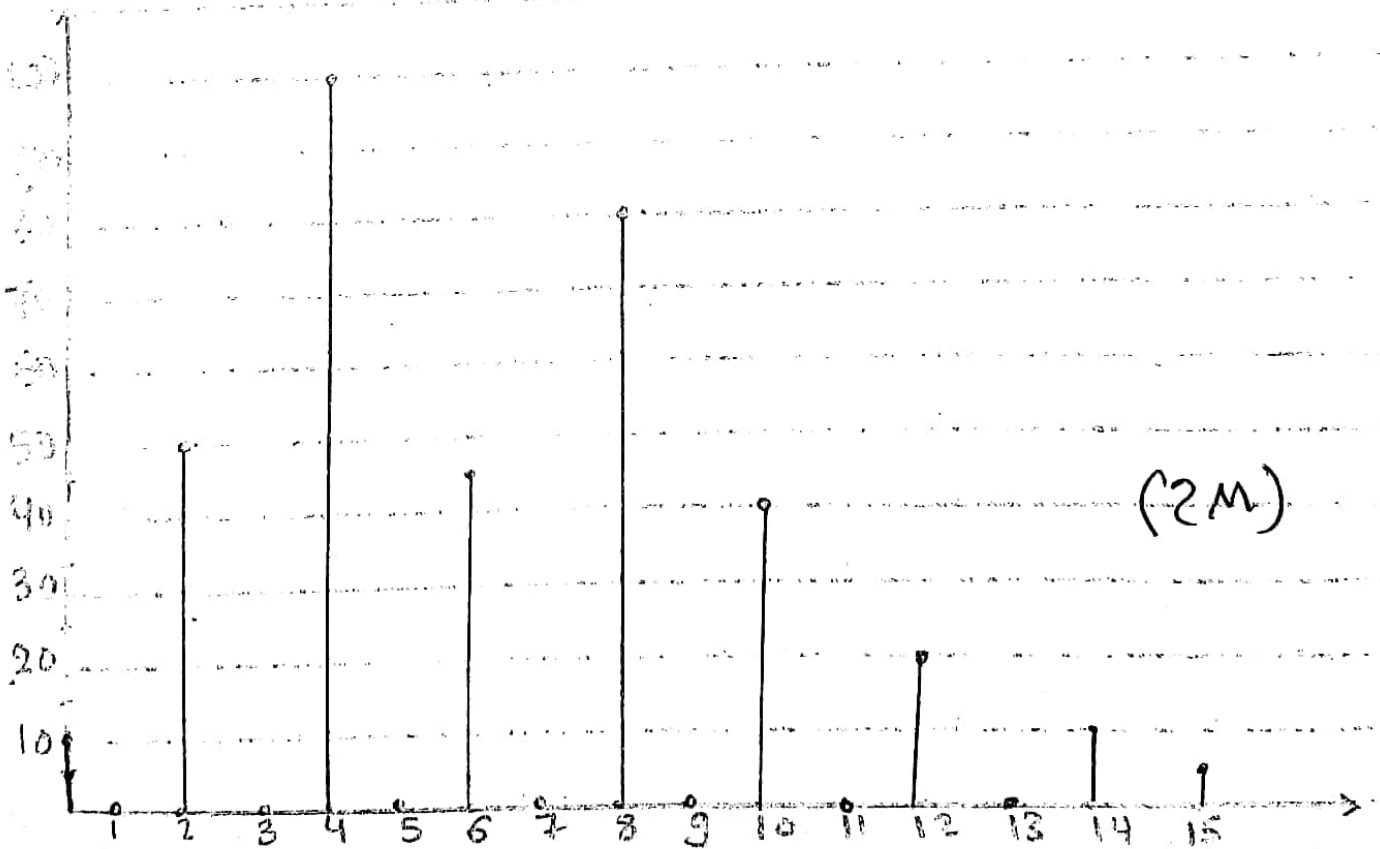
$$i=5 \rightarrow j=10$$

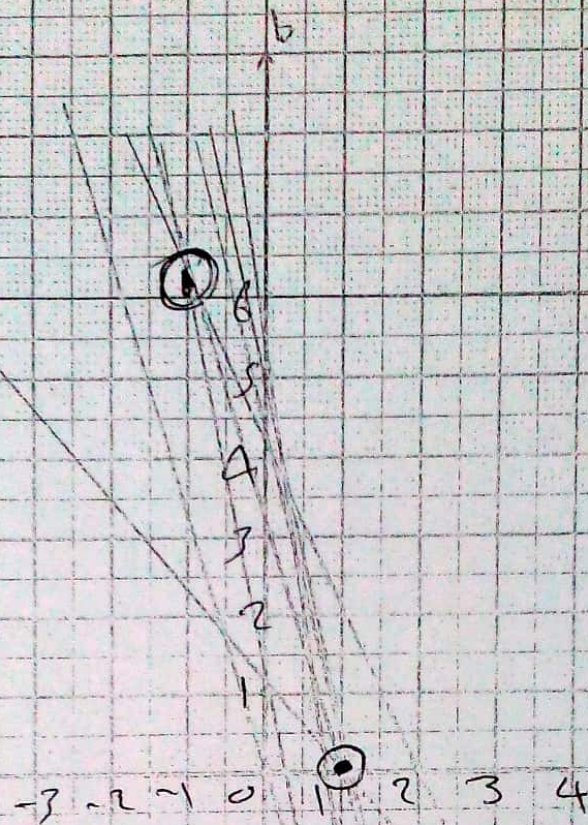
$$i=6 \rightarrow j=12$$

$$i=7 \rightarrow j=14$$

(3M)

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
n	10	0	50	0	100	0	45	0	20	0	40	0	20	0	10	5





point $\rightarrow (1, 0)$
point $\rightarrow (-1, 6)$

line ① $\rightarrow y = x$

line ② $\rightarrow y = 6 - x$