

Software Design and Development

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
Black pen is preferred
- Draw diagrams using pencil
- Write your Centre Number and
Student Number at the top of
either pages 29 and 31,
or page 35

Total marks – 100

Section I Pages 2–9

20 marks

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

Section II Pages 13–28

60 marks

- Attempt Questions 21–34
- Allow about 1 hour and 50 minutes for this section

Section III Pages 29–38

20 marks

- Attempt either Question 35 or Question 36
- 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.

- 1** Some children under the age of 18 are participating in a multiplayer web-based game intended for adults.

What issue does this raise?

- (A) User privacy
 - (B) Cyber safety
 - (C) Data security
 - (D) Intellectual property
- 2** Which of the following is an ergonomic consideration in software design?
- (A) The placement of screen icons
 - (B) The provision of back supports
 - (C) The height adjustability of the screen
 - (D) The backward compatibility of the software
- 3** A user does not know how to use a feature of a computer program.
- Which type of documentation should the user consult?
- (A) An online tutorial
 - (B) The installation guide
 - (C) The licensing agreement
 - (D) A troubleshooting guide

4 Which row of the table correctly compares features of sequential and relative files?

	<i>Sequential</i>	<i>Relative</i>
(A)	Access to a specific record is faster	Access to a specific record is slower
(B)	All records must be the same size	All key fields must be the same size
(C)	Inserting a record requires all records to be rewritten	Sorting records requires all records to be rewritten
(D)	Records are accessed from the beginning of the file	Records can be accessed using a key

5 The following algorithm needs to be tested for logic errors.

```
BEGIN
  input amount
  IF amount > 25 THEN
    IF amount ≥ 80 THEN
      discount = 30%
    ELSE
      discount = 20%
    END IF
  ELSE
    discount = 10%
  END IF
  output discount
END
```

Which of the following sets of test data would provide the best test for the algorithm?

- (A) 15, 25, 50, 80, 100
- (B) 24, 26, 50, 79, 81
- (C) 10, 20, 25, 30, 80
- (D) 5, 10, 15, 20, 25, 30, 35

- 6 The following was generated under controlled conditions as part of a software development process.

<i>Subroutine name</i>	<i>Total time (s)</i>	<i>Number of calls</i>	<i>Time per call (s)</i>
reverse	8	120	0.067
duplicate	6	754	0.008
capitalise	9	143	0.063

What type of documentation is this?

- (A) An IPO table
 - (B) A function chart
 - (C) A data dictionary
 - (D) A benchmark report
- 7 In a program, a variable is set to TRUE if certain conditions are met.

What type of variable is this?

- (A) Flag
 - (B) Stub
 - (C) Sentinel
 - (D) Constant
- 8 A team is developing a computer program. The team members want to save time during the debugging process, and they do not want to give the end-user access to the final source code.

Which row of the table shows the best translation methods to achieve this?

	<i>During debugging process</i>	<i>After debugging is complete</i>
(A)	Interpretation	Interpretation
(B)	Interpretation	Compilation
(C)	Compilation	Interpretation
(D)	Compilation	Compilation

- 9 Which row of the table best matches an installation method with a valid reason for choosing that method?

	<i>Installation method</i>	<i>Reason for choosing the method</i>
(A)	Pilot	The new system is only for a small number of users
(B)	Direct cut over	Training time is needed in the new system
(C)	Parallel	The availability of the data in the system is critical
(D)	Phased	Resources are not available for a proper trial of the new system

- 10 Big is an array of 500 random numbers. Small is an array of 40 random numbers. Both arrays have been sorted.

Which is the most efficient approach to identify the numbers that are in both of the arrays Big and Small?

- (A) Use a linear search on Small for each element in Big.
 - (B) Use a linear search on Big for each element in Small.
 - (C) Use a binary search on Small for each element in Big.
 - (D) Use a binary search on Big for each element in Small.
- 11 Which of the following systems modelling tools shows the order of execution in a piece of software?
- (A) Data dictionary
 - (B) Structure chart
 - (C) Context diagram
 - (D) Data flow diagram
- 12 Which of the following statements about decompilation is true?
- (A) It is a manual process.
 - (B) It does not produce meaningful identifiers.
 - (C) It uses reverse engineering as one of its processes.
 - (D) It produces an exact copy of the original source code.

13 For which of the following errors is a program trace particularly useful?

- (A) An endless loop
- (B) Invalid data entry
- (C) Mismatch of data types
- (D) Incorrect use of a programming reserved word

14 The EBNF statements below describe the syntax of a variable name in a programming language.

variable = <letter> { <letter> <digit> } [symbol]

letter = A | B | C | ... | Z

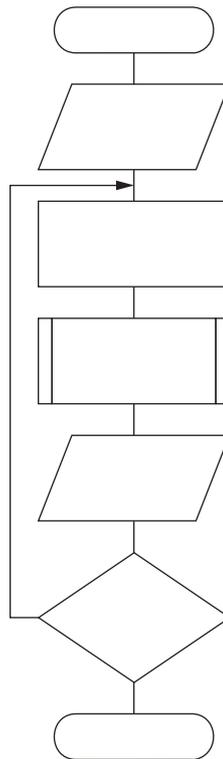
digit = 0 | 1 | 2 | ... | 9

symbol = ! | # | & | %

Which of the following is an acceptable variable name in this language?

- (A) FR2D2
- (B) FFF3#
- (C) A2A2%
- (D) B!#&%

15 Study the flow chart structure.



Which of the following sets of pseudocode has the same structure as the flow chart provided?

(A) BEGIN a(x,y)
 output z
 REPEAT
 func(done)
 y = y + 1
 output y
 UNTIL done
 END a

(B) BEGIN b(x,y)
 output z
 REPEAT
 y = y + 1
 func(done)
 output y
 UNTIL done
 END b

(C) BEGIN c(x,y)
 input z
 WHILE not done
 func(done)
 y = y + 1
 ENDWHILE
 END c

(D) BEGIN d(x,y)
 input z
 WHILE not done
 y = y + 1
 func(done)
 input z
 ENDWHILE
 END d

16 Which of the following occurs during the translation process?

- (A) Parsing of the machine code
- (B) Assembly of the source code
- (C) Syntactical analysis of the machine code
- (D) Generation of tokens from the source code

Use the following information to answer Questions 17–18.

Consider the fragment of code.

```
BEGIN Manipulate
  'REM List contains 20 elements, populated with data
  FOR index = 20 TO 1 STEP -1
    'REM random(x) produces an integer between 1 and x, inclusive
    N = random(index)
    Temp = List (N)
    List (N) = List (index)
    List (index) = Temp
  NEXT index
END Manipulate
```

17 What is random()?

- (A) An array
- (B) A variable
- (C) A function
- (D) A parameter

18 What does the fragment of code do to the elements of List?

- (A) It sorts the elements.
- (B) It reverses the order of the elements.
- (C) It rearranges the elements in random order.
- (D) It replaces all of the elements with one randomly generated value.

19 Consider the following assembly language instructions.

- LDA #nn Stores the number nn into the accumulator
- ADC #nn Adds the number nn to the contents of the accumulator
- ADC &nnnn Adds the number stored in address nnnn to the contents of the accumulator
- STA &nnnn Copies the contents of the accumulator and stores it in memory location nnnn

The following code is executed.

```
LDA #01
STA &8247
ADC #03
ADC &8247
```

Which of the following shows the change in the contents of the accumulator?

- (A) 1, 3, 4, 5
- (B) 1, 3, 4
- (C) 1, 3, 5
- (D) 1, 4, 5

20 A list of numbers is being sorted using one of these sorting methods: bubble, selection or insertion. The table shows the initial data and the list after the first pass.

Initial	4	2	8	5	7	1
After one pass	4	2	8	5	7	1

In what order will the items in the list be after the second pass?

- (A)

2	4	8	5	7	1
---	---	---	---	---	---
- (B)

4	2	8	5	7	1
---	---	---	---	---	---
- (C)

4	8	5	7	2	1
---	---	---	---	---	---
- (D)

8	4	2	5	7	1
---	---	---	---	---	---

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Software Design and Development

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Centre Number

Section II

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Student Number

60 marks

Attempt Questions 21–34

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

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.

Extra writing space is provided on pages 27 and 28. If you use this space, clearly indicate which question you are answering.

Write your Centre Number and Student Number at the top of this page.

Please turn over

Do NOT write in this area.

Question 21 (4 marks)

Using examples, describe how legal action can result from software development. **4**

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Question 22 (3 marks)

Contrast the use of storyboards and IPO diagrams during the software development process. **3**

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Question 23 (4 marks)

How can a software development company use project management tools to ensure satisfactory completion of its projects?

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Question 24 (3 marks)

A set of software is to be developed for a robotic vacuum cleaner.

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This robotic vacuum cleaner needs to be able to clean a house unattended, and needs to be able to move around objects that are in its way.

Explain why both sequential and event-driven approaches should be included in the design of the software.

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Question 25 (4 marks)

This diagram shows a webpage for registering users.

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REGISTRATION

Title <input style="width: 80%;" type="text"/>	Occupation <input style="width: 80%;" type="text"/>
Surname <input style="width: 90%;" type="text"/>	Hobby <input style="width: 90%;" type="text"/>
First Name <input style="width: 90%;" type="text"/>	
Sex <input style="width: 80%;" type="text"/>	Preferred Username <input style="width: 80%;" type="text"/>
Date of Birth <input style="width: 80%;" type="text"/>	Password <input style="width: 80%;" type="text"/>
<input style="border: 1px solid black; padding: 5px 15px; border-radius: 10px;" type="submit" value="Submit"/>	

New users are finding the registration process time consuming, having to enter details into a number of text boxes.

Draw and annotate a new registration webpage that captures user information more efficiently.

Do NOT write in this area.

Question 26 (6 marks)

A bank has outsourced the development of its new internet banking website to an overseas developer.

- (a) Describe the responsibility of the developer with respect to the website and to any related data that are to be stored in it. **3**

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- (b) Several months into the project, the bank is considering cancelling their agreement with the overseas developer due to dissatisfaction with the prototypes produced. **3**

Explain TWO possible problems in communication between the bank and the developer that may have caused this situation.

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Question 27 (6 marks)

A piece of custom software was used by a business for one year before errors started occurring. The software has not been updated since it was installed.

- (a) Outline TWO possible reasons for the errors occurring after one year. **3**

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- (b) In order to resolve the situation, what actions should be taken by the business and by the developer of the software? **3**

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Question 28 (3 marks)

The following algorithm is intended to store the results of the times tables of the numbers 1 through to 6 in the array product. The algorithm has logic errors.

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```
BEGIN
  row = 1
  WHILE row < 6
    FOR column = 1 to 6
      product (row, row) = column * column
    NEXT column
  END WHILE
END
```

The expected content of the array product is shown below.

1	2	3	4	5	6
2	4	6	8	10	12
3	6	9	12	15	18
4	8	12	16	20	24
5	10	15	20	25	30
6	12	18	24	30	36

Modify the algorithm so that it operates correctly.

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Question 29 (3 marks)

A real estate agency uses a system of three programs:

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- Sell — list properties, record owner details
- Buy — search for properties, record buyer details
- Rent — calculate rent, record leasing information.

The agency has checked that the leasing information is correct, but tenants have reported that they have been charged too much rent.

Which level(s) of testing (system, program, module) should be used to isolate the error? Justify your answer.

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Question 30 (4 marks)

A login subroutine is required. The subroutine should ask for a username and password, and allow for a maximum of five attempts from a user before locking the user's account.

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The subroutines `Check_details` and `Lock_account` have already been developed.

`Check_details` (username, password)

Returns true if the password is correct for the username, and false if it is incorrect.

`Lock_account` (username)

Locks the user out of the system.

Write an algorithm for the login subroutine. You may use `Check_details` and `Lock_account` in your algorithm.

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Question 31 (9 marks)

A campsite has 20 cabins, each with 10 beds.

Students attending the campsite must form small groups (between 2 and 10 students per group) and are allocated to cabins to minimise groups being split.

A computer program needs to be developed to allocate groups to the different cabins.

Camp staff must then be able to:

- look up which cabin a student has been allocated to
- print out lists of students in each cabin, showing their name and the name of their group
- look up which group a student is in.

(a) Outline how arrays of records could be used in this program. **2**

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(b) Cabins are filled to capacity whenever possible so that the minimum number of cabins is used. Outline the steps required to allocate the groups to cabins. **3**

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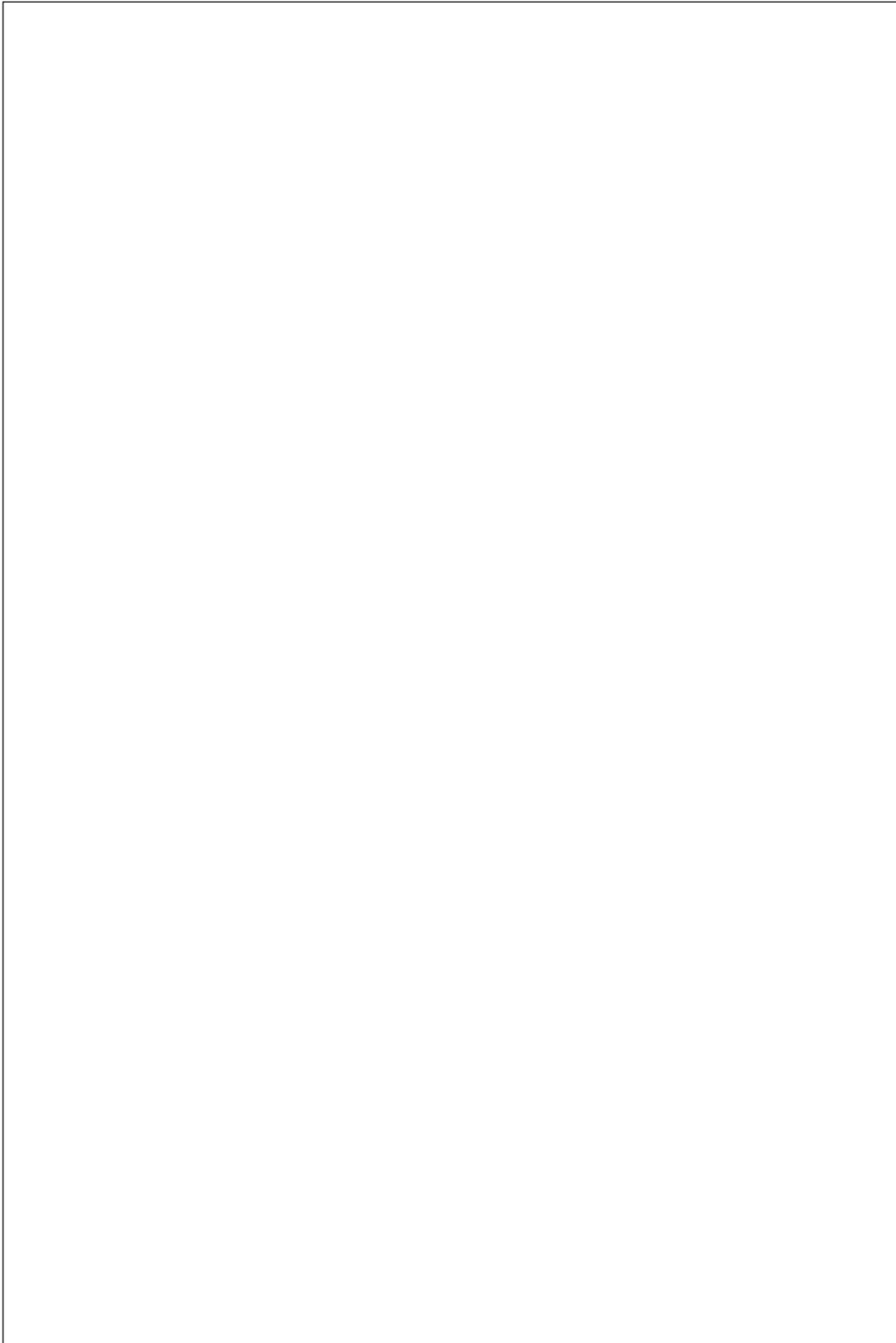
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Question 31 continues on page 23

Question 31 (continued)

(c) Draw a data flow diagram for this program.

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End of Question 31

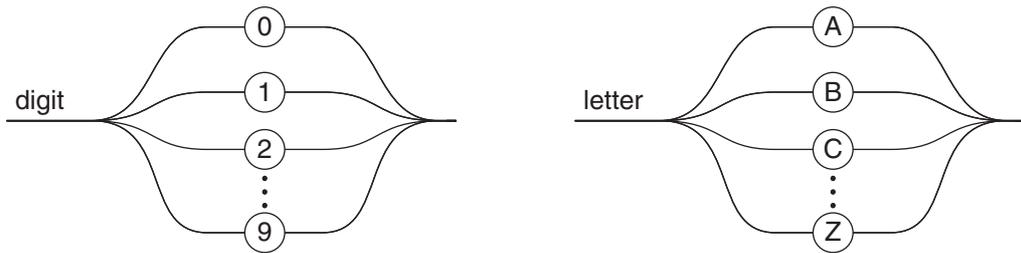
Question 32 (3 marks)

DIM statements are used to declare arrays in a particular programming language, for example:

3

DIM LIST[4] as string
DIM TABLE[3,125] as string
DIM MULTI[4,6,3,12,9] as integer

A digit and a letter are defined in this programming language as follows.



Draw a railroad diagram to define a DIM statement in this programming language.

Do NOT write in this area.

Question 33 (4 marks)

An electronic book is to be developed. The book has 20 chapters. Chapter 1 has only one version. For each of the other chapters, there are three versions.

4

At the end of each chapter (except Chapter 20), a brief description of each version of the next chapter is displayed, as a list of three options. The reader chooses a version of the next chapter from that list of options.

Write an algorithm to show the order in which the chapter versions are displayed, based on the reader's input.

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Question 34 (4 marks)

This algorithm finds and replaces a specific record in an array of records called recordlist. When coded, it runs unnecessarily slowly on an interpreter.

```
1  BEGIN find_and_replace (recordlist, key, record)
2      IF key ≤ size of recordlist THEN
3          FOR k = 1 to size of recordlist
4              IF k = key THEN
5                  recordlist (k) = record
6                  output 'record replaced at', k
7              END IF
8          NEXT k
9      END IF
10 END
```

- (a) Identify why the code runs unnecessarily slowly. 2

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- (b) Modify the algorithm so that, when coded, it runs faster on the same interpreter. 2

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Development**

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Centre Number

Section III

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Student Number

20 marks**Attempt either Question 35 or Question 36****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 35 — Programming Paradigms (20 marks)**Please turn over**

Question 35 — Programming Paradigms (20 marks)

- (a) (i) Describe the strengths of the logic paradigm, with reference to a specific type of problem. **3**

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- (ii) Describe the strengths of the object-oriented paradigm, with reference to a specific type of problem. **3**

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Question 35 continues on page 31

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Software Design and Development

Centre Number grid

Centre Number

Section III (continued)

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Question 35 (continued)

- (b) In object-oriented programming, what is a method? 2

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- (c) A bank has decided to implement new software using the object-oriented paradigm.

The bank has two types of tellers: a normal teller and a FastCash teller. FastCash tellers are not allowed to open accounts because they take a long time. The developer for the bank has created a class called FastCash, which is a subclass of Teller.

```
class Teller {
  public -
  open_account(customer):
    type = class of customer
    balance = 0
    database.create_account(customer, type, balance)
  withdraw(customer,amount):
  deposit(customer,amount):
  get_balance(customer):
}
class FastCash {
  is a Teller
}
```

- (i) Outline ONE way that the FastCash class can be prevented from opening accounts while keeping all the other aspects of a Teller. 2

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Question 35 continues on page 32

Question 35 (continued)

- (ii) The bank has different types of customers. One type of customer is a VIP customer. VIP customers are allowed to have any type of teller open an account for them. The developer for the bank has created a class called VIP, which is a subclass of Customer and has modified the FastCash class to only allow VIP customers to open an account.

3

```
class Customer {
    public –
        current_teller: Teller

    open_account():
        IF current_teller is set THEN
            current_teller.open_account(self)
        ENDIF
    withdraw(amount):
    deposit(amount):
    get_balance():
}
class VIP {
    is a Customer
}
```

The developer has written the following code to test the software.

```
chris = new Customer()
sam = new Customer()
kim = new VIP()
lyndon = new VIP()

cameron = new Teller()
denny = new FastCash()

chris.current_teller = cameron
kim.current_teller = cameron
sam.current_teller = denny
```

Question 35 continues on page 33



Question 35 (continued)

For each of the following instructions, state whether it will open an account or not. For those that do, explain why. For those that don't, explain why not.

- 1 chris.open_account
- 2 kim.open_account
- 3 sam.open_account
- 4 lyndon.open_account

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Question 35 continues on page 34



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Software Design and Development

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Centre Number

Section III (continued)

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Student Number

Do NOT attempt Question 36 if you have already attempted Question 35.

Question 36 — The Interrelationship between Software and Hardware
(20 marks)

- (a) Explain how 2's complement is used in the binary subtraction $00110011 - 01001010$. 3

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Question 36 continues on page 36

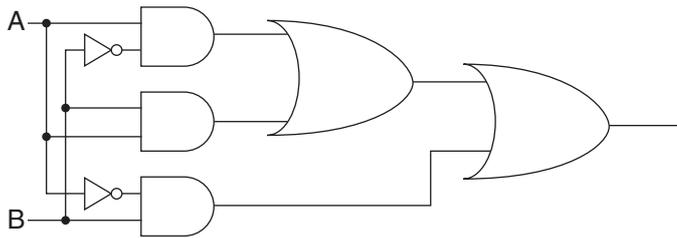
Question 36 (continued)

(b) The notations of Boolean algebra are:

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<i>Notation</i>	<i>Meaning</i>
$A \cdot B$	A AND B
$A + B$	A OR B
$A \oplus B$	A XOR B
\overline{A}	NOT A

Consider this logic circuit.



Write the Boolean representation of this circuit.

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(c) A logic circuit has two inputs, A and B, and one output, Z.

3

Z is 1 if the input A is 0.
 Z is also 1 if the inputs A and B are not the same.
 Otherwise, Z is 0.

Draw a circuit that achieves this. You may use a truth table to help you.

Question 36 continues on page 37



Question 36 (continued)

- (d) Explain how flip-flop circuits are used in the storage and shifting of bits in memory. You may include a diagram in your response. **3**

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- (e) Floating point numbers and integers can both be stored using 32 bits. Compare and contrast these two methods of number representation. **3**

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Question 36 continues on page 38





Question 36 (continued)

(f) A computer network consists of several workstations and a number of printers. When a print job is sent to a printer, data is sent back to the workstation indicating the status of the job. A document containing both text and graphics is sent to a printer.

(i) Explain the need for control characters in the data block of the data stream sent to the printer. 2

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(ii) With specific reference to the header, data block and trailer, compare the data stream sent from a workstation to a printer with the data stream sent from that printer back to the workstation. 4

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