INSTRUCTIONS TO CANDIDATES

1. Do NOT open this examination paper until instructed to do so.

2. Answer ALL questions from the THREE sections.
1. (a) Draw the symbol and give the corresponding truth table for THREE primary logic gates. [6 marks]

(b) The following is the truth table for an exclusive-OR gate:

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Using the primary logic gates from (a) above, design and draw a circuit which behaves exactly like an exclusive-OR gate. [6 marks]

(c) Draw a clearly labelled block diagram of a 4 x 1 multiplexer (4 inputs, 1 output). [6 marks]

(d) (i) Calculate the decimal equivalent of \(00011011_2\). [1 mark]

(ii) Determine if the result of \(0111 + 1110\) can be stored as a 4 bit binary number. [2 marks]

(iii) Showing all working, find the largest and smallest integers that can be represented using 4 bits signed magnitude.

Hint: the leftmost bit is to be used for the sign and the other bits are used for representing the integer itself. [2 marks]

(iv) Find the 4 bit two's complement of \(-5\). [2 marks]

Total 25 marks
2. (a) Explain what is meant by EACH of the following terms:

(i) Word size
(ii) Cache memory
(iii) Clock speed

(b) Distinguish between EACH of the following pairs of terms as they pertain to computer memory:

(i) ROM and RAM
(ii) Access speed and access method
(iii) Volatility and capacity

(c) (i) Define the terms, ‘instruction set’ and ‘instruction format’.

(ii) State THREE types of instructions that are typically included in an instruction set.

(iii) Suppose 16 bits are used for representing instructions in a certain computer. Using a diagram, explain how a 2-address instruction can be formatted using the 16 bits available.

(iv) Describe what happens in a typical instruction cycle, assuming that direct addressing is used.

Total 25 marks
SECTION B

PROBLEM SOLVING WITH COMPUTERS

Answer BOTH questions.

3. (a) What is an algorithm? [2 marks]

(b) Name THREE basic control constructs used in structured programming. [3 marks]

(c) The algorithm below is designed to generate, print and count the odd numbers between 1 (inclusive) to 99 (inclusive). However there are errors.

1. begin
2. \( j = 2 \)
3. \( c = 1 \)
4. while \( (j < 99) \)
5. \( \text{print } j \)
6. \( j = j + 2 \)
7. \( c = c + 1 \)
8. endwhile
9. \( \text{print } ('c = ', c) \)
10. \( \text{print } ('j = ', j) \)
11. end

(i) What are the final values in the variables \( c \) and \( j \) when the algorithm terminates? [2 marks]

(ii) By referring to the specific line numbers:

Identify and correct the errors in the algorithm. [6 marks]

(iii) Using the corrected algorithm, give the value of variable \( c \) at the end of execution. [1 mark]
(d) Construct a flowchart to represent the following algorithm.

```
begin
  read name
  if name = 'enddata'
    print 'no data supplied'
  else
    while name <> 'enddata'
      read amount
      read quantity
      sale = amount * quantity
      print 'This sale = ', sale
      read name
    endwhile
  endif
end

[11 marks]
```

Total 25 marks
4.  (a) BuyLo is a grocery. Management has decided that it needs to track all the goods that are sold on a daily basis by using a computer-based solution.

Discuss what the ‘Identifying and evaluating possible solutions’ stage of problem solving would involve for BuyLo.  [ 6 marks]

(b) Trace through the execution of the following algorithm and draw the output in your answer booklet exactly as it would be generated by the algorithm. You should carefully note the following:

- printSpaces(n) prints n spaces from the current cursor position, use a dash ‘−’ to indicate a space
- print continues output on the current line from the current cursor position
- println continues output on the current line from the current cursor position but any subsequent output begins on a new line

SIZE = 10
begin
while j >= 0
begin
    printSpaces ( j + 1 )
    print ( '*' )
    printSpaces ( 8 − j )
    println ( '*' )
    j = j − 1
endwhile
for j = 1 to (SIZE + 1) do
    print ( '*' )
end for
println ( )
end

[11 marks]

(c) Write an algorithm that uses repetition to find the sum of all multiples of 7 between 14 (inclusive) and 126 (inclusive).  [ 8 marks]

Total 25 marks
5. (a) Describe the ‘lexical analysis’ and ‘semantic analysis’ stages of the translation process. [6 marks]
(b) Write a C function which accepts two integer parameters, $a$ and $b$, and returns the larger of the two. Assume the integers are different. [4 marks]
(c) Write a C program with the following functionality. The steps MUST be followed exactly as stated.

Accept 10 integers from the user and place them in a text file ‘in.dat’, one integer per line. Assume all integers are valid.

Close the file ‘in.dat’, reopen it, read the data and find and print the average of the integers stored in the file.

Print an appropriate message if the file cannot be found.

[Note: You cannot use arrays to solve this problem.] [15 marks]

Total 25 marks
6. (a) Briefly describe EACH of the following classifications of programming languages:

(i) Declarative
(ii) Imperative (procedural)
(iii) Scripting

[6 marks]

(b) Distinguish between ‘syntax’ and ‘semantics’ as used in computer programming.

[3 marks]

(c) You are given the following declarations in a C program:

```c
struct payRec {
    long int id;
    float totalPay;
    int numDays;
};

void main () /
    // start of main function
{
    int emplId;
    float pay, rate;
    int hrs;
    struct payRec Smith, Jones, Singh;

    reading input data (explained later) and updating the totalPay and numDays fields
    for each employee.

    prompting the user for id, hrs and rate. Calculate the salary by multiplying hrs by
    rate for the employee and adding that result to the totalPay.

    NOTE:
    An employee can have more than one set of data, where each set corresponds to a
day worked by the employee.

    Data are terminated by the sentinel id of 999.

    At the end, print each employee id, total pay and number of days worked.
```
Sample screen:

<table>
<thead>
<tr>
<th>NAME</th>
<th>ID</th>
<th>TOTAL PAY</th>
<th>DAYS WORKED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith</td>
<td>1000</td>
<td>136.50</td>
<td>2</td>
</tr>
<tr>
<td>Jones</td>
<td>1001</td>
<td>27.50</td>
<td>1</td>
</tr>
<tr>
<td>Singh</td>
<td>1002</td>
<td>105.00</td>
<td>1</td>
</tr>
</tbody>
</table>