The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Egineering

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX5314 /DMX5571 Machine Vision**
Academic Year	:	2021/2022
Date	:	30th January 2023
Time	:	09.30-12.30
Duration	:	**3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Six (6)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. Answers should be in clear handwriting.
7. Do not use Red colour pen.

Question 01

a) Discuss ***Human vision*** vs. ***Machine vision*** considering Decision making, Speed of response and Quality of measurements.

b) Using suitable drawings to support to your answer discuss ***Back lighting*** and ***Front lighting***.

c) Briefly explain **Quantization error** and **Measurement error** in the context of machine vision.

d) What are the two categories of data processing used in image processing algorithms?

e) Discuss the use of image ***Addition***, ***Subtraction*** and ***Multiplication***.

Question 02

Presence of noise in digital images is one of the major barriers which make image analysis process difficult.

a) What is the **noise** in digital images? Give **three reasons** for the presence of noise in digital images.

b) Briefly explain two categories of noises available in digital images.

c) Name three **mechanisms** which can be used to remove noise.

d) Name and explain three **filters** which can be used to remove noise in images.

e) Figure Q2 shows X-ray image of brain which contains a large amount of salt and pepper noise. For a project assume that it is required to segment the tumor from the image. Explain the necessary steps that needed to be followed in order to remove the noise in Figure Q2(a) and segment the tumor and obtain an image similar to the image shown in Figure Q2(b)

Figure Q2(a)

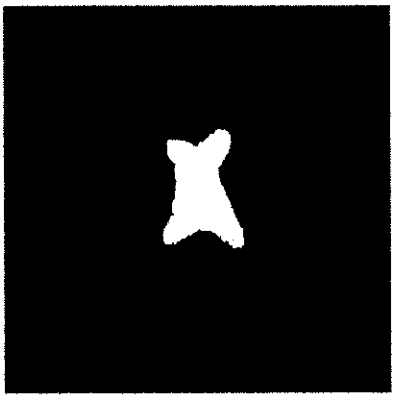


Figure Q2(b)

Question 03

A photographer has taken the image below, at night. 0 corresponds to black and 15 to white. In this image we can recognize one bright house in the left (the pixel with gray levels >= 8) and the moon on the right (the pixels with grey level =<6 and >=2). We need to extract clear region of the moon.

0	0	1	0	0	0	2	3	0
0	8	0	0	0	5	4	6	3
9	14	9	0	0	3	4	4	2
5	12	10	0	0	0	2	2	0
11	13	13	0	1	0	0	0	0

a) Plot the **histogram** for this image.

b) Design a **point processing** letting the moon unchanged and transforming the house and the background to black. You are supposed to provide the function and the new image matrix after the point processing operation.

c) Plot the **histogram** of inverse of the image transformed after b)

d) Apply grey level reduction operator to the original image to output an image which has only 3 grey levels. Write the necessary function and mention the intervals to be used. What is the new image matrix?

Question 04

a) Design with the aid of structured lighting, a computer vision-based system to measure the depth of the groove of a channel shown in figure Q4. Use an appropriate sketch to illustrate your method.

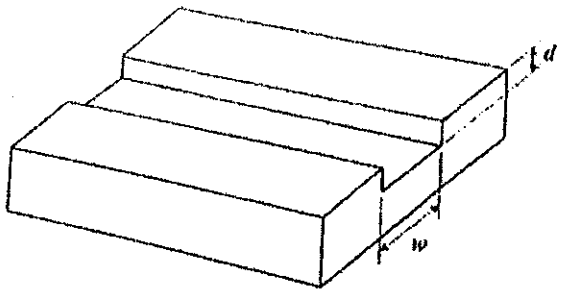


Figure Q4

b) Consider an automated vision-based system for dimensional measurement. The system setup has an object view is a 4 cm by 4 cm square. The solid-state sensor is a 512 by 512 array arranged in a 0.8 cm by 0.8 cm square. If the required tolerance of the measurement is 20 μm, determine whether this system setup is suitable. Explain your answer.

c) Consider a surface inspection system using a microscope. The vision system has a 256 by 256 sensor array, arranged in a 0.8 cm by 0.8 cm square, the lens has a f-stop of 16 and a magnification of 10. Determine whether the system can be used to inspect surface irregularities with maximum height of 0.05 mm. Explain your answer.

Question 05

a) Briefly explain ***Morphological filtering***

b) Prove the **Decomposition theorem** given below using the binary images shown in Figure Q5(a)

$$(A \cap B) \ominus K = (A \ominus K) \cap (B \ominus K)$$

[Note: Submit your results in the sheet provided for Figure Q5(a) along with the question paper]

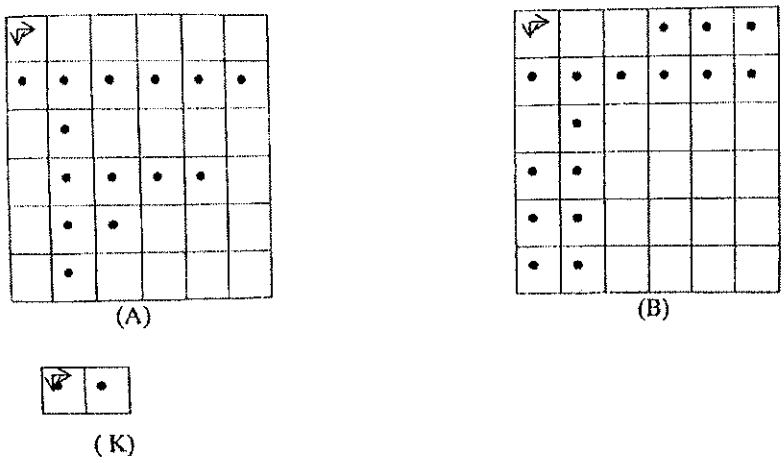


Figure Q5(a)

c) Figure Q5(b) shows a digital binary image A, and two structural elements B and C. Determine the results of the following morphological operations.

I. $(A \ominus B) \ominus C$

II. $A \ominus (B \oplus C)$

III. What conclusions can be drawn from the results of parts (I) and (II).

IV. Find the result of $(A \ominus C)$. Explain the importance of expected result?

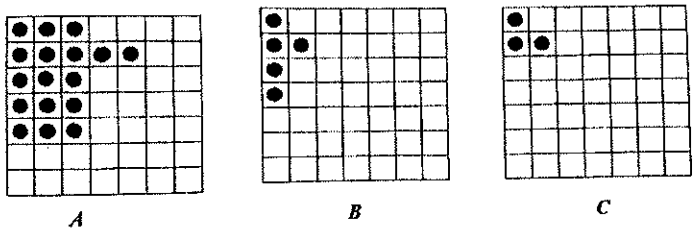


Figure Q5(b)

[Note: Submit your results in the sheet provided for Figure Q5(b) along with the question paper]

Question 06

Expanding and shrinking operators are most important in image processing algorithms. The primary application of morphology occurs in binary images, though it is also used on gray level images. The two basic morphological set transformations are erosion and dilation.

a) Define **erosion** and explain the importance of the erosion operator.

b) Explain a suitable process for the extraction of the border of the image shown in figure Q6.

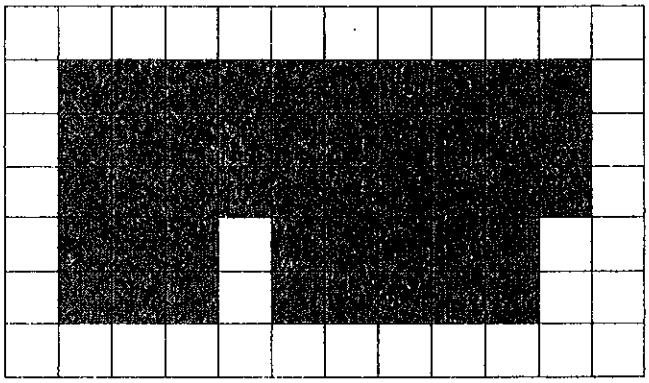
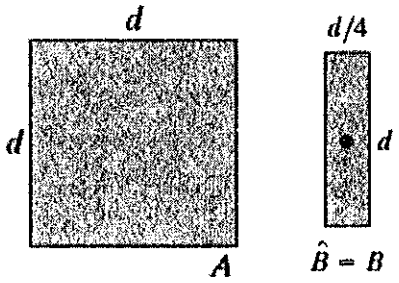


Figure Q6

c) Show the result after dilation of object A by structural element B.



d) Define "Hit-and-Miss Transform" and briefly explain importance of this transform.

Question 07

a) Define an **edge** (with respect to digital images).

b) Name **three techniques** which can be used for edge detection and explain two of them.

c) What is **Canny's operator**?

d) Explain main components and steps of **Canny's operator**.

a) Sketch the first and second derivative profiles of image shows in figure Q7

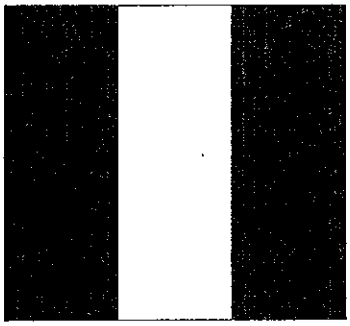


Figure Q7

Question 08

a) Given the 3-bit 4×4 image is shown in figure Q8(a). Preform the histogram equalization and find the resulting image.

0	3	1	6
0	0	1	7
4	6	3	1
3	3	2	7

Figure Q8(a)

b) Figure Q8(b) represent a gray-level probability density function of an image $P_1(Z)$ corresponds to objects and $P_2(Z)$ corresponds to the background. Find the optimal threshold between object and background pixels. Note that $P_1 = P_2$

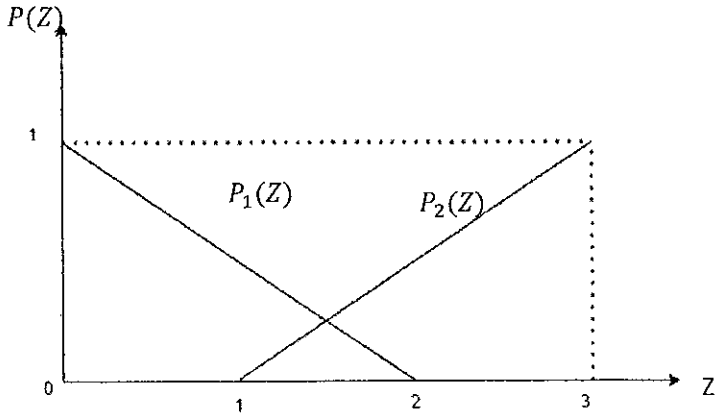
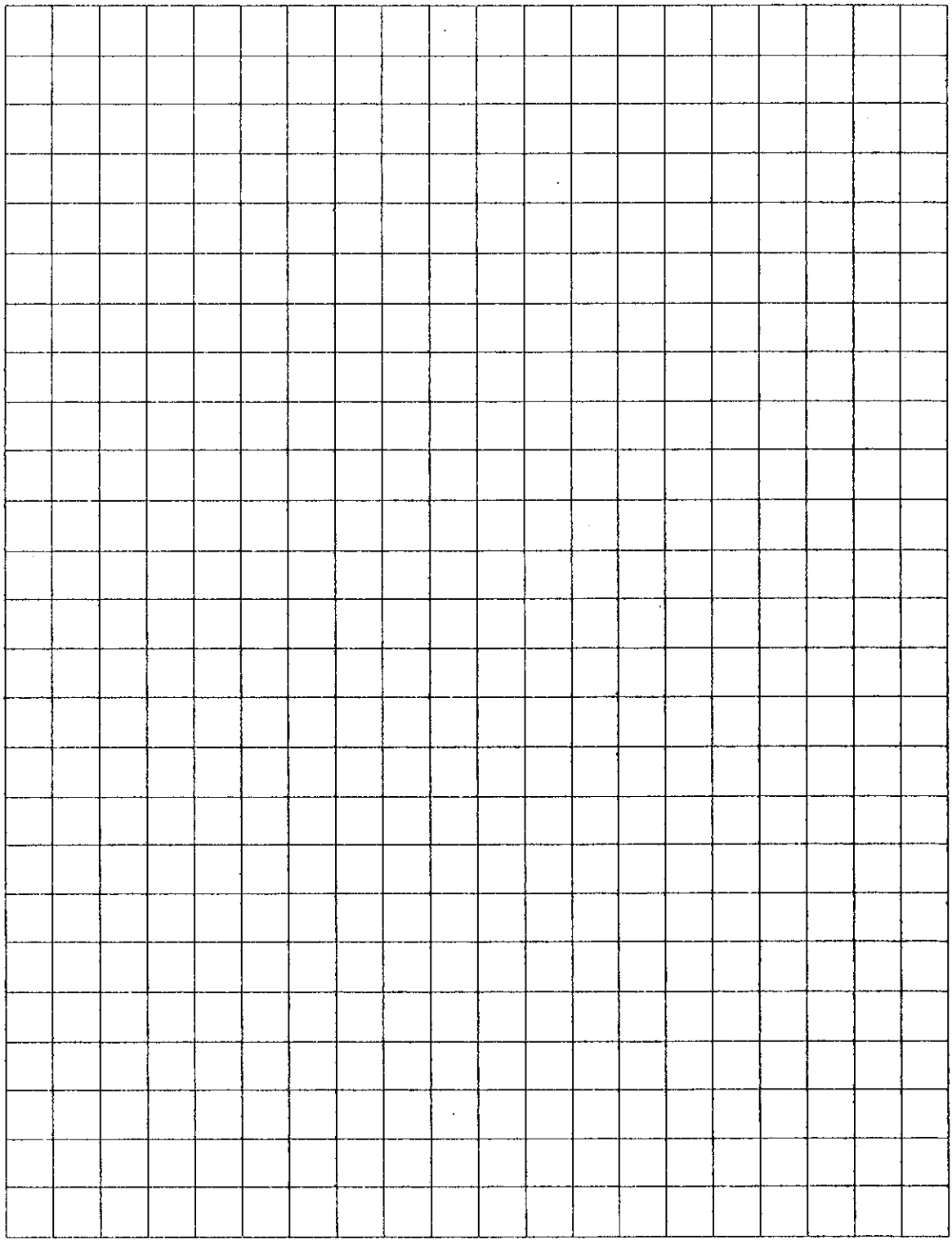


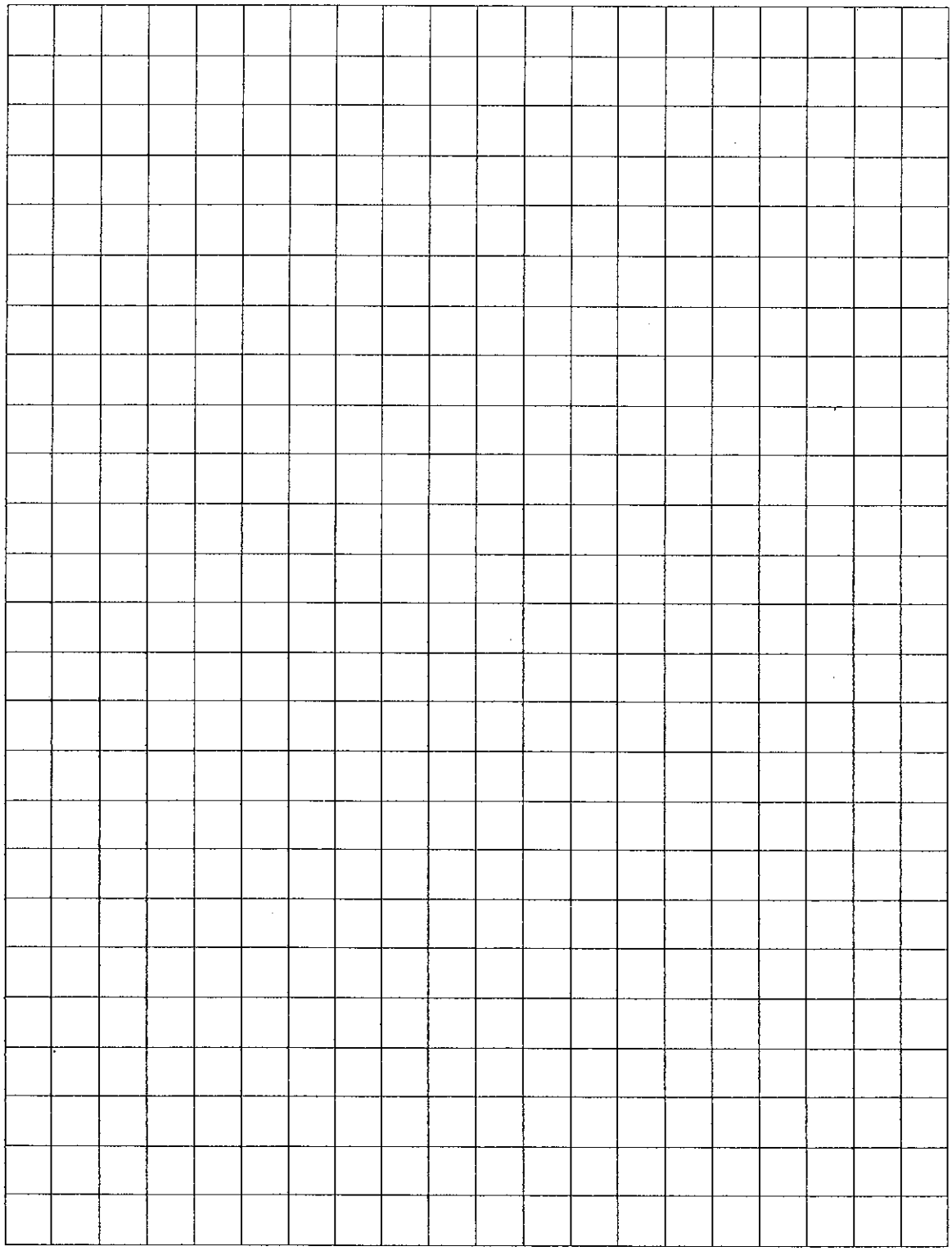
Figure Q8(b)

Index No:



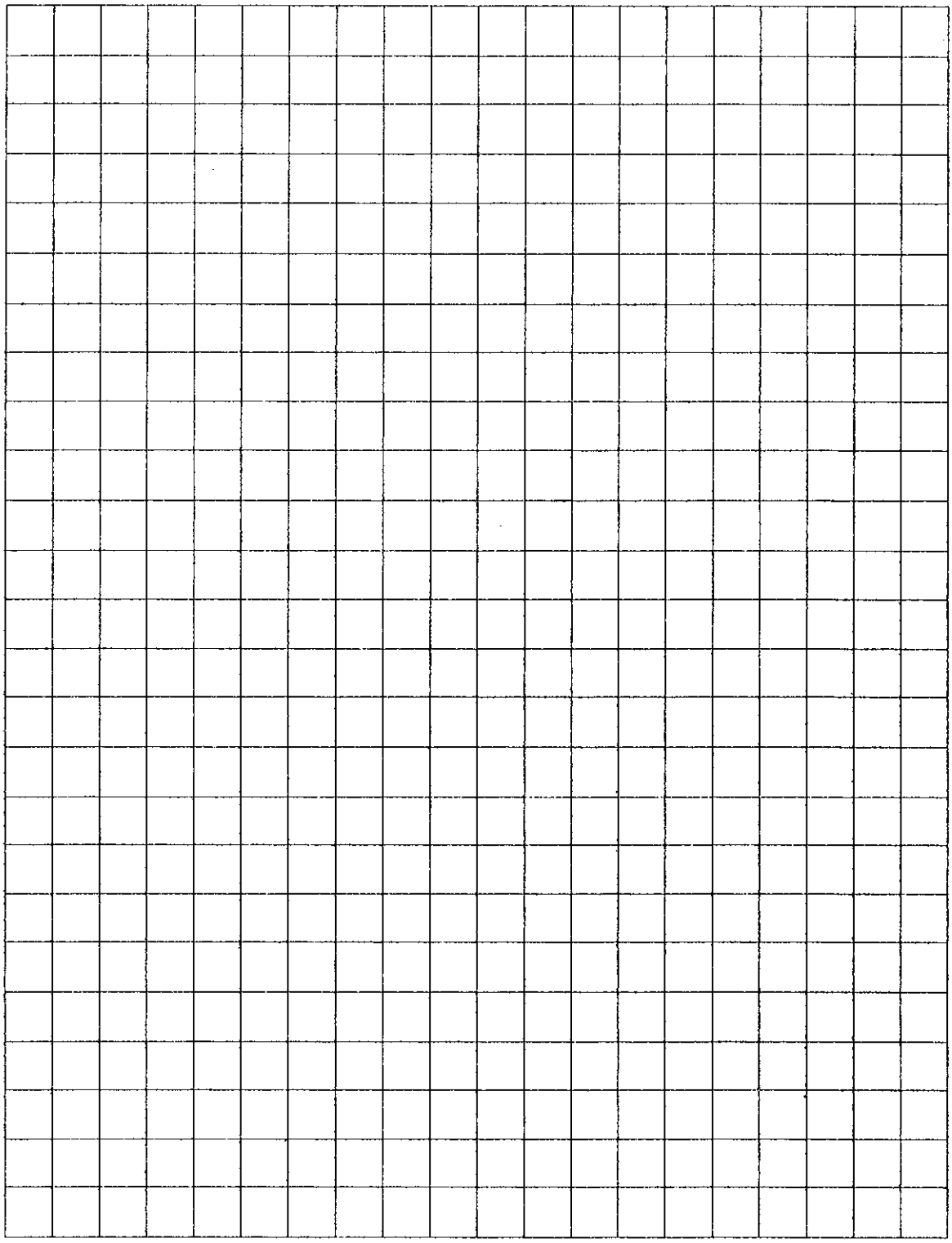
Note: Please use this sheet to answer the question related to Figure Q5(a)

Index No:



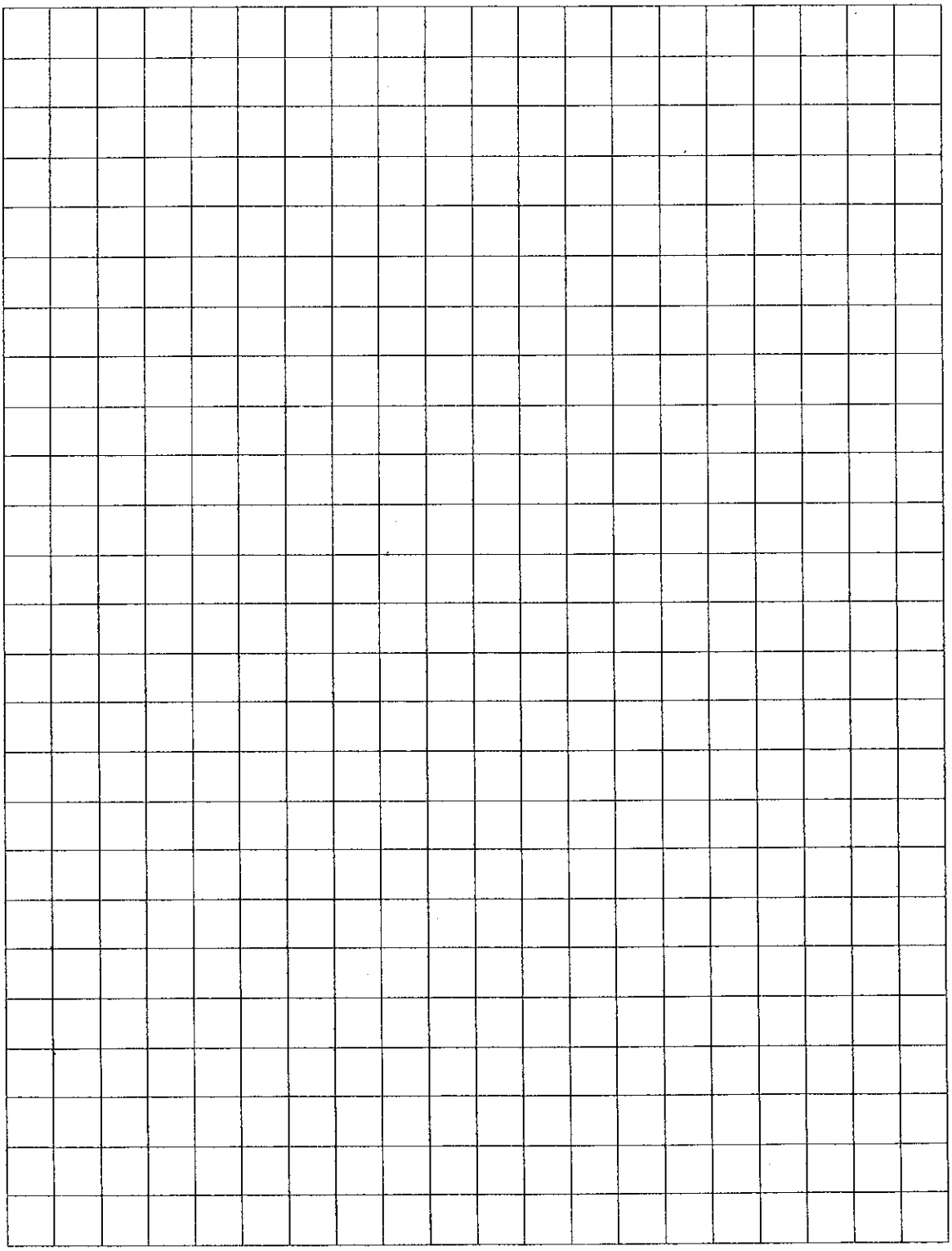
Note: Please use this sheet to answer the question related to Figure Q5(a)

Index No:



Note: Please use this sheet to answer the question related to Figure Q5(b)

Index No:



Note: Please use this sheet to answer the question related to Figure Q5(b)