**Barker College**

# 2001
## Year 12 Trial HSC
### EXAMINATION

# SOFTWARE DESIGN and DEVELOPMENT

## General Instructions

- Reading time - 5 minutes
- Working time - 3 hours
- Write using blue or black pen
- Flowchart templates may be used
- Write your **Student Number** and your **teacher's initials** on each sheet of writing paper used.
- Start a new sheet of paper for each question

**( Section I )** Multiple Choice. Pages 1 – 5

Total marks **(20)**
- Attempt Questions 1 - 20
- Allow about 35 minutes for this section

**( Section II )** Core. Pages 6 – 9

Total marks **(60)**
- Attempt Questions 21 - 23
- Allow about 110 minutes for this section

**( Section III )** Option Topic. Pages 10 – 11

Total marks **(20)**
- Attempt Question 24
- Allow about 35 minutes for this section

## CALCULATORS ARE NOT PERMITTED

## Section I

**Total marks (20)**
**Attempt Questions 1 – 20**
**Allow about 35 minutes for this section**

Use the multiple-choice answer sheet.
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

**Sample**        2 + 4 = (A) 2        (B) 6        (C) 8        (D) 9

A ○        B ●        C ○        D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ●        B ✗        C ○        D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

*correct*

A ✗        B ✗        C ○        D ○

**1**  A method of representing integers within a computer that has two possible representations of 0 and has the left most bit as a '1' to indicate the number is negative is called

   (A)  long integer
   (B)  2's compliment
   (C)  sign and modulus
   (D)  floating point

**2**  The correct order for the steps in the translation of high level language to machine code is

   (A)  Syntactic Analysis, Code Generation, Lexical Analysis, Code Optimisation
   (B)  Code Generation, Lexical Analysis, Syntactic Analysis, Code Optimisation
   (C)  Syntactic Analysis, Lexical Analysis, Code Generation, Code Optimisation
   (D)  Lexical Analysis, Syntactic Analysis, Code Generation, Code Optimisation

**3**  A programming language that uses inference rules and assertions can best be described as

   (A)  a machine language.
   (B)  a procedural language.
   (C)  an event driven language.
   (D)  a declarative language.

**4**  The error message "Incompatible assignment to variable" occurs when

   (A)  an integer is assigned to a real number variable.
   (B)  a real number is assigned to an integer variable.
   (C)  a character is assigned to a string variable.
   (D)  the program attempts to write past the end of an array.

**5**  The syntax for a LOONA is given in BNF:

   LOONA ::= 'a' I 'b' <HAP><HAP>
   HAP ::= 'A' I 'B'

Which of the following is a legitimate LOONA?

   (A)  abAB
   (B)  AAA
   (C)  aB
   (D)  bAB

**6**  The following are descriptions of four methods of language translation.
   (i)    The process of converting an entire source program written in a high-level language into machine language before executing any of the program.
   (ii)   A translator program that translates one line at a time of the high-level source code into a low-level object code, whereupon the computer executes that line before the next line is translated.
   (iii)  A section of high-level language code which is frequently used in the program is translated as one unit, while the rest of the code is translated one line at a time.
   (iv)   A process by which individual modules of a large program are translated without the need to translate the entire program. All necessary translated units are later collected together by the linker before execution.

Which row in the table below correctly matches all descriptions to their translation method?

|     | Interpretation | Independent Compilation | Incremental Compilation | Compilation |
|-----|----------------|-------------------------|-------------------------|-------------|
| (A) | (ii)  | (iii) | (iv)  | (i)  |
| (B) | (iii) | (iv)  | (ii)  | (i)  |
| (C) | (i)   | (iii) | (iv)  | (ii) |
| (D) | (ii)  | (iv)  | (iii) | (i)  |

**7** Which type of loop terminates when the condition being tested is true?

(A) REPEAT......UNTIL
(B) WHILE.......ENDWHILE
(C) CASEWHERE........ENDCASE
(D) IF........ENDIF

**8** An array is represented by the diagram below.

| 7 | 2 | 3 | 1 | 8 | 6 | 9 | 4 | 7 | 1 |
|---|---|---|---|---|---|---|---|---|---|

An ascending order bubble sort is performed on the contents of the array. After two passes through the array it would appear as:

(A)

| 2 | 3 | 1 | 4 | 1 | 6 | 7 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|

(B)

| 2 | 3 | 1 | 7 | 6 | 8 | 4 | 1 | 7 | 9 |
|---|---|---|---|---|---|---|---|---|---|

(C)

| 1 | 1 | 2 | 3 | 7 | 8 | 6 | 9 | 4 | 7 |
|---|---|---|---|---|---|---|---|---|---|

(D)

| 2 | 1 | 3 | 6 | 7 | 4 | 7 | 1 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|

**9** Which of the following would **not** enhance the user friendliness of a computer program?

(A) Context sensitive help
(B) User manual
(C) Installation manual
(D) Intrinsic documentation

**10** A stub is

(A) a procedure which validates data.
(B) used to locate a syntax error, report it and stop execution.
(C) a substitute for a real subprogram.
(D) a stop within the program which occurs if a certain event happens.

**11** Below is a sample Pascal program:

```
        program GoodOne;
(i)     {This program reads in a students name and ID number and}
        {prints them in a specified format  }
        var
(ii)    Counter: integer;
        StudentName: string;
        IDnumber: integer;
        begin
        showtext;
(iii)   writeln('Please enter student name');
        readln(StudentName);
        writeln('Please enter student ID');
        readln(IDnumber);
        writeln(StudentName : 10, IDnumber : 10);
        end.
```
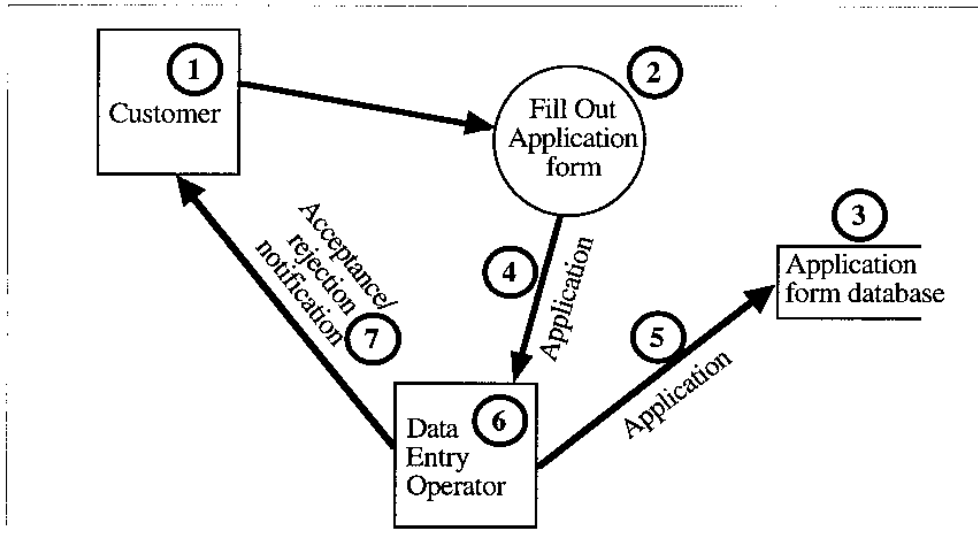
The areas labelled (i), (ii) and (iii) demonstrate

(A) comment in code, a constant and an output debugging statement.
(B) comment in code, intrinsic documentation and an output statement.
(C) internal documentation, a variable and a stub.
(D) internal documentation, a variable and an output debugging statement.

**12**



In the above dataflow diagram, an example of a datastore, data item, process and entity, *in that order* is

(A)   3, 5, 2, 6
(B)   5, 4, 2, 3
(C)   3, 5, 7, 1
(D)   6, 2, 7, 3

**13**   In constructing a structure diagram, what is the conventional symbol used to show a control parameter?

(A)   

(B)   

(C)   

(D)   

**14**   This question refers to the following algorithm.

```
BEGIN MAINPROGRAM
        Set A to 1
        Set B to 18
        Set C to 0
        Read Number
        WHILE Number < B
                Set B to B - C
                Set C to C + 2
                Set Number to Number + A
                Print Number
        ENDWHILE
END MAINPROGRAM
```

If 2 is used as input data, the output from the algorithm would be

(A)   2, 3, 4, 5, 6, 7
(B)   3, 4, 5, 6, 7
(C)   3, 4, 5, 6
(D)   2, 3, 4, 5, 6

**15**

(i)   set count to 0
      WHILE count < 1000
        set array[count + 1] to 0
        increment count
      ENDWHILE

(ii)   set count to 1
      WHILE count <= 1000
        set array[count] to 0
        increment count
      ENDWHILE

(iii)   set count to 0
      WHILE count < 1000
        increment count
        set array[count] to 0
      ENDWHILE

Which of the above algorithms perform identical tasks?

(A)   (i) and (ii)
(B)   (ii) and (iii)
(C)   (i) and (iii)
(D)   all of them

**16**    Which of the following errors could not be detected by exception handling built into a program?

(A)  Arithmetic overflow
(B)  Errors in logic
(C)  Division by zero
(D)  Incompatible assignment to variables

**17**    The development strategy where the problem is refined into smaller subproblems which are then treated as separate problems which may then be further broken down would best be classified as

(A)  bottom up design.
(B)  top down design.
(C)  stub programming.
(D)  hierarchical programming.

**18**    The essential difference between a *file of records* and an *array of records* is

(A)  in an array of records all elements must be of the same data type.
(B)  a file of records is stored on a secondary storage device.
(C)  an array of records can only hold data for one object.
(D)  a file of records must be accessed sequentially.

**19**    A set of test marks have been set up in an array **Test** as shown:

| 32 | 64 | 20 | 84 | 90 | 62 |
|----|----|----|----|----|----|

If the value of **Test[1]** is 64, what output will be produced by this section of algorithm?

    value = 5
    **WHILE** value >= 5
        decrease value by 1
        display Test [value]
    **ENDWHILE**

(A)  84
(B)  90
(C)  62
(D)  90  84

**20**    The data structure most often manipulated using a repetition would be

(A)  a record.
(B)  variables.
(C)  an array.
(D)  a string.

## Section II - CORE Structured Responses

**Question 21.** (20 Marks) Start a new sheet of Writing Paper

(a)     The software development cycle is fundamental to the Software Design and Development course.

     i)   Name in order the FIVE stages of the software development cycle.     2

     ii)  Describe why software development can be viewed as a cycle.     1


(b)     During the first stage of the software development cycle, a Feasibility Study should be carried out.

     i)   Name and describe the FOUR main factors that will determine whether a project is feasible.     4

     ii)  If a program is deemed to **not** be feasible, what are the alternatives available to the programmer and project management team?     1


(c)     As an accomplished programmer, you have been asked to develop a program to extract data from a compiled database that a company has been using for years. Unfortunately, the program does not allow all fields to be exported, and you do not have access to the original source code of the program. You are also asked to develop a new database to replace the old program.

     i)   Describe how reverse engineering could be used in this situation.     1

     ii)  What legal and ethical problems does the decision to use reverse engineering pose?     1

     iii) Which software development approach would be most suitable for the development of a new database? Justify your answer.     1

     iv) CASE tools would be ideally suited to the development of the new program. What are CASE tools and how could they be used in this situation?     2

     v)  Name the method of implementation that would allow for the company to gradually move one department at a time over to the new system, while other departments continue using the old system.     1


(d)     As a computer security consultant you have been asked to help Coca-Cola protect their computer system from viruses. Users and the IT Department have noticed a significant decline in the processing speed of the computers and internal network.

     i)   Describe, using a known virus as an example, how computer viruses can be rapidly spread throughout the world.     2

     ii)  How could a computer virus affect the processing speed of the computer?     1

     iii) Describe TWO ways that Coca-Cola could prevent viruses from affecting their employee's computers.  1

     iv) The computer programs used by Coke may need to be tested at both the **program** and **system** levels. Differentiate between these two methods of testing.     1

     v)  Explain how benchmarking could be used to test whether the computers are operating correctly.     1

**Question 22.** (20 Marks) Start a new sheet of Writing Paper

(a)    A large law firm is facing liquidation due to dwindling profits. To solve their problems, the firm has decided that an Internet presence will help them become more competitive and able to offer a better service. One problem they foresee is that any proposed system will take too long to be approved by the board of directors who are not computer literate.

   i)   Explain why prototyping would be an appropriate development approach for this problem.                     1

   ii)  Name and describe ONE project management tool that could be used by the board of directors to track the development of the project.                                      1

   iii) Employees and clients will be able to view the firm's web site. A restricted section containing confidential information can be accessed by employees when they are not in the office. Clients can only view information about the business including the firm's history, the types of law practised, and a list of lawyers employed by the firm. Clients can also provide details to receive further information. Draw a story board to demonstrate this system.                          2

(b)    Part of the syntax of a language is given below.
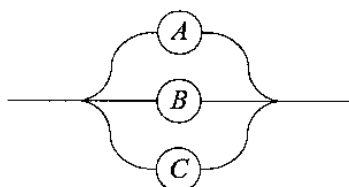
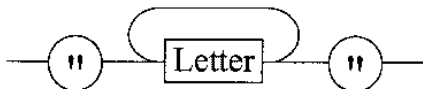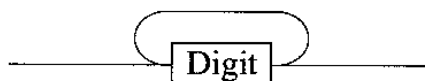Letter                                     Symbol
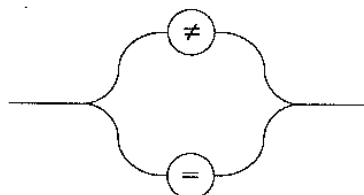


Variable                                   Number



The following assignment statements are syntactically correct in that language.

        Assign A = "AB" END
        Assign B ≠ 5 END
        Assign C = "BB", B = 4, A = "B" END

   i)   Express the syntax of a **Variable** in EBNF.                            1
   ii)  Draw a 'railroad' diagram for the **assignment statement** in this language.       3
   iii) In terms of language description, differentiate between **operators** and **operands**.   1

(c)    A scientist uses a program which calculates the orbit of planets, speed of rotation and other variables. He notices that there are occasional discrepancies in the results of calculations.

   i)   Give an explanation of how these errors may have been caused by the programming code.    1
   ii)  Suggest how the programming code could be improved to avoid such errors in the future.    1

(d)    A computer program allows the users to type in a sentence terminated by a full stop. After a full stop has been read, the user is given three options:

1)    Typing U will print out the contents of the array in **UPPER CASE**
2)    Typing L will print out the contents of the array in **lower case**
3)    Typing T will print out the contents of the array in **Title Case** (ie the first letter of every word is a capital)

These options are repeatedly available until the user types the letter **X** to exit from the program. An algorithm attempting to solve this problem is shown below.

**BEGIN MAINPROGRAM**
    length = 0
    **REPEAT**
        read character
        Sentence[length] = character
        add 1 to length
    **UNTIL** character = "."
    read choice

```
REPEAT
      index = 1
      CASEWHERE choice is
            "U"  :   Print UPPERCASE(Sentence[index])
            "L"  :   Print LOWERCASE(Sentence[index])
            "T"  :   Print TITLECASE(Sentence[index])
      ENDCASE
      index = index + 1
UNTIL choice = "X"
```

**END MAINPROGRAM**

i)    Draw a desk check table and perform a desk check of this algorithm using the test data:

        **A qUick TeSt.**

        **U**

        **T**

        **X**                                                                          2

ii)   There are several problems with the algorithm that prevent it from accomplishing the aims described in the problem definition. State the problems with the current algorithm and how they prevent the algorithm from achieving the desired result.                                                    3

iii)  Rewrite the section of the algorithm shown in the box, so that it performs the desired task correctly.    2

iv)   Design a set of test data that could be used to test that all parts of this algorithm work correctly. Justify the inclusion of the data you have selected.                                                  2

— 8 —

**Question 23.** (20 Marks) Start a new sheet of Writing Paper

(a)    An interactive program prompts the user several times for the response to questions. The responses need only to be "Y" for yes or "N" for no. The program does allow the user to enter the full word answers "yes" or "no" and this is stored as an answer of "Y" or "N". If the user enters a value other than one of those indicated, they are asked to re-enter their answer until a valid response is given.

     i)    Write an algorithm that will carry out the error trapping and range check described above. The program will not proceed until either the value "Y" or "N" is recorded.                                                    2

     ii)   You have decided to incorporate a Graphical User Interface to make your program more usable. Describe FOUR common components of a GUI.                                                                                         2

     iii)  When designing the interface you remember that there are screen design principles that you should follow. Describe why **fonts, borders** and the **placement of elements** are important to consider when developing an interface.                                                                                              3

     iv)   What is the difference between event-driven and sequential programming?                                      1

(b)    The organisers of the Barker Fair have decided that they will be recording the **names** and **ticket numbers** of all people attending the fair. As a person purchases a ticket, their name is entered and a ticket is printed with their name and the ticket number.

The ticket numbers start at 1000 and are incremented by 1 as each ticket is printed. The organisers have decided that every 100th ticket will be a winning ticket, and the word WINNER is printed on the appropriate ticket. Ticket sales are not expected to exceed ticket number 9999. Two sample tickets are shown below:

| **Barker Fair** | **Barker Fair** |
|:---:|:---:|
| **Ticket number: 1052** | **Ticket number: 1300** |
| **Geoff Lancaster** | **Leigh Klein** |
| | **WINNER** |
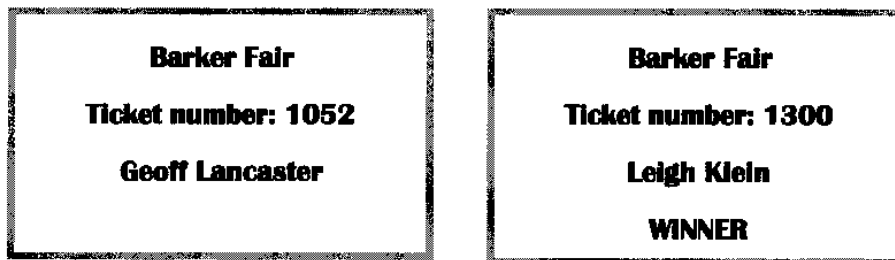
The program stores data in a text file called **FairData**. FairData is an empty text file if the program has not run. When opening the program, data in the text file is loaded into the appropriate data structure and further names and ticket numbers are added. The data is saved to FairData before the program is closed.

The mainline of this program is shown below:

        **BEGIN MAINPROGRAM**
            Load data from file
            Purchase tickets
            Save data to file
        **END MAINPROGRAM**

     i)    Describe the data structures you would use to store the names and ticket numbers of all people attending the Fair within the program. Justify your answer.                                                                  2

     ii)   Create a data dictionary to show all of the data items needed to create this program.                        2

     iii)  Draw an IPO diagram to help explain this program.                                                              2

     iv)   Describe how a sentinel value could be used when reading data in from the text file.                          1

     v)    Write an algorithm to carry out the subprogram Load data from file. This will read the data from a text file into the appropriate data structure.                                                                              2

     vi)   Write an algorithm to carry out the subprogram Purchase tickets. This will allow the ticket seller to enter names and print tickets. The ticket seller should be able to continue entering names until the name "END" is entered. As each name is entered the ticket number is automatically incremented and a ticket is printed. When "END" is entered as the name, control is passed back to the mainline of the program.    3

## Section III - Option Topic - Software Developer's view of the Hardware

**Question 24.** (20 Marks) Start a new sheet of Writing Paper

(a)    i)   Copy the following table onto your writing paper and complete the unfilled spaces.    2

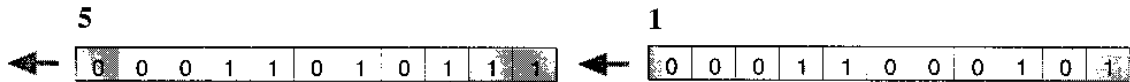|  | Binary | Decimal | Hexadecimal |
|---|---|---|---|
| A | 10101110 | | |
| B | | 13 | |
| A + B | | | |

    ii)  Using a 4 bit system, illustrate how two's complement may be used to subtract $3_{10}$ from $6_{10}$.    1

    iii) The character A is represented in ASCII as 65 decimal. What character is represented by the binary pattern 01000101?    1

    iv) Carry out the following operation using the binary number system. Divide the binary number 1001101 by the binary number 1011, showing all working.    1

    v)  Represent the decimal number 150.4375 as a 32 bit IEEE floating point number.    2

(b)    i)   Describe the behaviour of a flip-flop with regard to storage of a single bit of information. Support your answer with EITHER a circuit diagram OR a truth table    2

    ii)  With the aid of a diagram, explain the role of a half-adder.    1

    iii) Draw a truth table for the circuit below, showing the signals at points W, X, Y and Z.    2
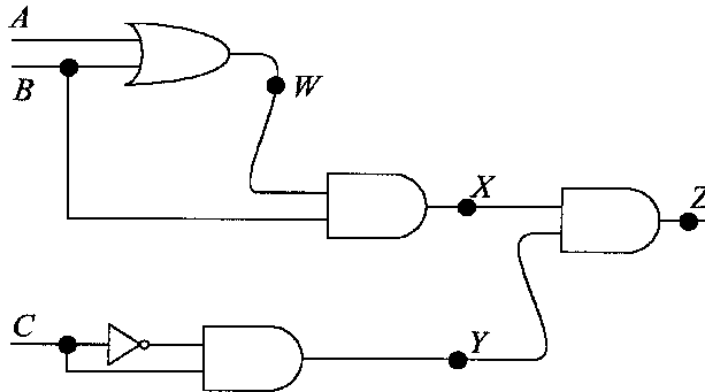


    iv) The circuit shown above can be simplified. Draw a simpler circuit to achieve the same result using the least number of logic gates.    1

(c)    The Lanklein numeric keypad communicates with the computer by sending packets of data. Each packet contains a start bit, 8 data bits, a parity bit and a stop bit. The data is encoded in ASCII as shown in the table below:

| Character | ASCII | Decimal | Character | ASCII | Decimal |
|---|---|---|---|---|---|
| 0 | 110000 | 48 | 7 | 110111 | 55 |
| 1 | 110001 | 49 | 8 | 111000 | 56 |
| 2 | 110010 | 50 | 9 | 111001 | 57 |
| 3 | 110011 | 51 | + | 101011 | 43 |
| 4 | 110100 | 52 | - | 101101 | 45 |
| 5 | 110101 | 53 | = | 111101 | 61 |
| 6 | 110110 | 54 | | | |

When the numbers 5 and 1 are entered the contents of the transmitted packets would be:

**5**                                                          **1**

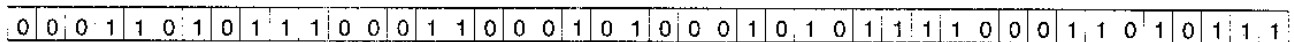◄— | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |     ◄— | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |

i) What is the role of a parity bit in data communications?     1

ii) What type of parity checking is used in the example above? Justify your answer.     1

iii) Write down the data stream that would be sent from the Lanklein keypad to transmit "27–8="     1

iv) Explain why the packets transmitted contain redundant data. How could the data be sent in more efficient packets?     1

v) A simple Calculator program communicates directly with the Lanklein keypad. The algorithm below shows the main control of the Calculator program.

```
BEGIN MAINPROGRAM Calculator
    WHILE Calculator is open
        Read Packets
        Perform Calculation
        Print Result
    ENDWHILE
END MAINPROGRAM


BEGIN SUBPROGRAM Convert to Decimal (Start)
    DecimalNum = 0
    Stop = Start + 6
    Current = Start
    WHILE Current <= Stop
        IF DataStream[Current] = 1 THEN
            DecimalNum = DecimalNum + 2^(Stop - Current)
        ENDIF
        Current = Current + 1
    ENDWHILE
    RETURN DecimalNum
END SUBPROGRAM
```

The Read Packets subprogram will read all of the data entered up until the = sign is entered. (**NB** *you do not have to write this subprogram*) This data stream is read straight into an array called **DataStream**. If the data 51+5= was entered, the contents of the array **DataStream** would appear as shown in the diagram below:

| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |

From this calculation, the decimal value 56 would be printed to the screen as the result.

The command ASCII(*decimal number*) will convert from a decimal number to it's ASCII character. The subprogram Convert to Decimal can be used to convert a portion of the **DataStream** array into a decimal value.

Your task is to write the subprogram **Perform Calculation**. This subprogram will process and interpret the binary data that has been read into the array and calculate the required result. You can assume that the decimal numbers entered will be less than 100000 (ie up to 5 digits).     3

**END OF EXAM**

— 11 —