

Software Design and Development

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 31 or pages 35 and 39

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 21–32
- Allow about 1 hour and 50 minutes for this section

Section III Pages 29–40

20 marks

- Attempt either Question 33 or Question 34
- 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 A team has been contracted to create a software package.

Which of the following is the team's most appropriate first step?

- (A) Use a Gantt chart to plan the development
- (B) Look for useful modules in a software library
- (C) Interview the client for the system requirements
- (D) Create a prototype to show different interface styles

2 A council website is being developed to allow residents to nominate one day of the week for garbage collection, and to select a bin from one of three sizes.

Which combination of screen elements would be best for capturing the residents' choices of collection day and bin size?

	<i>Collection day</i>	<i>Bin size</i>
(A)	Drop-down list	Radio buttons
(B)	Drop-down list	Check boxes
(C)	Text box	Radio buttons
(D)	Text box	Check boxes

3 Which of the following is represented in a data flow diagram?

- (A) The order in which processes occur
- (B) Where data originates and where it is stored
- (C) The sequence of tasks involved in completing a project
- (D) The decisions that are made when sub-modules are called

- 4 It is legal to copy software and sell the copies if
- (A) copyright is acknowledged.
 - (B) the software is open source.
 - (C) the software has been paid for.
 - (D) the licence specifies that this is allowed.
- 5 Some of the variables in a program are to be given new names.

Which documentation must also be modified?

- (A) Storyboard
 - (B) Data dictionary
 - (C) System flowchart
 - (D) Requirements definition
- 6 Consider this algorithm.

```
BEGIN
  N = 20
  CASEWHERE N is
    less than 10 : N = N + 5
    less than 30 : N = N + 10
    less than 50 : N = N + 30
    OTHERWISE : N = N + 50
  ENDCASE
  Display N
END
```

What is the output of the algorithm?

- (A) 70
- (B) 60
- (C) 30
- (D) 25

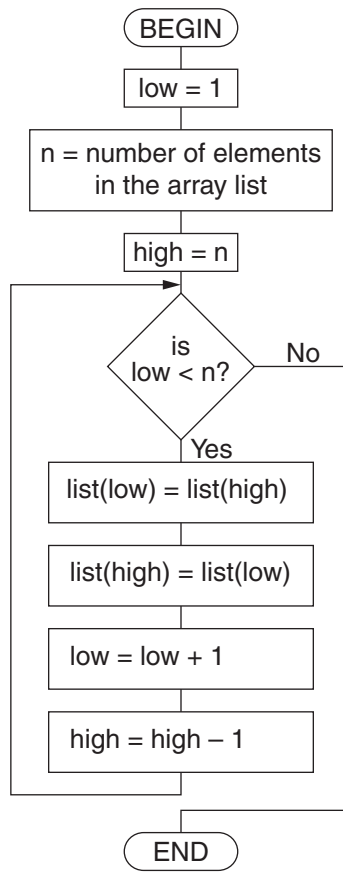
- 7 How can the inclusivity of a computer program be enhanced?
- (A) By replacing password characters with asterisks
 - (B) By providing a range of methods for inputting data
 - (C) By providing all the necessary library routines in a single DLL
 - (D) By ensuring that all sources have been included in the acknowledgements
- 8 Which of the following is usually a benefit of using the pilot method of installation?
- (A) The development time is reduced.
 - (B) A backup of data is created for each new transaction.
 - (C) The personnel involved can be available to train others.
 - (D) CASE tools can be more effectively used.
- 9 Which row of the table best matches the data item with a suitable data type?

	<i>Data Item</i>	<i>Data Type</i>
(A)	A telephone number	Boolean
(B)	One student's personal details	Real
(C)	The status of a radio button	Boolean
(D)	A list of winning lottery numbers	Real

- 10 Which row of the table correctly matches documentation with its purpose?

	<i>Documentation</i>	<i>Purpose</i>
(A)	Logbook	Recording progress and problems encountered during software development
(B)	Storyboard	Showing the links between hardware devices and the data being processed
(C)	IPO chart	Testing the system for logic errors
(D)	Benchmark report	Showing the order of execution of program modules

Use the following algorithm to answer Questions 11 and 12.



11 Which of the following control structures is used in the flowchart?

- (A) Binary selection
- (B) Pre-test repetition
- (C) Post-test repetition
- (D) Multiway selection

12 Originally the array called list contains five numbers.

1	3	5	7	9
---	---	---	---	---

What will list contain after the algorithm is executed?

- (A)

1	3	5	3	1
---	---	---	---	---
- (B)

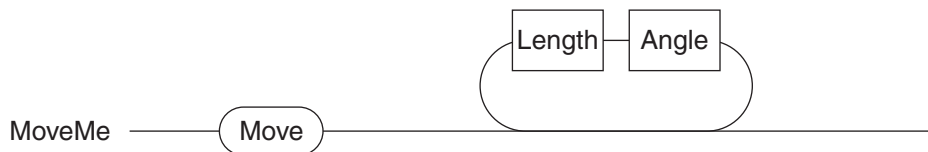
1	3	5	7	9
---	---	---	---	---
- (C)

9	7	5	3	1
---	---	---	---	---
- (D)

9	7	5	7	9
---	---	---	---	---

- 13** What is the role of the program counter?
- (A) It stores the address of the next instruction.
 - (B) It counts the number of times a loop is executed in a program.
 - (C) It keeps track of the line number in the source code as it is being translated.
 - (D) It stores the number of users permitted to simultaneously access a program.

- 14** MoveMe is defined by the following railroad diagram.



Which of the following EBNF statements is a correct representation of MoveMe?

- (A) $\text{MoveMe} = \text{Move} \{ \langle \text{Angle} \rangle \langle \text{Length} \rangle \}$
 - (B) $\text{MoveMe} = \text{Move} [\langle \text{Angle} \rangle \langle \text{Length} \rangle]$
 - (C) $\text{MoveMe} = \text{Move} \{ \langle \text{Length} \rangle \langle \text{Angle} \rangle \}$
 - (D) $\text{MoveMe} = \text{Move} [\langle \text{Length} \rangle \langle \text{Angle} \rangle]$
- 15** A developer applies reverse engineering to a piece of software.

What is the developer trying to achieve?

- (A) To revert to a previous version
- (B) To retrieve the original source code
- (C) To understand how the software works
- (D) To ensure compatibility with older versions

- 16 The following algorithm is designed to allow the user up to three attempts to enter a correct password.

```
1 BEGIN
2     Count = 1
3     Flag = False
4     WHILE.....
5         GetPassword(PasswordAttempt)
6         IF PasswordAttempt is correct THEN
7             Flag = True
8             Display "Enter"
9         ELSE
10            Display "Incorrect"
11            Count = Count + 1
12        ENDIF
13    ENDWHILE
14 END
```

Which of the following correctly completes line 4?

- (A) $\text{Count} < 3 \text{ OR } \text{Flag} = \text{True}$
 - (B) $\text{Count} < 4 \text{ OR } \text{Flag} = \text{True}$
 - (C) $\text{Count} < 3 \text{ AND } \text{Flag} = \text{False}$
 - (D) $\text{Count} < 4 \text{ AND } \text{Flag} = \text{False}$
- 17 An array was originally

4	5	10	7	7
---	---	----	---	---

After one pass of a sort, the array became

4	5	7	7	10
---	---	---	---	----

In which of the following are ALL the sorting methods listed capable of producing this result?

- (A) Bubble, insertion
- (B) Bubble, selection
- (C) Insertion, selection
- (D) Bubble, insertion, selection

18 Consider the following algorithm.

```
BEGIN
  number = 5
  WHILE number < 200
    Display number
    Increment number by 2
  ENDWHILE
END
```

Which of the following algorithms will produce the same output?

(A) BEGIN
 REPEAT
 Display number
 number = number + 2
 UNTIL number > 200
END

(B) BEGIN
 FOR number = 2 to 100
 Display number * 2 + 1
 NEXT number
END

(C) BEGIN
 number = 5
 REPEAT
 Display number
 Increment number by 2
 UNTIL number = 200
END

(D) BEGIN
 FOR number = 5 TO 200 STEP 2
 Display number
 NEXT number
END

19 After an array is sorted, its elements appear in the following order.

-10	100.78	7.8	71
-----	--------	-----	----

What type(s) of data does the array contain?

- (A) Real
- (B) String
- (C) Real and integer
- (D) String and integer

- 20** Diff(a, b, result) is a subroutine that accepts two numbers as input. It returns “yes” in result if the difference between the numbers is less than 10. Otherwise it returns “no”.

Which of the following code fragments would be most useful for testing the subroutine with a range of values?

- (A) REPEAT
 input a
 input b
 Diff(a, b, result)
UNTIL result = “yes”
- (B) result = “no”
input a
input b
IF $b - a < 10$ OR $a - b < 10$ THEN
 result = “yes”
ENDIF
Display result
- (C) FOR x = 1 TO 100
 input a
 input b
 Diff(a, b, result)
NEXT x
Display result
- (D) input again
WHILE again \neq “no”
 input a
 input b
 Diff(a, b, result)
 Display result
 input again
ENDWHILE

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Software Design and Development

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Centre Number

Section II

60 marks

Attempt Questions 21–32

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

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Student Number

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.

Do NOT write in this area.

Please turn over

Question 21 (2 marks)

Outline TWO reasons for maintaining software.

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Question 22 (4 marks)

Describe how a completed program could be tested before it is released.

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Question 23 (7 marks)

- (a) What information about a library routine should be documented to enable its use by other programmers? **3**

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- (b) The subroutine CharTally(String, Char, Count) counts the number of times a character (Char) appears in String and returns the result in Count. **4**

A one-dimensional array called Students contains 20 names.

Write an algorithm to count the total number of times that the lower-case letter 'f' appears in the array Students. Use the subroutine CharTally in your algorithm.

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Question 24 (3 marks)

Using examples, distinguish between the effects of runtime errors and logic errors. **3**

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Question 25 (3 marks)

Explain why software developers may provide free updates for purchased software. **3**

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Do NOT write in this area.

Question 26 (4 marks)

A club has 200 members.

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Each member's information is contained in an unsorted array of records called Members. The ID for each member is unique.

The following algorithm displays the name of a member after the member's ID is entered.

```
BEGIN
  Get MemberID
  FOR Counter = 1 to 200
    IF MemberID = Members(Counter).ID THEN
      Display Members(Counter).Name
    ENDIF
  NEXT Counter
END
```

Rewrite the algorithm so that:

- it displays 'Invalid ID' if the ID entered is not found
- the linear search terminates as soon as a member's name has been displayed.

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Question 27 (3 marks)

Software applications are now created to run on a range of portable devices, such as smart phones and tablets, as well as a range of desktop computers.

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Outline how this affects software development.

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Question 28 (7 marks)

A chain of video stores is introducing an ATM-style kiosk that will enable customers to copy movies to their own USB devices.

The kiosk will provide movie information, enable payment and allow download to a USB device.

- (a) Discuss the suitability of both the prototyping and rapid application development approaches for developing this system.

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Question 28 continues on page 19

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Question 28 (continued)

(b) The kiosk interface will include the following features:

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- a search option
- a list of movies resulting from a search
- ability to choose to see details of a selected movie
- payment and download instructions.

A storyboard is being produced to represent how the kiosk interface will operate. The first screen of the storyboard is shown below.

Complete the storyboard. Note that within each screen there need only be a title and necessary buttons.

SEARCH screen
<input type="text"/>
<input type="button" value="Search movies"/>

Do NOT write in this area.

End of Question 28

Question 29 (9 marks)

A program is required to operate an online shopping service. The following algorithm was written by a developer at an early stage of development.

```
BEGIN Main
  VegPrice = 0
  MeatPrice = 0
  Display menu
  Input MenuChoice
  WHILE MenuChoice is not "Finish"
    CASEWHERE MenuChoice is
      "Vegies" : Veg (VegPrice)
      "Meat"   : Meat (MeatPrice)
    ENDCASE
    Display menu
    Input MenuChoice
  ENDWHILE
  ShowTotal (VegPrice, MeatPrice, Total)
END Main

BEGIN Veg (VegPrice)
  Display "Veg module called"
  VegPrice = 10
END

BEGIN Meat (MeatPrice)
  Display "Meat module called"
  MeatPrice = 20
END

BEGIN ShowTotal (VegPrice, MeatPrice, Total)
  Total = VegPrice + MeatPrice
  Display VegPrice, MeatPrice, Total
  get confirmation
  IF confirmation = True THEN
    Pay (Total)
  ELSE
    Clear
  ENDIF
END

BEGIN Pay (Total)
  Display "Pay module called"
  Display Total
END

BEGIN Clear
  Display "Clear module called"
END
```

Do NOT write in this area.

Question 29 continues on page 21

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Question 29 (continued)

- (a) What purpose does the Main module have for the user? 2

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- (b) The algorithm contains the stubs Veg, Meat, Pay and Clear. 3

Explain the purpose of these stubs in developing this program.

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- (c) Draw a structure chart corresponding to the algorithm shown. 4

End of Question 29

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Question 30 (5 marks)

A car dealership maintains information about all the cars that it has for sale. The information about each car includes:

- ID
- Make
- Model
- Manual/Auto
- Price
- Year of manufacture.

A developer is required to write a program which:

- maintains records of cars bought and sold
- enables dealers to search for cars that meet different specifications.

(a) Why is an array of records appropriate for manipulating this data? **2**

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(b) Discuss whether the data in the array of records should be sorted. **3**

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Question 31 (9 marks)

Valid serial numbers for a device must be:

- 5 characters in length
- start with a # symbol
- contain 3 digits
- end with a # symbol.

For example, #123# is a valid serial number.

The following algorithm was designed to check if a given serial number is valid.

```
1 BEGIN
2     Input SerialNumber and store the characters in the array of characters called Serial
3     Valid = False
4     IF (Length of SerialNumber = 5) AND (Serial(1) is "#") THEN
5         FOR Counter = 2 to 5
6             IF Serial(Counter) is a digit THEN
7                 Valid = True
8             ELSE
9                 Valid = False
10            ENDIF
11        NEXT Counter
12    ENDIF
13    IF Serial(5) is not "#" THEN
14        Valid = False
15    ENDIF
16    Display Valid
17 END
```

(a) Deskcheck the algorithm using the serial number #1k3# as input.

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Question 31 continues on page 25

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Question 31 (continued)

- (b) The algorithm contains errors. Show how the algorithm should be modified to correct the errors. 3

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- (c) List test data necessary to test the logic of the algorithm. Justify each item in your list. 3

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End of Question 31

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Question 32 (4 marks)

A computer game based on cards numbered from 1 to 28 is to be developed. The 28 cards are stored randomly in an array called Cards. An example is shown.

4

Cards

8	1	7	5	11	12	26	13	19	14	22
---	---	---	---	----	-----	-----	-----	----	----	----	----	----	----

There are four players and each player is dealt seven cards. An array is assigned to each player for storing their cards. The players are given cards from the array Cards one card at a time starting with Player 1, then Player 2, Player 3, Player 4, and then back to Player 1, Player 2, Player 3, Player 4 and so on.

Examples of the players' arrays are shown.

Player 1

8	11	4	3	17	27	13
---	----	---	---	----	----	----

Player 2

1	9	2	10	20	28	19
---	---	---	----	----	----	----

Player 3

7	21	16	15	25	12	14
---	----	----	----	----	----	----

Player 4

5	18	23	6	24	26	22
---	----	----	---	----	----	----

Write a subroutine called DealCards to distribute the cards from the array Cards to each of the four players. In your algorithm, include appropriate control and data structures.

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Section II extra writing space

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2015 HIGHER SCHOOL CERTIFICATE EXAMINATION
Software Design and Development

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Centre Number

Section III

20 marks

Attempt either Question 33 or Question 34

Allow about 35 minutes for this section

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Student Number

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 33 — Programming Paradigms (20 marks)

- (a) An e-learning application, composed of various types of activities, is to be developed. 4

Each type of activity will have:

- a user interface specification
- prerequisite conditions that students must meet before they can use it.

When an activity is completed, the application suggests further activities based on the student’s interests and how well the student completed the activity.

Discuss the suitability of the logic paradigm and the object oriented paradigm for developing this application.

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Question 33 continues on page 30

Question 33 (continued)

- (b) Using an example, outline why heuristics are used in some software solutions. 2

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- (c) This is a fragment of logic paradigm code, with

- salary(P,S) defined as ‘the salary of person P is amount S’
- employer(P,E) defined as ‘the employer of person P is employer E’.

```
salary(kim,56000).
salary(chris,23000).
salary(jay,46000).
salary(al,51000).
salary(jo,61000).
employer(chris,kim).
employer(kim,jay).
employer(al,jay).
employer(sam,jay).
valuable_employee(X):- employer(X,_), salary(X,S), S > 50000.
```

- (i) Extend the fragment of code, using facts only, so that Ling is a valuable employee. 2

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- (ii) Evaluate valuable_employee(E)?. Show reasoning. 2

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Question 33 continues on page 31



2015 HIGHER SCHOOL CERTIFICATE EXAMINATION
Software Design and Development

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Centre Number

Section III (continued)

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Student Number

Question 33 (continued)

Please turn over



Question 33 (continued)

- (d) A custom car manufacturer makes cars to order based on customers' selections of components. Each component may be standard or specialised.

The cost of a car is calculated by totalling the costs of all components. The cost of each standard component is fixed. The cost of a specialised component is calculated by adding the cost of the specialisation to the cost of the standard component.

The software to manage customers' selections is being developed. This fragment of code has been designed to be part of the software.

```
class Car {
  private –
    components: array of Component
  public –
    cost():
      sum = 0
      FOR i = 1 TO number of components
        sum = sum + components[i].cost()
      NEXT i
      return sum
}
class Component {
  public –
    cost(): REM returns the cost of the component
}
```

- (i) Explain how polymorphism AND inheritance can be used in the development of this software. 4

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Question 33 continues on page 33



Question 33 (continued)

- (ii) A standard engine costs \$2000, but a V8 engine costs an extra \$800. **3**

Write the cost() method to calculate the cost of instances of the following subclasses of Component.

```
class Engine {  
    is a Component  
}
```

```
class V8Engine {  
    is a Engine  
}
```

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Question 33 continues on page 34



Question 33 (continued)

- (e) The following fragment of code from the object oriented paradigm was developed to declare an array that always keeps all its items in sorted order, when numbers are added or removed.

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The methods add() and remove() always call the method sort(). The method sort() calls the method swap().

```
class SortedArray {
    private –
        items: array of integer
        size: integer
    public –
        sort():
        swap(index1, index2):
            tmp = items(index1)
            items(index1) = items(index2)
            items(index2) = tmp
        add(number):
        remove(index):
}
```

The code contains an error.

Explain the consequences of the error and show how it can be corrected.

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End of Question 33

2015 HIGHER SCHOOL CERTIFICATE EXAMINATION
Software Design and Development

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Centre Number

Section III (continued)

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Do NOT attempt Question 34 if you have already attempted Question 33.

Question 34 — The Interrelationship between Software and Hardware
(20 marks)

- (a) Perform the calculation of 10111×111 using binary arithmetic, showing all necessary working. 2

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- (b) What are the benefits of using 2's complement to represent integers in computers? 2

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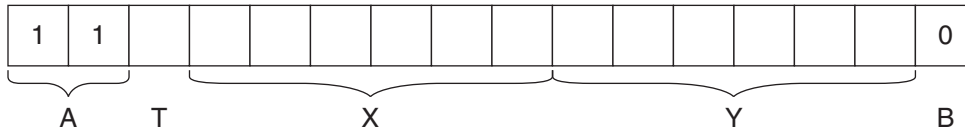
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Question 34 continues on page 36

Question 34 (continued)

(c) A computer-controlled cutting tool cuts straight lines.

Data streams sent from the computer to the tool are made up of 16-bit packets with the following structure.



A: start bits, always

1	1
---	---

T: tool setting bit
 0 = Tool up (not cutting)
 1 = Tool down (cutting)

X: 6 bits specifying the X-coordinate to which the cutter moves

Y: 6 bits specifying the Y-coordinate to which the cutter moves

B: stop bit, always

0

(i) The following data stream, in hexadecimal form, is sent to the cutting tool 3

D 6 A 0.

Each hexadecimal digit represents 4 bits of the data stream.

Describe what this data stream achieves.

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Question 34 continues on page 37

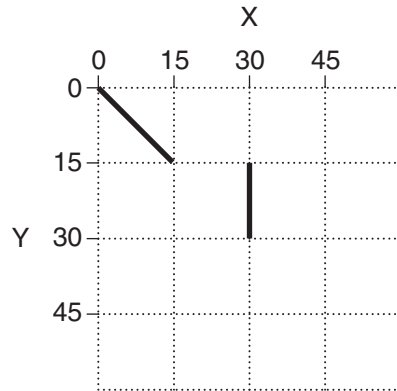


Question 34 (continued)

- (ii) The cutting tool is currently at $X = 0, Y = 0$.

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Write the data stream needed to cut the pattern shown below.



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Question 34 continues on page 39





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2015 HIGHER SCHOOL CERTIFICATE EXAMINATION Software Design and Development

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Centre Number

Section III (continued)

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Student Number

Question 34 (continued)

(d) In binary, the decimal fraction 7.5 is 111.1.

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In IEEE754 single precision floating point representation, the decimal fraction -7.5 is:

1	10000001	111000000000000000000000
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Identify the THREE components of the single precision floating point representation and outline how to represent -7.5 in this notation.

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Question 34 continues on page 40

Question 34 (continued)

(e) A car has an alarm system which works as follows:

- An alarm will sound if the key is in the ignition and the driver's door is open.
- The alarm will also sound if the key is not in the ignition while the lights are on.

In your answers to the questions below, use the following:

Component	1	0
Key	In ignition	Not in ignition
Door	Open	Closed
Lights	On	Off
Alarm	On	Off

(i) Draw a truth table for this alarm system.

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(ii) Draw a logic circuit to represent this system.

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