

Student Name: _____ School: _____



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

2016 SCHOLARSHIP EXAMINATION

WRITTEN SECTION

DEPARTMENT	Computer Science
COURSE TITLE	Year 13 Scholarship
TIME ALLOWED	Two Hours
NUMBER OF QUESTIONS IN PAPER	Fifteen
NUMBER OF QUESTIONS TO BE ANSWERED	Fifteen
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

TURN OVER

Section A
Computing Concepts

1. An 8 bit integer may store values in sign/magnitude or in 2's complement form.
 - (a) Write down in binary the largest (positive) and smallest (most negative) integer value that can be expressed in 32 bit sign/magnitude and in 32 bit 2's complement form.
 - (b) Write down in decimal the values of the largest and smallest 32 bit sign/magnitude and 32 bit 2's complement integers.

(5 marks)

2. Multiply the eight bit binary number 00010101 by 00001010. Show your working, including carry bits.

(5 marks)

3. We can use binary numbers to represent fractions as a natural extension of the way in which they are used to represent whole numbers. Just as 100_2 represents 4, 1000_2 represents 8 and 1100_2 represents 12_{10} we have fractions – 0.1_2 represents $\frac{1}{2}$, 0.01_2 represents $\frac{1}{4}$, and 0.11_2 represents $(\frac{1}{2} + \frac{1}{4})$ or $\frac{3}{4}$.
 - (a) Convert the binary fraction 0.11001_2 to a decimal fraction.
 - (b) Write $\frac{3}{8}$ as a binary fraction.
 - (c) Can you write $\frac{1}{10}$ as a binary fraction? Discuss.

(5 marks)

4. It has become common for small laptop computers to have an SSD for storage, where a few years ago they would have had a 'spinning' hard disk. How do these two storage technologies differ? What operations on your computer would be made faster by having an SSD instead of a 'spinning' hard disk?

(5 marks)

5. Many, if not most, of the electronic resources we use collect information. There is concern that this represents a significant threat to personal privacy. List four examples of data that might be collected as you use a cellphone or the internet. Of the four, two should be data that you would be happy to reveal and two should be data that you would prefer to keep private.

(5 marks)

6. A friend has recently had connected to their home a 'fibre' internet system which will allow them to transfer data at 30 megabits per second. They ask you what that means. You know that your friend is an enthusiastic photographer who owns a 20 mega pixel camera. You also know that they like to store their images in an uncompressed form. It might help them to understand their new connection if you could explain how many photographs per hour they could upload. Do the calculation, explaining your working.

(5 marks)

7. Early versions of Unix (an old operating system that was the inspiration for Linux) ran on computers with as little as 64KB of memory, running at clock speeds of 10MHz. My current laptop has 8GB of memory and seems to have 2GB of it in use even when I am not running any applications. Its clock speed is 2.1GHz and it has 4 processors. My elderly relative, who was a computer user back in the 1970's, says that the computers in those days seemed quite responsive and powerful. In fact programmers could sometimes compile and test their work more quickly on those old machines than is possible today on modern machines with much more memory and processing power. Why do modern machines use so much memory? What has been the benefit from a user's or programmer's perspective of faster computers with more memory?

(5 marks)

Section B Programming

Note: In answering questions 8 – 14 you may find that the question wording does not always fully explain what your program fragment should do in all situations. If this is the case you should describe the problem, then choose and implement a solution.

8. Write instructions to display a row of N asterisk '*' characters for a positive number N. For example when N is 5 your instructions should display *****

(6 marks)

9. There is a rectangle on your screen. Its top left corner pixel is at location (a, b) – meaning the bth pixel from the left in the ath row of pixels. Your rectangle is w pixels wide and h pixels high. Consider a pixel which is the xth pixel from the left in the yth row of pixels. Write an expression that returns true if the (y, x) pixel is inside the rectangle (not on an edge), false otherwise.

(6 marks)

10. Given integers N and M and a character C, write a fragment of code that outputs N lines in the shape of a box M characters wide, filled with asterisk '*' characters.

For example, output for values N=5, M = 12 and C = '@' should appear as follows:

```
@@@@@@@@@@@@@
@*****@
@*****@
@*****@
@*****@
@@@@@@@@@@@@@
```

(6 marks)

11. As part of a game, you want the player to guess a number between 1 and 99. Write a fragment of code that allow the player to enter guesses. If they guess incorrectly, your code should tell them whether their number was too large or too small and allow them to guess again. When they enter the correct number your code should report the number of incorrect guesses made. A sample interaction might look like this (user input is underlined).

```
Enter guess: 50
Your number was too big
Enter guess: 25
Your number was too small
Enter guess: 32
Correct, after 2 incorrect attempts.
```

(6 marks)

12. You are given a 32 bit integer value N and a character array of length 30. Write instructions to convert the integer into the corresponding character sequence followed by an asterisk '*' character to signal the end.

For example: If N is 12327. You should put '1', '2', '3', '2', '7', '*' into the first 6 locations of the array.

(6 marks)

13. A 'palindrome' is a string which reads the same from left to right or from right to left. One famous example is "able was I ere I saw elba" – as might have been said by Napoleon after he was exiled to the island of Elba. We can say a string is nearly a palindrome if it reads nearly the same from left to right and right to left. For example the string 'abddefedcba' would be a palindrome if the first 'd' were changed to a 'c' (or the 'c' were changed to a 'd'). You are given an array of characters S, of length N. Write a fragment of code which returns the number of mismatches when checking to see if the array holds a palindrome. For the example just given (S = 'a','b','d','d','e','f','e','d','c','b','a'; N = 11), your code should return 1.

(6 marks)

14. On a Linux computer file paths are written as a series of folder names followed by the file name; preceded and separated by '/' characters. For example the name '/home/mary/homework/assignment1.txt' has folders 'home', 'mary', and 'homework'. The filename is 'assignment1.txt'. A path may have from zero to many folder names. Given character arrays P and F, where P holds a file path and F holds a file name, write a fragment of code to replace the file name in P with F.

For example: If P is '/home/mary/homework/assignment1.txt' and F is 'newname.txt', your fragment should update P to '/home/mary/homework/newname.txt'. As another example: If P is '/abc.def' and F is 'xyz.fed', you should change P to '/xyz.fed'.

You may assume that the array P is large enough to hold the new file name.

(6 marks)

Section C
Analysing a Program

15. Consider the following code fragment.

```
int I, J, K, T;

I = 0;
while (I < N)
{
    J = I;
    K = J;
    while (J < N)
    {
        if (A[J] < A[K])
        {
            K = J;
        }
        J = J + 1;
    }

    T = A[I];
    A[I] = A[K];
    A[K] = T;

    I = I + 1;
}
```

Where

- A is an array of integers
- N is a positive integer value
- Array A has N elements.
- Arrays are accessed with indices 0, 1, 2,

For example, if N is 4 the elements of A are A[0], A[1], A[2] and A[3]

Hint: Read through this whole question before answering starting to answer. Parts (a) and (b) ask you to work through the execution of the code fragment with some sample data. Later parts ask more questions about that analysis.

- (a) Consider starting the fragment with array A holding values 9, 8, 1, 2, 4, 1, 2, 8 in elements 0, 1, ... 7 respectively and N holding the value 8. What values will be in the array A afterwards.

(7 marks)

- (b) What would have happened if the array A held the values 1, 2, 3, 5, 4, 6, 7, 8?

(4 marks)

(Question 15 – continued next page)

CONTINUED

(Question 15 – continued)

- (c) If you had to give this code fragment a name, describing its function, what would you call it?
(4 marks)
- (d) The code includes two ‘while’ loops. How many times was the body of each loop executed with the data in part (a) of this question? If N was increased to 20, how many times would the body of each loop be executed? Does the number depend on the data values?
(4 marks)
- (e) Write down an (approximate) formula or otherwise provide an explanation of the time the program will take to run for arbitrary values of N.
(4 marks)