2005 SCHOLARSHIP EXAMINATION

WRITTEN SECTION

The University of Waikato
Te Whare Wānanga o Waikato

DEPARTMENT	Computer Science
COURSE TITLE	7th Form Scholarship
TIME ALLOWED	Two Hours
NUMBER OF QUESTIONS IN PAPER	Eleven
NUMBER OF QUESTIONS TO BE ANSWERED	Eleven
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. Express the base-10 value 93 in:

   (a) Binary (base 2)

   (b) Octal (base 8)

   (c) Hexadecimal (base 16)

   (5 marks)

2. Multiply the two eight bit binary numbers 00000110 and 00001101. Show your work, including carry bits.

   (5 marks)

3. Real numbers (floating point numbers) are stored in the variables X and Y. Later, the value Y / X (i.e. Y divided by X) must be calculated and stored in the variable Z. Sometimes the program fails while performing this calculation. Why would this happen? The programmer tries to fix the problem by writing:

   if X does not equal 0.0 then set Z to Y / X

   This helps, but the program still sometimes fails. Explain.

   (5 marks)

4. Voice over Internet Protocol (VoIP) is an increasingly popular technology, allowing people to communicate by voice in real-time over the internet using the microphone and speakers on their computer. VoIP is unlike other more common internet protocols, like HyperText Transport Protocol (HTTP), in that it has no mechanism to correct corrupted data, or to recover data that is lost during transmission. Why is such susceptibility to error tolerable, even desirable, for transmitting voice over the internet?

   (5 marks)

5. When I was buying a new computer to use for game playing recently, the salesperson told me that it was more important to invest in a good graphics card than it was to have a particularly fast processor. Was this good advice? What functions does a graphics card perform on a modern computer system?

   (5 marks)

Section B
Programming

Note: In answering questions 6 – 10 you may notice that the wording of a question fails to explain what your program should do in certain situations. If this is the case, then you should describe the problem and implement a solution. Marks will be awarded for such analysis.

6. Given an array V with N signed integer values, write code to calculate the average.

(5 marks)

7. Given two signed-integer values in variables X and Y, write code to calculate and display the quotient and remainder that result from dividing the value in X by the value in Y, where the calculation is carried out **using only repeated addition and/or subtraction** (i.e. no multiply, divide, or modulo operations). For example, if X is 13 and Y is 3 then the quotient is 4 and the remainder is 1 because 13 = 3 * 4 + 1.

(10 marks)

8. Given an unsigned integer M, write code to display an equilateral triangle of asterisks with M asterisks on each side; so that, for example, if M is 6 then the following output is displayed:

```
     *
    * *
   * * *
  * * * *
 * * * * *
* * * * * *
```

(10 marks)

9. The square root of a number N can be calculated by fixing a minimum and maximum possible solution, then repeatedly testing if the square of the value midway between the minimum and maximum equals N, and narrowing the range defined by the minimum and maximum if the midpoint is not the solution. The process iterates until the exact root is found or (due to limitations of precision) a more accurate approximation of the root cannot be calculated. Write code to calculate the square root of any real value N.

(10 marks)

10. An array V holds N real numbers representing the market value of a barrel of oil on each of N successive days of trade.

    (a) Write code to calculate the largest one-day change in the price of oil for the data provided (where the price can go up or down).

    (5 marks)

    (b) Write code to calculate the number of days between the maximum and minimum price of oil for the data provided.

    (10 marks)

Section C
Problem Solving

11. Given a positive integer value for X, the following two functions produce the same result, but compute the solution in different ways.

```
function FibOne(X)
  set A to 1
  set B to 1
  set Y to 2
  while (X > Y) do
        set C to A + B
        set B to A
        set A to C
        set Y to Y + 1
 return A
end FibOne
```

```
function FibTwo(X)
  if (X = 1) then
        set A to 1
  else
        if (X = 2) then
              set A to 1
        else
              set A to FibTwo(X-1) + FibTwo(X-2)
  return A
  end FibTwo
```

a) Compare the number of additions each version of the function must perform if

i) X = 3
ii) X = 4
ii) X = 5
iv) X = 10

(10 marks)

b) What are the relative merits of each function (i.e. which is better, and why)?

(15 marks)