

# Software Design and Development

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**General Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Write your Centre Number and Student Number at the top of either pages 29 and 33 or page 37

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**Total marks:**  
**100**

**Section I – 20 marks** (pages 2–9)

- Attempt Questions 1–20
- Allow about 35 minutes for this section

**Section II – 60 marks** (pages 13–28)

- Attempt Questions 21–33
- Allow about 1 hour and 50 minutes for this section

**Section III – 20 marks** (pages 29–40)

- Attempt either Question 34 or Question 35
- Allow about 35 minutes for this section

## Section I

20 marks

Attempt Questions 1–20

Allow about 35 minutes for this section

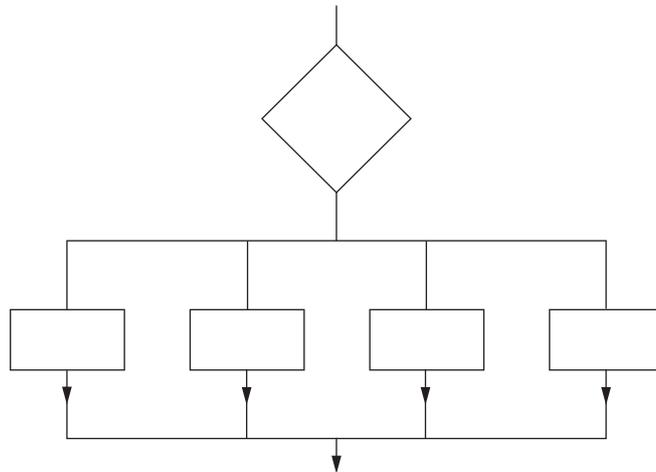
Use the multiple-choice answer sheet for Questions 1–20.

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- 1 A project team has been contracted to develop a project but the client is uncertain about the requirements.

Which software approach would be best to clarify the requirements?

- A. End user
  - B. Structured
  - C. Prototyping
  - D. Rapid application development
- 2 Consider the flow chart shown.



Which set of pseudocode keywords matches the flow chart?

- A. FOR ... NEXT
- B. WHILE ... ENDWHILE
- C. CASEWHERE ... ENDCASE
- D. IF ... THEN ... ELSE ... ENDIF

- 3 Which row of the table correctly shows items found in documentation for developers and for users?

	<i>Developer</i>	<i>User</i>
A.	Hardware requirements and Gantt chart	IPO charts and test results
B.	Balloon text and program specifications	Storyboard and screen designs
C.	Online help and system flow charts	Tutorials and data flow diagrams
D.	Algorithms and data dictionary	Installation guide and FAQs

- 4 Which of the following describes the syntax of a programming language?

- A. Gantt chart
- B. Data dictionary
- C. Railroad diagram
- D. Program specifications

- 5 Which of the following is a reason for releasing software as open source?

- A. To simplify decompilation of the software
- B. To allow others to contribute to improving the software
- C. To protect the software developer's intellectual property
- D. To gather feedback from users about its features and functionality

- 6 At which stage of the software development cycle is the nature of the data first considered?

- A. Implementing
- B. Testing and evaluating
- C. Planning and designing
- D. Defining and understanding

**7** During the execution of a program, an incorrect value is displayed on screen. That value is much higher than expected.

What type of error caused this?

- A. Logic
- B. Overflow
- C. Runtime
- D. Syntax

**8** What should be considered if an analyst is asked to identify the functionality requirements of a piece of software?

- A. What the client requires from the software
- B. The hardware requirements of the software
- C. The time when the software will be ready for release
- D. How to document the modular structure of the software

**9** For which of the following is a one-dimensional array of Booleans an appropriate data structure?

- A. Pixel colours on a screen
- B. Match results for a soccer team for a season
- C. The state of each light in a set of traffic lights
- D. The number of males and females in each class

**10** A software developer is concerned with compatibility issues.

How can the software developer make sure that these concerns are adequately addressed?

- A. Run the software using real-world data
- B. Test the software in a range of possible situations
- C. Compile the software for a variety of computer platforms
- D. Compare the performance of the software with benchmark software

- 11** What is the purpose of a sentinel value?
- A. To separate fields in a record
  - B. To mark the end of a set of input values
  - C. To mark the position of an element in an array
  - D. To indicate where the first data item is stored in memory
- 12** Which row of the table contains a true statement for both sequential and event driven software?

	<i>Sequential</i>	<i>Event driven</i>
A.	User input is restricted to self-validating interface elements	Execution involves a fixed sequence of events
B.	User input does not significantly affect the order of execution	Execution involves a fixed sequence of events
C.	User input is restricted to self-validating interface elements	The order of execution is not predetermined by the developer
D.	User input does not significantly affect the order of execution	The order of execution is not predetermined by the developer

- 13** The translation of source code into object code involves a number of steps.

Which of the following lists the steps in the correct order?

- A. Syntactical analysis, lexical analysis, code generation
- B. Syntactical analysis, code generation, lexical analysis
- C. Lexical analysis, syntactical analysis, code generation
- D. Lexical analysis, code generation, syntactical analysis

14 After the first pass of a sort, only the last two elements of an array have changed value.

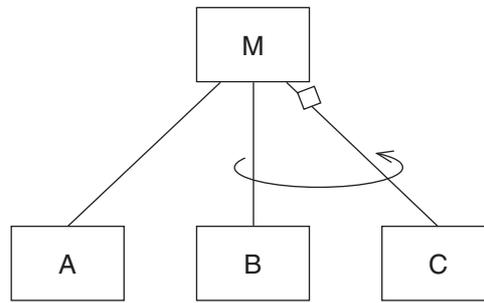
Which list identifies ALL the possible sort methods that could have been used?

- A. Bubble, selection
- B. Bubble, insertion
- C. Insertion, selection
- D. Bubble, selection, insertion

15 Which row of the table contains a true statement for both sequential and relative files?

	<i>Sequential files</i>	<i>Relative files</i>
A.	A priming read is used to check that the file is not empty	Must include at least one integer field
B.	A priming read is used to check that the file is not empty	Must contain a fixed number of records
C.	A priming read is needed to open the file	Must include at least one integer field
D.	A priming read is needed to open the file	Must contain a fixed number of records

16 Refer to the following diagram.



Which of the following algorithm fragments corresponds to the diagram?

- A. BEGIN M  
     A  
     FOR Counter = 1 to 5  
         B  
         IF Counter is even THEN  
             C  
         ENDIF  
     NEXT Counter  
 END M
- B. BEGIN M  
     A  
     B  
     IF Counter is even THEN  
         C  
     ENDIF  
 END M
- C. BEGIN M  
     A  
     Counter = 1  
     REPEAT  
         IF Counter is even THEN  
             B  
         ELSE  
             C  
         ENDIF  
         Increment counter  
     UNTIL Counter = 5  
 END M
- D. BEGIN M  
     FOR Counter = 1 to 5  
         A  
         B  
         IF Counter is even THEN  
             C  
         ENDIF  
     NEXT Counter  
 END M

Use the following algorithm to answer Questions 17 and 18.

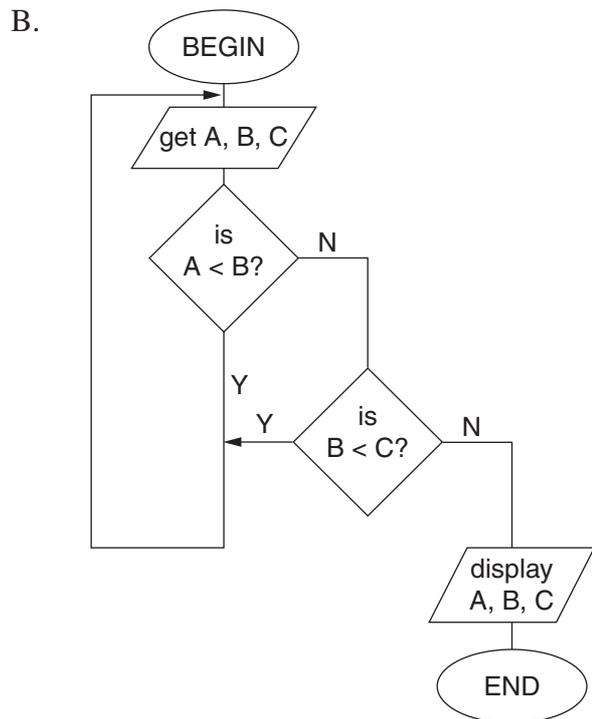
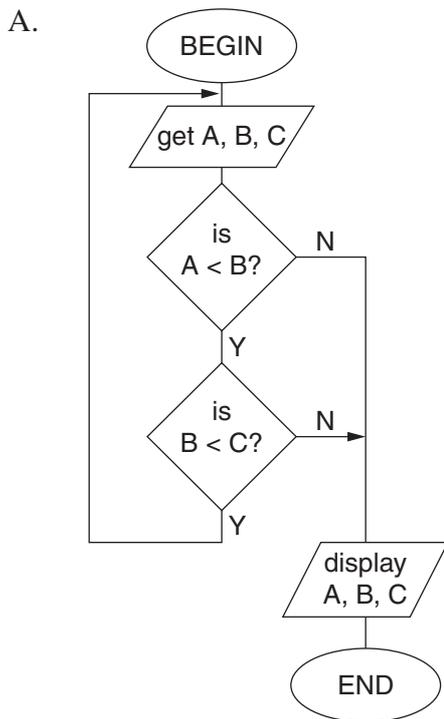
```

BEGIN
  get A, B, C
  WHILE A < B AND B < C
    get A, B, C
  ENDWHILE
  display A, B, C
END
  
```

17 What is the output from the algorithm if the input data is 4, 5, 6, 3, 9, 8?

- A. 3 9 8
- B. 4 5 6
- C. 5 6 3
- D. 4 5 6 3 9 8

18 Which of the following algorithms would produce the same output as the algorithm above?



C. BEGIN  
 REPEAT  
 get A, B, C  
 UNTIL A < B AND B < C  
 display A, B, C  
 END

D. BEGIN  
 REPEAT  
 get A, B, C  
 UNTIL A > B AND B > C  
 display A, B, C  
 END

- 19 The following code fragment is designed to calculate the cost of entry to a swimming pool for a family. The entry fee is \$5 for adults and \$2 for children. A subroutine call at REM is missing.

```
BEGIN Pool
    Display "Enter the number of adults"
    Get A
    Display "Enter the number of children"
    Get C
    REM **** Place subroutine call here ****
    Display "The total cost is ", T
END Pool
```

```
BEGIN Value(X, Y, Z)
    X = 2*Y + 5*Z
END Value
```

Which of the following correctly calls the subroutine?

- A. Value(A, C, T)
- B. Value(X, Y, Z)
- C. Value(Z, Y, X)
- D. Value(T, C, A)

- 20 The following shows two program fragments.

<i>Program 1</i>	<i>Program 2</i>
BEGIN Glob	BEGIN Loc
X is Global	X = 20
X = 20	<u>Sub</u>
<u>Sub</u>	Print X
Print X	END Loc
END Glob	
	BEGIN Sub
BEGIN Sub	X is local
X = 10	X = 10
END Sub	END Sub

Which row in the table shows the correct output for each program?

	<i>Program 1</i>	<i>Program 2</i>
A.	10	10
B.	10	20
C.	20	10
D.	20	20

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# Software Design and Development

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## Section II Answer Booklet

**60 marks**

**Attempt Questions 21–33**

**Allow about 1 hour and 50 minutes for this section**

### Instructions

- Write your Centre Number and Student Number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- If you include diagrams in your answer, ensure that they are clearly labelled.

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**Please turn over**

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**Question 21** (3 marks)

A testing report is created prior to the release of software.

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Outline the information that this report should contain.

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**Question 22** (3 marks)

Compare storyboards and screen designs.

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**Question 23** (9 marks)

A software package is being developed for a retail store. The package will include separate modules for tracking stock, recording sales and maintaining staff details.

- (a) Explain why a phased method of installation is appropriate for this system. **3**

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- (b) Describe how a system modelling tool can be used in the development of this software. **3**

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- (c) Describe how the team leader should manage the development of this software. **3**

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**Question 24** (3 marks)

Describe how the use of CASE tools can benefit a software developer.

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**Question 25** (3 marks)

There are many different programming languages available.

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Outline TWO factors a developer should consider when choosing a programming language for developing a particular piece of software.

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**Question 26** (3 marks)

The two algorithms shown below both achieve the same thing.

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*Algorithm 1*

```
BEGIN Pay
input Hours
IF Hours > 7 THEN
  BaseHours = 7
  Overtime = Hours – 7
ELSE
  BaseHours = Hours
  Overtime = 0
ENDIF
BasePay = BaseHours * 50
OvertimePay = Overtime * 50 * 1.5
TotalPay = BasePay + OvertimePay
Display TotalPay
END
```

*Algorithm 2*

```
BEGIN Pay

  BaseRate = 50
  PenaltyRate = 1.5
  NormalHours = 7
  Overtime = 0

input Hours

IF Hours > NormalHours THEN
  BaseHours = NormalHours
  Overtime = Hours – NormalHours
ELSE
  BaseHours = Hours
ENDIF

  BasePay = BaseHours * BaseRate
  OvertimePay = Overtime * BaseRate * PenaltyRate
  TotalPay = BasePay + OvertimePay

  Display TotalPay

END
```

Explain how features of *Algorithm 2* make it easier than *Algorithm 1* to maintain.

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**Question 27** (3 marks)

Explain how cloud computing affects both developers and users of software.

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**Question 28** (8 marks)

List() is a sorted array of 8 integers, indexed from 1.

Index	1	2	3	4	5	6	7	8
List()	7	9	12	33	47	54	56	67

The following binary search algorithm has been written to check whether the integer 42 appears in the list. The algorithm is not correct.

```
1  BEGIN BinarySearch
2      Set Low to 1
3      Set High to 8
4      Set Found to False
5      WHILE High is greater than or equal to Low AND Found is False
6          Set Middle to the integer part of (High + Low)/2
7          IF 42 < List(Middle) THEN
8              Set High to Middle
9          ELSE
10             IF 42 = List(Middle) THEN
11                 Set Found to True
12             ELSE
13                 Set Low to Middle
14             ENDIF
15         ENDIF
16     ENDWHILE
17     IF Found = True THEN
18         Display "42 found at index", middle
19     ELSE
20         Display "42 not found"
21     ENDIF
22 END
```

**Question 28 continues on page 21**

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Question 28 (continued)

- (a) Perform a desk check on the algorithm to show that there is an infinite loop. 3

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- (b) Correct the errors in the algorithm. You may refer to the line numbers provided. 2

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- (c) An algorithm is needed to find ALL occurrences of 42 in the array below. 3

Index	1	2	3	4	5	6	7
List()	12	33	42	42	42	56	83

Explain whether a linear search or a binary search should be used.

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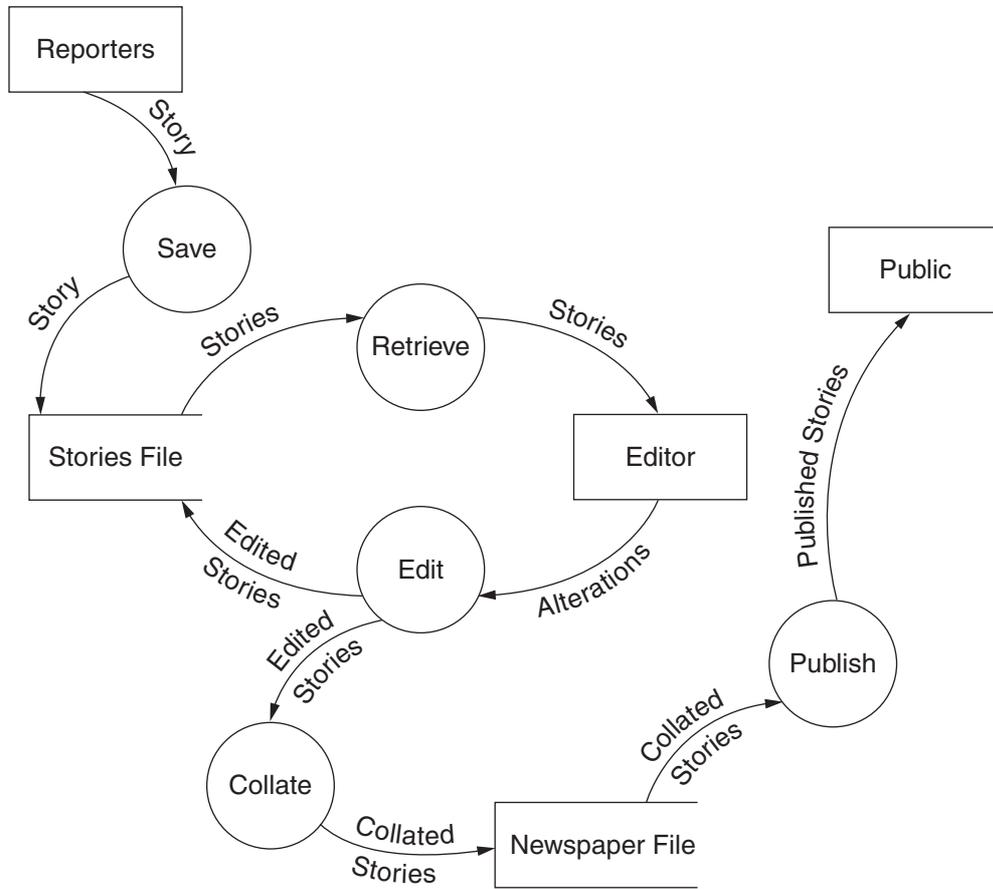
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**End of Question 28**

**Question 29** (3 marks)

The following data flow diagram represents a system for publishing newspapers.

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Draw a context diagram for this system.

**Question 30** (3 marks)

Describe what happens during the fetch–execute cycle.

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**Question 31** (3 marks)

A simple robotic device is controlled using the language ROBO. The following EBNF statements describe part of that language.

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```
program = BEGIN {<statement> ;} END
statement = <turn>|<forward>|<back>|<repetition>
turn = (LT <integer>)|(RT <integer>)
forward = FD <integer>
back = BK <integer>
repetition = REP <integer> # {< statement> ;} #
integer = <digit> {<digit>}
digit = 0|1|2|3|4|5|6|7|8|9
```

Convert the following algorithm into ROBO code.

```
BEGIN
  FOR loop = 1 to 5
    go forward 100 steps
    turn left 90 degrees
    go forward 50 steps
    go back 100 steps
    turn right 90 degrees
  NEXT loop
END
```

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**Question 33** (12 marks)

A clothing store needs software to enable customers to make online purchases and pay by credit card, maintain a list of items in stock and archive records of purchases.

(a) Outline responsibilities of the developer for this system.

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(b) On the clothing store’s website customers are presented with images and details of items.

The purchase module will enable the following:

- customer selection of an item and indication of how many they require
- confirmation that sufficient numbers of the item are in stock by referring to the StockList array
  - if there are NOT enough in stock the customer is informed
  - if there ARE sufficient numbers in stock then the order details are added to the CartList array and the StockList array is updated
- customer choice to continue to shop or proceed to checkout
- at checkout, the total price is displayed.

Other modules deal with payment.

The system includes two arrays of records. Samples of these are shown.

StockList()

StockIndex	ItemName	NumInStock	PricePerItem
1	Cotton Socks	23	12.59
2	Leather Belt	5	15.00
...	...	...	...

CartList()

CartIndex	ItemName	NoRequired
1	Leather Belt	1
2	Shirt Red	4
...	...	...

**Question 33 continues on page 27**





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## Section III

20 marks

Attempt either Question 34 or Question 35

Allow about 35 minutes for this section

Answer the question in the spaces provided. These spaces provide guidance for the expected length of response.

If you include diagrams in your answer, ensure that they are clearly labelled.

### Question 34 — Programming Paradigms (20 marks)

- (a) In relation to object oriented programming, what is *polymorphism*? 2

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Question 34 continues on page 30

Question 34 (continued)

- (b) A pet shop has developed a software system to control its inventory. The following fragment of code used for the system is based on the object oriented programming (OOP) paradigm.

```
class Pet {
    private –
        itemNumber: integer

    public –
        Pet()
        supplier: string
        getPrice()
            RETURN price
        END getPrice
}

class Dog {
    is a Pet

    public –
        Dog()
        breed: string
        name: string
        colour: string
        male: Boolean
        microchipped: Boolean
}

class Accessory {
    private –
        itemNumber: integer

    public –
        Accessory()
        type: string
        price: real
}
```

- (i) Using examples from the above code, outline the differences between the private and public declarations within a class. **3**

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**Question 34 continues on page 31**





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Question 34 (continued)

(d) A family tree database was written using the logic paradigm.

Some facts for the database include:

parent(Geoffrey, Deborah)

– Geoffrey is the parent of Deborah

parent(Geoffrey, Graham)

parent(Deborah, Gemma)

parent(Graham, Alice)

parent(Gemma, Harley)

Some rules for the database include:

sibling(X, Y) :- parent(Z, Y), parent(Z, X), X ≠ Y

– X and Y are siblings (that is, brother or sister) if they have the same parent and they are different people

grandparent(X, Y) :- parent(Z, Y), parent(X, Z)

– X is the grandparent of Y if X is the parent of Y's parent

first\_cousin(X, Y) :- grandparent(Z, X), grandparent(Z, Y), X ≠ Y, \+sibling(X, Y)

– X is the first cousin of Y if they have the same grandparent, they are different people and they are not siblings

(i) Show how backward chaining can be used to evaluate the query first\_cousin(Alice, Gemma). 3

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Question 34 continues on page 35



## Question 34 (continued)

- (ii) A great-grandparent is the parent of a grandparent. Two people are second cousins if they have the same great-grandparent and they are not siblings or first cousins. Using the above information, write a rule which will determine if X and Y are second cousins.

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**End of Question 34**





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Section III (continued)

Do NOT attempt Question 35 if you have already attempted Question 34.

Question 35 — The Interrelationship between Software and Hardware (20 marks)

- (a) In the CPU, the number 50 has to be subtracted from 72. 3

Explain why the binary representation of 50 is converted to its 2's complement.

Dotted lines for answer (a)

- (b) For single precision floating point representation, system IEEE754 uses 8 bits for the exponent and 23 bits for the mantissa. 3

A different system, called MySystem, uses 11 bits for the exponent and 20 bits for the mantissa.

Contrast the numbers that can be represented by these two systems. Justify your answer.

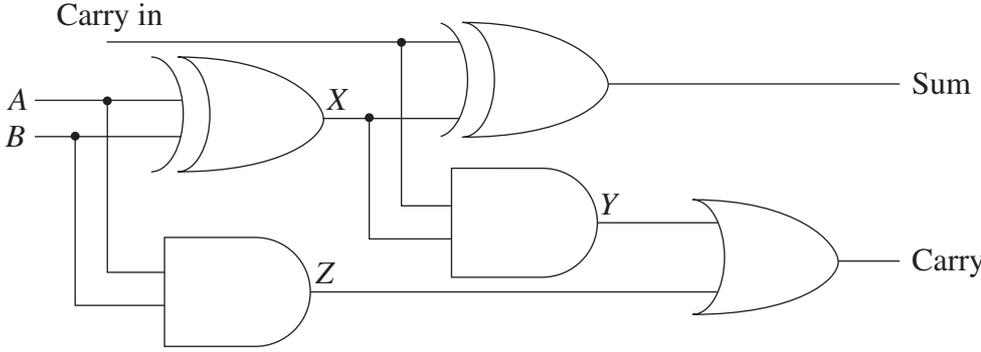
Dotted lines for answer (b)

Question 35 continues on page 38



Question 35 (continued)

(c) Use this circuit diagram of a 1-bit full adder to answer parts (c) (i) and (c) (ii).



(i) Produce a truth table for the circuit. Include columns for X, Y and Z. 3

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(ii) Explain the purpose of the OR gate in this circuit. 2

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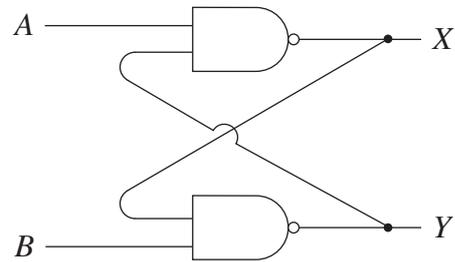
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Question 35 continues on page 39



Question 35 (continued)

(d) Consider the following flip-flop circuit.



Explain how the properties of this circuit make it suitable for its purpose.

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(e) A light is controlled by two switches. It can be turned ON or OFF by changing either one of the switches. When both switches are off the light is off.

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Design a logic circuit to represent this system. You may choose to use a truth table.

Question 35 continues on page 40

