

**Answer TWO questions only**

**The figures in brackets indicate the provisional allocation of maximum marks per sub-section of a question.**

1. Describe the transformation which occurs when a general local neighbourhood operator is applied to a grey-level image. Include both a diagram and a mathematical statement in your answer. **[4 marks]**

Describe in detail the Laplacian operator as it is applied to a digitised image, and explain its effect on areas containing

- [a] uniform grey level values
- [b] a junction between two uniform areas of different grey levels
- [c] a single line of higher pixel values on a uniform background
- [d] a single pixel of lower value than the background

**[8 marks]**

Calculate the effect of the Laplacian operator on the data shown below. Explain how you have dealt with points near the edge of the image area. **[4 marks]**

5	5	5	2	2	2	1	1	1	1
5	5	5	2	2	1	1	1	1	1
5	5	5	2	1	1	1	5	1	1
2	2	2	1	2	1	1	1	1	1
2	2	1	1	1	2	1	1	1	1
2	1	1	1	1	1	2	1	1	1
1	1	1	1	5	1	1	2	1	1
1	1	1	5	5	1	1	1	2	1
1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1

Convolution with a Gaussian and spatial averaging are both grey-level operators. Using a one-dimensional data set as illustration, show the relationship between them. **[4 marks]**

2. State the purpose of the linear Hough transform. Between which two representations of data does the transform operate? **[3 marks]**

Using a flowchart, give an algorithm to locate the boundary of a rectangular object in a noisy image. Your algorithm must use the Hough transform as its central step. **[5 marks]**

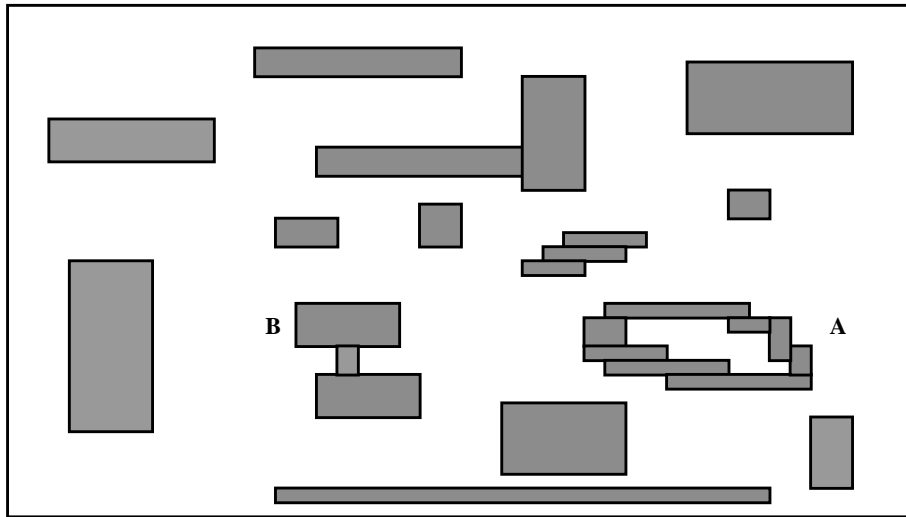
Give a full explanation of the Hough transform itself. **[5 marks]**

Explain, in general terms, each additional operator you use in the algorithm and illustrate its effect. **[7 marks]**

3. The binary image shown below is an example of one which contains objects of different sizes. Describe how you could use the techniques of (binary) morphology to construct a histogram of the object sizes in such an image. **[3 marks]**

Explain and illustrate any morphological operations you refer to. **[4 marks]**

Suggest techniques which might help you to deal rationally with the objects marked (A) and (B). **[3 marks]**



Which aspects of object size would be represented in your histogram, and which would be ignored? **[2 marks]**

Explain the process of binary skeletonisation using the Levaldi masks, and illustrate your answer with suitable sketches. **[5 marks]**

Two of the Levaldi masks are shown here. Derive the full set of masks from these, and explain how you have done so.

0	0	X
0	1	1
X	1	X

0	0	0
X	1	X
1	1	X

**[3 marks]**