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COMPUTER SCIENCE

9608/42

Paper 4 Further Problem-solving and Programming Skills

October/November 2017

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **14** printed pages and **2** blank pages.

- 1 Students are choosing their A Level subjects based on their IGCSE subject results.

A student can take:

- Computer Science, if they have a grade C in Maths or a grade C in Computer Science
- Maths, if they have a grade C in Maths
- Physics, if they have a grade C in Science and a grade C in Maths.

- (a) Complete the decision table.

| | | Column | | | | | | | |
|------------|-----------------------------|--------|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Conditions | Grade C in Computer Science | Y | Y | Y | Y | N | N | N | N |
| | Grade C in Maths | Y | Y | N | N | Y | Y | N | N |
| | Grade C in Science | Y | N | Y | N | Y | N | Y | N |
| Actions | Take Computer Science | | | | | | | | |
| | Take Maths | | | | | | | | |
| | Take Physics | | | | | | | | |

[4]

- (b) Simplify your solution by removing redundancies.

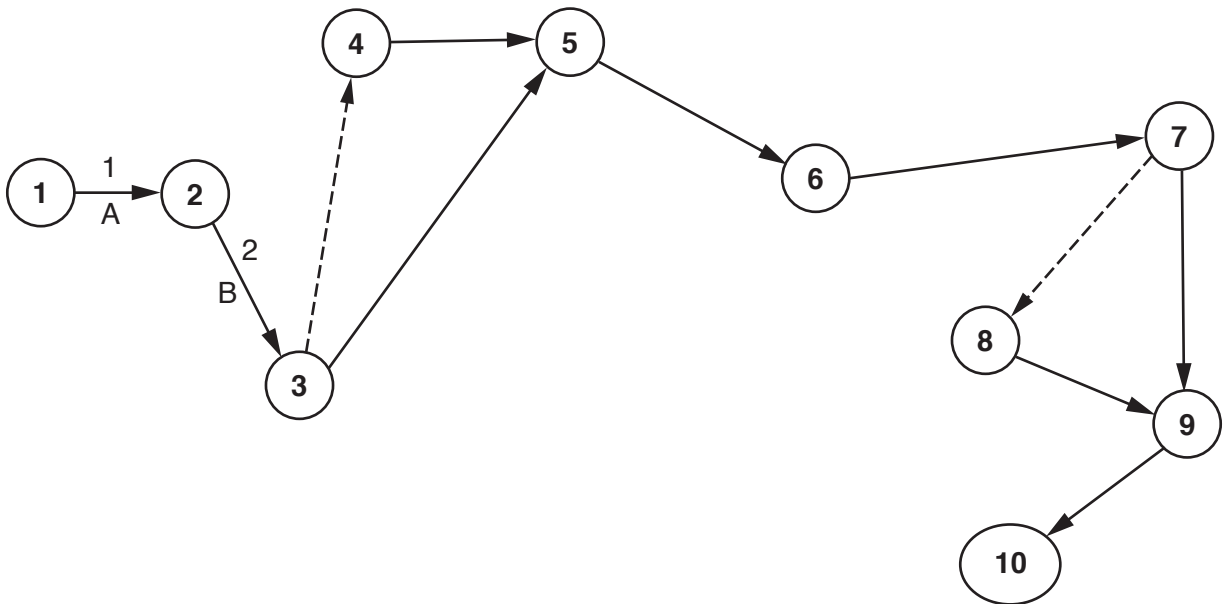
| | | Column | | | | | | | |
|------------|-----------------------------|--------|---|---|---|---|---|---|---|
| | | S | T | U | V | W | X | Y | Z |
| Conditions | Grade C in Computer Science | | | | | | | | |
| | Grade C in Maths | | | | | | | | |
| | Grade C in Science | | | | | | | | |
| Actions | Take Computer Science | | | | | | | | |
| | Take Maths | | | | | | | | |
| | Take Physics | | | | | | | | |

[3]

- 2 (a) A project manager is planning to create a new computer game. The following table shows the activities and the estimated number of weeks to complete each activity.

| Activity | Description | Weeks to complete |
|----------|---------------------------------|-------------------|
| A | Interview end user | 1 |
| B | Produce requirements analysis | 2 |
| C | Design program structure | 3 |
| D | Design Interface | 1 |
| E | Program development | 12 |
| F | Black-box testing | 2 |
| G | Produce technical documentation | 4 |
| H | Acceptance testing | 1 |
| I | Installation | 1 |

Complete the labelling of the Program Evaluation Review Technique (PERT) chart using the data in the table. The first two activities have been done for you.



[7]

- (b) State what the dashed lines in the PERT chart represent.

.....

.....[1]

3 A declarative programming language is used to represent the knowledge base:

```

01     room(master_bedroom).
02     room(ensuite_bathroom).
03     room(office).
04     room(spare_bedroom).
05     room(nursery).
06     furniture床).
07     furniture(desk).
08     furniture(cot).
09     furniture(wardrobe).
10     furniture(computer).
11     located(床, master_bedroom).
12     located(床, spare_bedroom).
13     located(cot, nursery).
14     located(computer, office).
15     located(computer, master_bedroom).
    
```

These clauses have the following meanings:

| Clause | Explanation |
|--------|--------------------------------------|
| 01 | Master bedroom is a room |
| 06 | Bed is an item of furniture |
| 11 | Bed is located in the master bedroom |

(a) Corridor is a room that contains a table and a lamp.

Write additional clauses to represent this information.

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[5]

(b) Using the variable `WhatItem`, the goal:

```
located(WhatItem, master_bedroom).
```

returns:

```
WhatItem = bed, computer
```

Write the result returned by the goal:

```
located(bed, WhichRoom).
```

WhichRoom =
..... [2]

(c) (i) Clauses to identify rooms that are next to each other need to be stored.

The nursery is next to the master bedroom. This information is stored as:

```
21 nextTo(nursery, master_bedroom).
22 nextTo(master_bedroom, nursery).
```

Explain why both clauses are necessary.

.....
.....
.....
..... [2]

(ii) The corridor is next to the main bathroom.

Write additional clauses for this fact.

23
24
25 [3]

(d) B can be moved into A, if B is furniture, A is a room and B is not already in A.

Write this as a rule.

```
canBeMovedTo (....., .....)  
IF .....  
..... [6]
```

- 4 (a) The array `Numbers[0 : Max]` stores numbers. An insertion sort can be used to sort these numbers into ascending order.

Complete the following **pseudocode** for the insertion sort algorithm.

```

FOR Pointer ← 1 TO (Max - 1)
    ItemToInsert ← .....
    CurrentItem ← .....
    WHILE (CurrentItem > 0) AND (Numbers[CurrentItem - 1] > ItemToInsert)
        Numbers[.....] ← Numbers[CurrentItem - 1]
        CurrentItem ← CurrentItem - 1
    ENDWHILE
    Numbers[CurrentItem] ← .....
ENDFOR

```

[4]

- (b) Identify **two** features of the array `Numbers` that would have an impact on the performance of this insertion sort algorithm.

1

2

[2]

- 5 The following table shows part of the instruction set for a processor. The processor has one general purpose register, the Accumulator (ACC), and an Index Register (IX).

| Instruction | | Explanation |
|-------------|------------|--|
| Op code | Operand | |
| LDM | #n | Immediate addressing. Load the number n to ACC. |
| LDD | <address> | Direct addressing. Load the contents of the location at the given address to ACC. |
| LDI | <address> | Indirect addressing. The address to be used is at the given address. Load the contents of this second address to ACC. |
| LDX | <address> | Indexed addressing. Form the address from <address> + the contents of the index register. Copy the contents of this calculated address to ACC. |
| LDR | #n | Immediate addressing. Load the number n to IX. |
| STO | <address> | Store the contents of ACC at the given address. |
| STX | <address> | Indexed addressing. Form the address from <address> + the contents of the index register. Copy the contents from ACC to this calculated address. |
| ADD | <address> | Add the contents of the given address to the ACC. |
| INC | <register> | Add 1 to the contents of the register (ACC or IX). |
| DEC | <register> | Subtract 1 from the contents of the register (ACC or IX). |
| JMP | <address> | Jump to the given address. |
| CMP | <address> | Compare the contents of ACC with the contents of <address>. |
| CMP | #n | Compare the contents of ACC with number n. |
| JPE | <address> | Following a compare instruction, jump to <address> if the compare was True. |
| JPN | <address> | Following a compare instruction, jump to <address> if the compare was False. |
| LSL | #n | Bits in ACC are shifted n places to the left. Zeros are introduced on the right hand end. |
| LSR | #n | Bits in ACC are shifted n places to the right. Zeros are introduced on the left hand end. |
| IN | | Key in a character and store its ASCII value in ACC. |
| OUT | | Output to the screen the character whose ASCII value is stored in ACC. |
| END | | Return control to the operating system. |

- (a) Six letters are stored, starting at the location labelled LETTERS. A program is needed to perform a linear search on LETTERS to find the letter 'x'. The program counts the number of times 'x' appears in LETTERS.

The following is the pseudocode for the program.

```
FOR COUNT ← 0 TO 5
  IF LETTERS[COUNT] = LETTERTOFOUND
    THEN
      FOUND ← FOUND + 1
    ENDFOR
  ENDFOR
```

Write this program. Use the op codes from the given instruction set.

| Label | Op code | Operand | Comment |
|----------------|---------|---------|---------------------------------|
| START: | LDR | #0 | // initialise Index Register |
| LOOP: | | | // load LETTERS |
| | | | // is LETTERS = LETTERTOFOUND ? |
| | | | // if not, go to NOTFOUND |
| | | | // increment FOUND |
| NOTFOUND: | | | // increment COUNT |
| | | | // is COUNT = 6 ? |
| | | | // if yes, end |
| | | | // increment Index Register |
| | | | // go back to beginning of loop |
| ENDP: | END | | // end program |
| LETTERTOFOUND: | | 'x' | |
| LETTERS: | | 'd' | |
| | | 'u' | |
| | | 'p' | |
| | | 'l' | |
| | | 'e' | |
| | | 'x' | |
| COUNT: | | 0 | |
| FOUND: | | 0 | |

[10]

- (b) Six values are stored, starting at the location `VALUES`. A program is needed to divide each of the values by 8 and store them back in their original location.

Write this program. Use the op codes from the instruction set on the next page.

| Label | Op code | Operand | Comment |
|---------|---------|---------|----------------------------------|
| START: | | | // initialise the Index Register |
| | | | // load the value from VALUES |
| | | | // divide by 8 |
| | | | // store the new value in VALUES |
| | | | // increment the Index Register |
| | | | // increment REPS |
| | | | |
| | | | |
| | | | // is REPS = 6 ? |
| | | | // repeat for next value |
| | END | | |
| REPS: | | 0 | |
| VALUES: | | 22 | |
| | | 13 | |
| | | 5 | |
| | | 46 | |
| | | 12 | |
| | | 33 | |

[10]

| Instruction | | Explanation |
|-------------|------------|--|
| Op code | Operand | |
| LDM | #n | Immediate addressing. Load the number n to ACC. |
| LDD | <address> | Direct addressing. Load the contents of the location at the given address to ACC. |
| LDI | <address> | Indirect addressing. The address to be used is at the given address. Load the contents of this second address to ACC. |
| LDX | <address> | Indexed addressing. Form the address from <address> + the contents of the index register. Copy the contents of this calculated address to ACC. |
| LDR | #n | Immediate addressing. Load the number n to IX. |
| STO | <address> | Store the contents of ACC at the given address. |
| STX | <address> | Indexed addressing. Form the address from <address> + the contents of the index register. Copy the contents from ACC to this calculated address. |
| ADD | <address> | Add the contents of the given address to the ACC. |
| INC | <register> | Add 1 to the contents of the register (ACC or IX). |
| DEC | <register> | Subtract 1 from the contents of the register (ACC or IX). |
| JMP | <address> | Jump to the given address. |
| CMP | <address> | Compare the contents of ACC with the contents of <address>. |
| CMP | #n | Compare the contents of ACC with number n. |
| JPE | <address> | Following a compare instruction, jump to <address> if the compare was True. |
| JPN | <address> | Following a compare instruction, jump to <address> if the compare was False. |
| LSL | #n | Bits in ACC are shifted n places to the left. Zeros are introduced on the right hand end. |
| LSR | #n | Bits in ACC are shifted n places to the right. Zeros are introduced on the left hand end. |
| IN | | Key in a character and store its ASCII value in ACC. |
| OUT | | Output to the screen the character whose ASCII value is stored in ACC. |
| END | | Return control to the operating system. |

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