Candidates are admitted to the examination room ten minutes before the start of the examination. On admission to the examination room, you are permitted to acquaint yourself with the instructions below and to read the question paper.

Do not write anything until the invigilator informs you that you may start the examination. You will be given five minutes at the end of the examination to complete the front of any answer books used.

May/June 2012 **SE3IA11 2011/12 A 001**

2 Answer Books
Calculators not permitted

UNIVERSITY OF READING

IMAGE ANALYSIS (SE3IA11)

One and a half hours

Answer **TWO** questions, **ONE** from **EACH** Section.

Use a separate Answer Book for **EACH** Question.

SECTION A

(Answer ONE question from this Section)

1. (a) Explain what is meant by spatial domain enhancement. Give TWO examples of spatial domain enhancement in image analysis. (5 marks)

(b) Histogram equalisation is an application of spatial domain enhancement. Consider a 5x5 grey image with 8 bit integer grey levels as shown below:

76	79	77	97	76
78	76	85	94	88
81	77	90	98	90
98	85	93	99	92
99	89	99	99	78

Derive the histogram equalised version of this image. Your answer should include derivation of the cumulative distribution function (cdf) and its application to derive the resulting image. Note: your answer only needs to show how ONE of the resulting image pixel intensities is computed. (10 marks)

(c) What is a 'binary code'? Consider the same 5x5 grey image given in (b) which has grey levels restricted to the range 76 to 99 inclusive. Explain how this restriction can be the basis of a code for compressing the image. (5 marks)

(d) How does video compression relate to image compression? Why are practical image *and* video compression methods lossy? (5 marks)

2. (a) Explain why edge detection is useful for image analysis. (5 marks)

(b) State with reasons why low pass filtering is a useful precursor to performing edge detection. How is low pass filtering performed in practice? (5 marks)

(c) Consider the following grey level image.

0	0	0	200	200	200
0	0	0	200	200	200
0	0	0	200	200	200
0	0	100	200	200	200
0	100	100	100	200	200
100	100	100	100	100	200
100	100	100	100	100	100

Explain why this image may cause difficulties for the Canny edge detection algorithm and suggest one way in which these difficulties might be overcome. (5 marks)

(d) The Hough Transform is a feature extraction method used in image analysis which utilises edge information. Describe in detail how the Hough Transform could be applied to identify cells present in an image of a microscope slide. Include details of how the algorithm is implemented in practice. (10 marks)

SECTION B

(Answer ONE question from this Section)

3. (a) Give the definition of digital image sampling. Explain how the image sampling affects image quality. (6 marks)

(b) In a binary image with objects in Set{1} and background in Set{0}. Sketch object A with elements

$$A = \{(1,1),(2,1),(3,1),(1,2),(2,2),(3,2),(2,3),(3,3),(4,2)\}$$

in an integer space Z^2. Work out how to extract the edge of the object by using mathematical morphology. Show your work step by step. (9 marks)

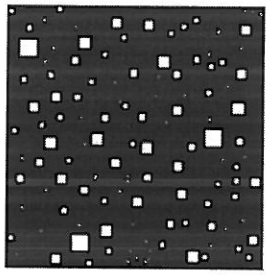
(c) In a photo shop, a request to process a digital image shown in the following figure is to colour the moon-shape grey patch with the tri-chromatic coefficients of $r = 0.5$ and $g = 0.4$.
Design algorithms which can automatically:

- Segment the moon-shape grey patch; and
- Assign values of Red, Green, and Blue to the identified patch with the requested colour.

State any assumptions you make in your answer, and justify your answer. (10 marks)

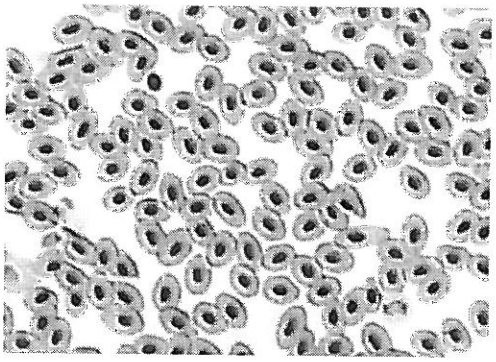
4. (a) For two pixels z_1, z_2 with coordinates (46, 55) and (260, 178), respectively, in a digital image, give the definition of the Euclidean distance between z_1 and z_2, and calculate the D_4 and D_8 distance between the two pixels. (6 marks)

(b) In a binary image, as shown in the following figure, there are squares of sizes 1, 5, 9, 13 and 17 pixels on the side. It is desired to only keep squares of size 9×9 in the binary image. Design morphology algorithms to achieve this. Show your work step by step.



(9 marks)

(c) A digital image was captured by a microscope showing blood cells (see the following figure). Design algorithms which can automatically count the number of cells presented in the image. Explain how these algorithms work for the purpose.



State any assumptions you make in your answer, and possible flaws of the final result. (10 marks)

(End of Question Paper)