THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

2009 SCHOLARSHIP EXAMINATION

WRITTEN SECTION

DEPARTMENT	Computer Science
PAPER TITLE	Computer Science Scholarship
TIME ALLOWED	Two Hours
NUMBER OF QUESTIONS IN PAPER	Fourteen
NUMBER OF QUESTIONS TO BE ANSWERED	Fourteen
VALUE OF EACH QUESTION	The value of each question is indicated.
GENERAL INSTRUCTIONS	Candidates are to answer ALL questions in the answer booklet provided
SPECIAL INSTRUCTIONS	None
CALCULATORS PERMITTED	Yes

Section A
Computing Concepts

1. A 32 bit binary storage location can be used either to store just positive values, or a range of both negative and positive values. In each case what range of values is possible? Explain. Your explanation should state what method of representing negative values you are assuming.

(5 marks)

2. Subtract the eight bit binary number 00001011 from 00001101. Show your work, including carry bits.

(5 marks)

3. Computer programming languages allow us to store and work with values like 10.5 and $1.2 * 10^{15}$ – values that might involve fractions or be very large or very small. Depending on the programming language they might be referred to as floats, singles, or real numbers. Describe one method of storing such values.

(5 marks)

4. Nowadays, the part of your desktop computer that can perform the largest number of calculations per second is usually the graphics card, not the main processor. Surprisingly the graphics card will usually take longer than the main processor to do a single calculation. Explain.

(5 marks)

5. My computer usually runs several programs at the same time. For example I can have a word processor, a web browser and a spreadsheet all running simultaneously. How is this possible?

(5 marks)

6. A friend has just been offered a great deal on a 4TByte disk drive. They ask your advice: should they buy it? You know they won't be satisfied with a simple yes/no answer. You have to explain to them whether it would be useful to them in terms the kinds and amount of data that they might store. Discuss.

(5 marks)

7. Two people each need to download a large file (1 gigabyte) over the internet. One has a dial-up connection at 50kilobits/second; the other has an ADSL (broadband) connection at 4 megabits/second. How long would you expect it to take in each case, assuming that the connection speed is the only limit on transfer speed?

(5 marks)

8. In mathematics we can manipulate expressions, following the rules of algebra, and be confident that they will still evaluate to the same result. So, for example, the expressions $(x + y) / 2$ and $x/2 + y/2$ give the same answer for any values of x and y. However, if we use these two expressions in a computer program, there may be values of x and y for which they behave differently. Explain.

(5 marks)

Section B
Programming

Note: **In answering questions 8 – 13 you may find that the question wording does not always fully explain what your program fragment should do in all situations. Where this is the case you should describe the problem, choose and implement a solution.**

9. Write a fragment of code to add together the first 100 counting numbers – ie: 1 + 2 + ...

(6 marks)

10. Write a fragment of code to add together all of the first 1000 counting numbers that are divisible by either 3 or 5.

(6 marks)

11. Write a fragment of code that reverses the order of numbers stored in an array of N integers. For example, if an array of 5 integers contains 1,2,3,4,5 it should contain 5,4,3,2,1 after your fragment has run.

(6 marks)

12. Write a fragment that examines an array of N integers and determines whether or not they are in ascending numeric order. If they are in order your fragment should display 'ordered'; if not your fragment should display 'not ordered'.

(6 marks)

13. Given a string (array of characters), write a fragment of code that counts the number of vowels. "Every sentence has vowels" has 8 vowels.

(6 marks)

14. Given a string (array of characters), write a fragment of code that counts the number of words in the string. You may assume that words are separated by spaces. The string "Hello, my name is Bill" has 5 words. Words may be separated by more than one space, so "Hello, my   name   is   Bill" also counts as 5 words.

(6 marks)

Section C
Problem Solving

14. Consider the following code fragment. [Note: This question looks very like the corresponding question in the 2008 examination. The code fragment is different.]

```
int s, v, i, k;

s = 0;
while (s < N)
{
    s = s + 1;
    v = a[s];
    k = s;
    i = s;
    while (i < N)
    {
        i = i + 1;
        if (a[i] > v)
        {
            v = a[i];
            k = i;
        }
    }
    a[k] = a[s];
    a[s] = v;
}
```

where 'a' is an array of integers.

(a) Describe what happens if the fragment is run with N = 5 and elements 1 to 5 of the array 'a' initially holding values 11, 23, 21, 17, and 35 respectively.

(10 marks)

(b) If you had to give this code fragment a name, describing its function, what would you call it?

(2 marks)

(c) How many times does comparison of the 'if' statement get executed with N = 5?

(4 marks)

(d) If N was 10, how many times would the comparison of the 'if' statement be executed?

(4 marks)

(e) Can you write down an (approximate) formula to give the number of times the comparison of the 'if' statement is executed for arbitrary N.

(4 marks)