General Certificate of Education
Advanced Subsidiary Examination
June 2010

Computing COMP1

Unit 1 Problem Solving, Programming, Data Representation and Practical Exercise

Monday 24 May 2010 9.00 am to 11.00 am

For this paper you must have:
- access to the Electronic Answer Document
- a copy of the *Preliminary Material*.

You must **not** use a calculator.

Time allowed
- 2 hours

Instructions
- Type your answers into the Electronic Answer Document.
- Enter the information required on the front of your Electronic Answer Document.
- Answer **all** questions.
- You will need access to:
  - a computer
  - a printer
  - appropriate software
  - the electronic version of the Skeleton Program.
- Before the start of the examination make sure your **Centre Number, Candidate Name** and **Number** are shown clearly in the footer of the Electronic Answer Document (not the front cover).

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- No extra time is allowed for printing and collating.
- The question paper is divided into four sections.
  You are advised to spend time on each section as follows:
  Section A - 35 minutes
  Section B - 20 minutes
  Section C - 15 minutes
  Section D - 50 minutes.

At the end of the examination
- Tie together all your printed Electronic Answer Document pages and hand them to the invigilator.

Warning
- It may not be possible to issue a result for this unit if your details are not on every page.

Section A

You are advised to spend no more than **35 minutes** on this section.

Type your answers to **Section A** in your Electronic Answer Document.
You **must save** this document at regular intervals.

Question 1

Figure 1 shows the contents of a memory location.

Figure 1

1	0	1	0	0	1	1	1

0 1 What is the denary equivalent of the contents of this memory location if it represents an **unsigned binary integer**?

Use the space below for rough working, then copy the answer to your Electronic Answer Document.

(1 mark)

0 2 What is the denary equivalent of the contents of this memory location if it represents an **unsigned binary fixed point number**, with 4 bits before and 4 bits after the binary point?

Use the space below for rough working, then copy the answer to your Electronic Answer Document.

(2 marks)

0 3 What is the denary equivalent of the contents of this memory location if it represents a **two's complement binary integer**?

Use the space below for rough working, then copy the answer to your Electronic Answer Document.

(2 marks)

0 4 What is the **hexadecimal** equivalent of the binary pattern shown in **Figure 1**?

Use the space below for rough working, then copy the answer to your Electronic Answer Document.

(1 mark)

Question 2

The ASCII system uses 7 bits to represent a character. The ASCII code for the character 'A' is 65; other alphabetic characters follow on from this in sequence.

0 5 How many different characters can be represented using ASCII? *(1 mark)*

0 6 How would the character 'B' be represented in ASCII using 7 bits?

Use the space below for rough working, then copy the answer to your Electronic Answer Document.

(1 mark)

Characters are transmitted using an 8-bit code that includes a parity bit in the most significant bit.

0 7 Using even parity, what bit pattern is sent for the character 'A'?

Use the space below for rough working, then copy the answer to your Electronic Answer Document.

(2 marks)

0 8 Explain how the even parity system works. Include a description of the roles of the sender and receiver during transmission. *(4 marks)*

Question 3

To record sound a computer needs to convert the analogue sound into a digital form. During this process samples of the sound have to be taken. **Figure 2** shows 6 samples that have been stored in a computer's memory. These samples have been taken from the analogue signal over a period of one hundredth of a second.

Figure 2

Sample 6	01101100
Sample 5	01101100
Sample 4	01100000
Sample 3	00001101
Sample 2	00001000
Sample 1	00011011

Look at the digital representation, shown in **Figure 2**, of the analogue sound.

One Hertz (Hz) is one sample per second.

0 9 What sampling rate, in Hertz, has been used? *(2 marks)*

1 0 What sampling resolution has been used? *(1 mark)*

1 1 State Nyquist's theorem. *(2 marks)*

Question 4

1 2 State **three** features of well-written program code that help to make it understandable without the need to include lots of comments. *(3 marks)*

Question 5

1 3 Explain what is meant by an *algorithm*. *(2 marks)*

One way of checking that an algorithm is correct is to complete a dry run.

1 4 Dry run the algorithm in **Figure 3** by completing **Table 1.**

*Copy **all seven** rows of your completed **Table 1** into the table provided in the Electronic Answer Document.*

Assume that `x` has a value of 7.
The `MOD` operator calculates the remainder resulting from an integer division.

Figure 3

```
Answer ← True
FOR Count ← 2 TO (x – 1) DO
  Remainder ← x MOD Count
  IF Remainder = 0 THEN
    Answer ← False
  ENDIF
ENDFOR
```

Table 1

Answer	Count	Remainder
True	-	-
	2	1

(6 marks)

1 5 What is the purpose of this algorithm? *(1 mark)*

Turn over for the next section

Section B

You are advised to spend no more than **20 minutes** on this section.

Type your answers to **Section B** in your Electronic Answer Document.
You **must save** this document at regular intervals.

The question in this section asks you to write program code
starting from a new program/project/file.

- Save your program/project/file in its own folder/directory.
- You are advised to save your program at regular intervals.

Question 6

Create a folder/directory **Question6** for your new program.

The variable table, **Table 2**, and the Structured English algorithm, **Figure 4**, describe a simplified version of a noughts and crosses match. A match consists of a user-specified number of games. In this simplified version, the two players complete each game on paper and then enter information about the result of each game into a program that totals the number of games won by each player. Assume that all games have a winner – there are no drawn games.

Table 2

Identifier	Data Type	Purpose
`NoOfGamesInMatch`	`Integer`	Stores the number of games in the match (specified by user)
`NoOfGamesPlayed`	`Integer`	Stores the number of games played so far
`PlayerOneScore`	`Integer`	Stores the number of games won by Player One
`PlayerTwoScore`	`Integer`	Stores the number of games won by Player Two
`PlayerOneWinsGame`	`Char`	Stores a 'Y' if Player One won the game and 'N' otherwise

Figure 4

```
PlayerOneScore ← 0
PlayerTwoScore ← 0
OUTPUT "How many games?"
INPUT NoOfGamesInMatch
FOR NoOfGamesPlayed ← 1 TO NoOfGamesInMatch Do
  OUTPUT "Did Player One win the game (enter Y or N)?"
  INPUT PlayerOneWinsGame
  IF PlayerOneWinsGame = 'Y'
    THEN PlayerOneScore ← PlayerOneScore + 1
    ELSE PlayerTwoScore ← PlayerTwoScore + 1
  ENDIF
ENDFOR
OUTPUT PlayerOneScore
OUTPUT PlayerTwoScore
```

What you need to do

Write a program for the above algorithm.

Test the program by showing the results of a match consisting of three games where Player One wins the first game and Player Two wins the second and third games.

Save the program in your new **Question6** folder/directory.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

1 6	Your PROGRAM SOURCE CODE.	*(9 marks)*
1 7	SCREEN CAPTURE(S) for the test described above.	*(4 marks)*

Turn over for the next section

Section C

You are advised to spend no more than **15 minutes** on this section.

Type your answers to **Section C** in your Electronic Answer Document.
You **must save** this document at regular intervals.

These questions refer to the *Preliminary Material* and require you to load the **Skeleton Program**, but do not require any additional programming.

Refer either to the *Preliminary Material* issued with this question paper or your electronic copy.

Question 7

1 8 State the name of an identifier used for a global variable that has been declared in the Skeleton Program. *(1 mark)*

1 9 State the name of an identifier used for a local variable that has been declared in the Skeleton Program. *(1 mark)*

2 0 Explain a difference between a global variable and a local variable. *(2 marks)*

Look at the instructions in the main program block used to choose Player One's symbol.

2 1 Describe the circumstances under which these instructions will stop being repeated. *(2 marks)*

When the Skeleton Program is run it is possible that a game might stop after 9 moves while there are still empty cells on the board – even though neither player has won.

2 2 Explain why this could happen. *(2 marks)*

2 3 State the name of an identifier for a variable that has a stepper role. *(1 mark)*

2 4 State the name of an identifier for a variable that has a fixed-value role. *(1 mark)*

2 5 State the name of an identifier for a user-defined subroutine that has exactly **three** parameters. *(1 mark)*

Study the code for the subroutine `GetWhoStarts`.

2 6 Give an example of an assignment statement in this subroutine. *(1 mark)*

2 7 Describe what the selection structure in this subroutine does. *(3 marks)*

Question 8

This question refers to the subroutine `CheckValidMove`.

As part of the testing of a subroutine, boundary data should be used.

2 8 Explain what is meant by a *boundary value*. *(1 mark)*

2 9 List the **three** essential boundary values that should be used to test the upper boundary of the x coordinate entered by a user. *(3 marks)*

3 0 Include SCREEN CAPTURE(S) showing the input and output when you run the **Skeleton Program** using **one** of the values given in your answer to **29** in your Electronic Answer Document. *(1 mark)*

Turn over for the next section

Section D

You are advised to spend no more than **50 minutes** on this section.

Type your answers to **Section D** in your Electronic Answer Document. You **must save** this document at regular intervals.

These questions require you to load the **Skeleton Program** and make programming changes to it.

Question 9

This question refers to the subroutine `CheckValidMove`.

This subroutine is used to check that the coordinates entered by a player are for a valid move. A valid move is defined as being an x coordinate and a y coordinate for a cell that exists and that is currently empty. At the moment the subroutine only checks that the x coordinate entered by the user is in the allowed range.

Adapt the program source code for the subroutine `CheckValidMove` so that it checks that the y coordinate entered by the user is in the allowed range and that the cell chosen by the user is empty.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

3 1	Your amended PROGRAM SOURCE CODE for the subroutine `CheckValidMove`.	*(5 marks)*
3 2	SCREEN CAPTURE(S) for test runs showing that moves with coordinates (2, -3) and (2, 7) are both rejected.	*(2 marks)*
3 3	SCREEN CAPTURE(S) for a test run showing that when the player selects a non-empty cell the move is rejected.	*(1 mark)*

Question 10

This question refers to the subroutine `CheckXOrOHasWon`.

This subroutine is used to check, after each move, if the player has won the game. The subroutine checks for three symbols in a line on the rows and on the columns. It should also detect three symbols in a line on the two diagonals.

Adapt the program source code for the subroutine `CheckXOrOHasWon` so that it does check for **three** symbols in a line along the diagonals.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

3 4 Your amended PROGRAM SOURCE CODE for the subroutine `CheckXOrOHasWon`. *(6 marks)*

3 5 SCREEN CAPTURE(S) showing a game won by a player getting three in a line along a diagonal. *(1 mark)*

3 6 SCREEN CAPTURE(S) showing a game won by a player getting three in a line along the other diagonal. *(1 mark)*

Question 11

This question refers to the main program block.

Part of the main program block updates the scores and displays the result using a selection structure.

Half a point should be awarded to each player if the game is drawn.

Adapt this part of the program source code to award points for a draw.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

3 7 Your amended PROGRAM SOURCE CODE for the selection structure. *(2 marks)*

3 8 SCREEN CAPTURE(S) showing the correct points awarded for a drawn game that is the **first and only** game in a match. *(2 marks)*

Question 12

This question expands the functionality of the **Skeleton Program**. The **Skeleton Program** needs to be changed so that the game is played on a **4x4** grid instead of a 3x3 grid. The aim of the game is still to get **three** consecutive symbols in a line.

Follow the steps below to change the **Skeleton Program** to work with a 4x4 grid.

- Change the `Board` array data type.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

3 9	Your amended PROGRAM SOURCE CODE for the necessary change to the `Board` array data type or an explanation of why no change is required. *(1 mark)*

- Change the condition for the selection structure in the main program that checks if the maximum number of allowed moves has been reached.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

4 0	Your amended PROGRAM SOURCE CODE for the necessary change to the condition for the selection structure in the main program. *(1 mark)*

- Change the subroutine `ClearBoard` so that it clears the 4x4 grid.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

4 1	Your amended PROGRAM SOURCE CODE for the subroutine `ClearBoard`. *(1 mark)*

- Change the subroutine `DisplayBoard` so that it displays the 4x4 grid.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

4 2	Your amended PROGRAM SOURCE CODE for the subroutine `DisplayBoard`. *(2 marks)*
4 3	SCREEN CAPTURE(S) showing an empty 4x4 grid is displayed at the beginning of the game. *(2 marks)*

- Change the subroutine `CheckValidMove` so that it checks that the move entered by a user is valid on the 4x4 grid.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

4 4 Your amended PROGRAM SOURCE CODE for the subroutine `CheckValidMove`. *(1 mark)*

- Change the subroutine `CheckXOrOHasWon` so that it checks for three of the same symbol in consecutive positions on a horizontal line on any row on the 4x4 grid. You are **not** expected to check for the extra winning positions along the diagonals or in the columns.

Evidence that you need to provide
Include the following in your Electronic Answer Document.

4 5 Your amended PROGRAM SOURCE CODE for the subroutine `CheckXOrOHasWon`. *(4 marks)*

4 6 SCREEN CAPTURE(S) showing a 4x4 grid game won with three symbols in a horizontal line – where one of the symbols in the winning line is in cell (2,4)*(2 marks)*

The Noughts and Crosses game has been adapted so that it is played using a 4x4 grid on a square. It is decided to alter the program further so that it is played using a 4x4x4 cube instead of a 4x4 square.

4 7 Describe how the data structure(s) for a cube-shaped board could be represented in the **Skeleton Program**. *(2 marks)*

END OF QUESTIONS

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