2018 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

Section A
Computing Concepts

1. A binary 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 12 bit sign/magnitude and in 12 bit 2's complement form.

   (b) Write down in decimal the values of the largest and smallest 12 bit sign/magnitude and 12 bit 2's complement integers.

   (5 marks)

2. Subtract the eight bit binary number 00010011 from 00101110. Show your working, including carry bits.

   (5 marks)

3. Consider the following pseudo-code instructions, where the variable 'x' has floating point type.

   > Store 0.0 in the variable x
   > Repeat the two lines following until x is equal to 1.0
   >   display a line with the word "Hello"
   >   x = x + 0.1

   How many times will the line "Hello" be displayed? Explain.

   (5 marks)

4. A friend has been advised to replace the hard drive in their computer with an SSD in order to make the computer faster. They ask for your advice. What, if any, speed improvement might be achieved? What other issues might arise?

   (5 marks)

5. People often use the same username and password when they create accounts on different web sites. Why is this not a good thing to do? In your answer you should describe two ways in which problems might arise.

    (5 marks)

6. When we think of computer networking we usually think of connection to the Internet. However small groups of computers can establish private networks and exchange data without connection to the internet. One kind of private network is the 'mesh' network. A mesh network may involve dozens or hundreds of computers, cooperating to exchange data. For example, a mesh network might be established by a collection of small computers in a classroom. In a mesh network there are no fixed connections – computers establish connections with others when they can. Messages don't always go directly from source to destination. Instead they may pass through one or more other computers on the way. There is no single point of control – each computer cooperates as an equal partner. Under what circumstances do you think that a mesh network would be useful? Explain.

    (5 marks)

7. A modern smart phone is a computer with very similar capabilities to a small desktop computer. Both have operating systems. Describe two ways in which the operating systems of a phone and a desktop computer that you have used differ.

    (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 string S of characters N times on one line. For example, if N is 5 and the string S is "hello" your output should appear as follows.

    ```
    hellohellohellohellohello
    ```

    (6 marks)

9. Four points are marked along a line, at distances a, b, c and d cm from the start. Write a Boolean expression that is true if the part of the line between a and b is shorter than the part between c and d. For example, if a is 10, b is 20, c is 18 and d is 38; then the a to b (10cm) is shorter than c to d (20cm).

    (6 marks)

10. Write a fragment of code which displays a hollow triangle of height and width D, made of '@' characters. For example, if D is 5 your fragment should display

    ```
    @
    @@
    @ @
    @  @
    @@@@@
    ```

    (6 marks)

11. Given a string S (array of characters) of length N, write a fragment of code that counts the number of times two vowels (letters 'a', 'e', 'i', 'o' or 'u') occur together in the string. For example the string "speedy eagle" has 'ee' and 'ea', so should give a result of 2. A string with three vowels together (e.g. 'Louise') should be counted as 2 (for the 'ou' and the 'ui').

    (6 marks)

12. Two rectangles (A and B) are drawn on a computer screen. Each rectangle is described by four numbers: x and y are the coordinates of the pixel at the top left corner; w and h are the width and height in pixels. In all then there are 8 values: Ax, Ay, Aw, Ay, Bx, By, Bw and Bh. Write a code fragment which prints 'overlapped' if the two rectangles overlap (have one or more pixels in common). For example, if Ax=2, Ay=15, Aw=10, Ah=6 and Bx=10, By=12, Bw=5, Bh=9 the rectangles are as shown in the diagram. They overlap.
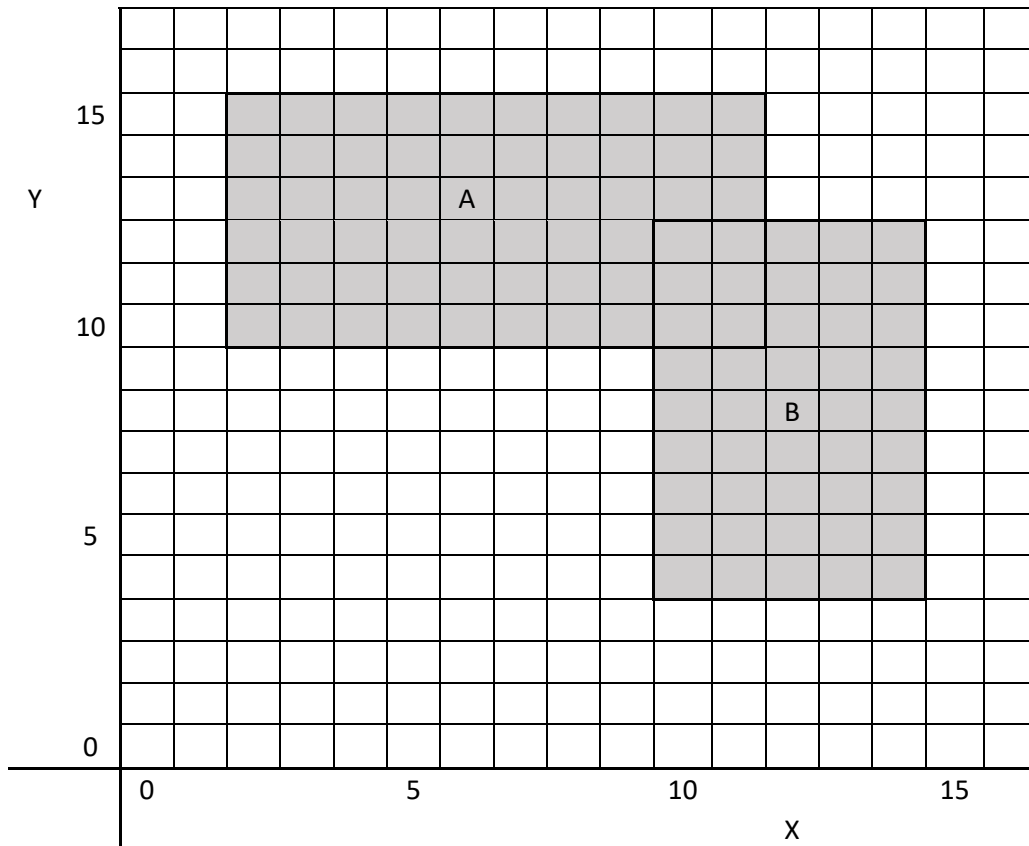
(6 marks)

13. The user interface of a drink dispensing machine has boxes that a user can touch to turn on or off selections. There are three buttons to select a base drink (Lemon, Coke or Iced Tea) and two buttons to select an additional syrup to add (Vanilla and Ginger). A valid drink selection involves one base drink and zero or one syrup. Write an expression that returns true if a drink is valid. You may assume that the variables L, C, I, V and G hold the current state of the selection buttons respectively. For example the expression 'L' is true if the Lemon selection is on; the expression 'L and C' is true if both Lemon and Coke are selected.

(6 marks)

TURN OVER

14. As part of the input of a program, you want your user select a product (A, B or C) and to select the size of their product.   A is available in sizes 2 and 3. B is available in sizes 1, 2, 3, and 5. C is available only in size 4. Write a fragment of code that requests this information from a user. If they enter an incorrect choice, your code should tell them that their entry was invalid and allow them to try again. When their entry is valid, your code should thank them and display the information entered. A sample interaction might look like this (user input is underlined).

```
Enter product: A
Enter size: 3
Thank you for ordering A in size 3

Enter product: P
Sorry, we do not stock that product

Enter product: C
Enter size: 3
Sorry, C is not available in that size
```

(6 marks)

Section C
Analysing a Progam

15. Consider the following code fragment.

```
J = 0;
while (J < M)
{
    B[J] = A[J];
    J = J + 1;
}

I = M;
while (I < N)
{
    K = -1;
    J = 0;
    while (J < M)
    {
        if (B[J] < A[I])
        {
            if (K < 0)
            {
                K = J;
            }
            else if (B[J] < B[K])
            {
                K = J;
            }
        }
        J = J + 1;
    }
    if (K >= 0)
    {
        B[K] = A[I];
    }
    I = I + 1;
}
```

Where
- A and B are arrays of integers
- N and M are positive integers
- Array A has N elements
- Array B has M elements
- I, J, and K are integer variables
- 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]

(Question 15 – continued next page)

(Question 15 – continued)

Hint: Read through this whole question before 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 N holding the value 7; array A holding values 1,2,3,4,5,6,7 in elements A[0], A[1], ... A[6] respectively; and M holding the value 3. What values will be in the array B afterwards?

(7 marks)

(b) What would have happened if N held the value 6; M held the value 4; and the array A held the values 10,11,9,7,12,10 ?

(4 marks)

(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 three 'while' statements. How many times was the body of the third 'while (J < M)' executed with the data in part (a) of this question? How many times was it executed with the data in part (b)?

(4 marks)

(e) If N was 35 and M was 7, how many times would the body of the third 'while' statement be executed?

(4 marks)