

Name: \_\_\_\_\_

Student Number: \_\_\_\_\_

MCMMASTER UNIVERSITY MIDTERM EXAMINATION  
PART I

CompEng 4TN4: Image Processing

Instructor: Dr. Xiaolin Wu

Date: February 24, 2015

Duration: 45 Minutes

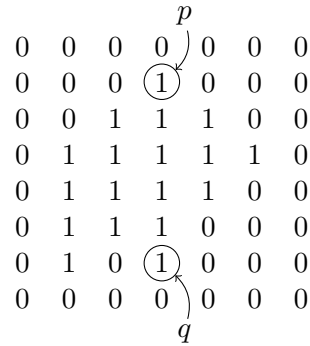
**Note:**

1. This is an open book exam. You can use the textbooks, lecture notes and other written materials.
2. You can use a calculator. However, laptops and cell phones are not allowed.
3. Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page.
4. This exam has 4 pages, including 4 questions for a total of 65 points. You are responsible for ensuring that your copy of the test is complete.
5. Answer all questions and good luck!

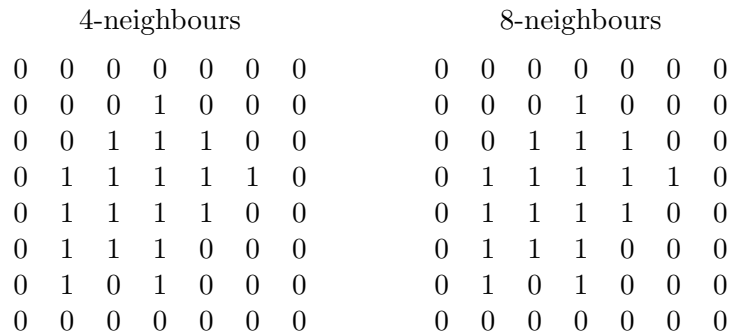
For instructor's use:

Question:	1	2	3	4	Total
Points:	20	10	20	15	65
Score:					

1. Let  $R$  be a subset of pixels in an image. We call  $R$  a region of the image if  $R$  is a connected set. The boundary of a region  $R$  is the set of pixels in the region that have one or more neighbours that are not in  $R$ . In the following image, all pixels with value “1” constitute a region.



- [8] (a) Mark the boundary pixels of the region in the sense of 4-neighbours and 8-neighbours respectively in the images below.



- [6] (b) A boundary image is a binary image where “1” represents a boundary pixel and “0” represents a non-boundary pixel in the original image. In the boundary image in the sense of 4-neighbours, what are the  $D_8$  and  $D_m$  distances between points  $p$  and  $q$ ?

- [6] (c) In the boundary image in the sense of 8-neighbours, what are the  $D_4$  and  $D_m$  distances between points  $p$  and  $q$ ?

- [10] 2. When reading a medical image, a physician is interested in fine textures of an organ. The organ has a gray scale range  $[a, b]$ . Design a transfer function to assist the physician in the diagnosis.

- [20] 3. Consider the image below. Show the results of  $3 \times 3$  median filtering if the following masks are used. A "0" in a mask position means that the corresponding pixel is not used for median calculation.

$$\begin{array}{cccc} 3 & 5 & 8 & 4 \\ 9 & 1 & 2 & 9 \\ 4 & 6 & 7 & 3 \\ 3 & 8 & 5 & 4 \end{array}$$

(a)  $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

(b)  $\begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$

(c)  $\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$

(d)  $\begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

- [15] 4. Consider the histogram (2, 2, 4, 8, 16, 32, 64, 128), where the number of gray levels is 8. What is the output histogram of histogram equalization? Explain using the result how histogram equalization enhances the contrast of an image.