



Student Name Malachhi Haskew

2023 TRIAL HIGHER SCHOOL CERTIFICATE Software Design and Development

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators are NOT allowed

77%

Total Marks:
100

Section I – 20 marks (pages 3-9)

15

- Attempt questions 1-20
- Allow about 35 minutes for this section

Section II – 60 marks (pages 10-28)

44

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

Section III – 20 marks (pages 29-36) 18

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

Year 12 Software Design and Development Section I - Answer Sheet

Student Name: Malachi Haskew

Quick sort

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
 A B C D

System flow chart + shapes identifying errors

- If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

- If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word correct and drawing an arrow as follows.

A B C D
 correct →

1. ✓ A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/>	11. ✓ A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input checked="" type="radio"/>
2. ✓ A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input checked="" type="radio"/>	12. A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/>
3. ✓ A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input checked="" type="radio"/>	13. A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/>
4. ✓ A <input type="radio"/> B <input type="radio"/> C <input checked="" type="radio"/> D <input type="radio"/>	14. A <input checked="" type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/>
5. ✓ A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/>	15. A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input checked="" type="radio"/>
6. ✓ A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/>	16. A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/>
7. ✓ A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/>	17. A <input type="radio"/> B <input type="radio"/> C <input checked="" type="radio"/> D <input type="radio"/>
8. A <input checked="" type="radio"/> B <input type="radio"/> C <input checked="" type="radio"/> D <input type="radio"/>	18. A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/>
9. A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input checked="" type="radio"/>	19. A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/>
✓10. A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/>	✓20. A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/>

Section I

Total marks (20)

Attempt Questions 1 – 20

Allow about 35 minutes for this section

Use the multiple choice answer sheet

Select the alternative A, B, C or D that best answers the question

1. A school is introducing a new Learning Management System. It is introduced to one Year 7 class and then to the rest of the school 3 months later. Which method of installation is being used?
 - (A) Direct cut over
 - (B) Pilot
 - (C) Parallel
 - (D) Phased
2. Consider the following symbol used in data flow diagrams.



What does this symbol represent?

-
-
3. During which stage of the software development cycle should the software be assessed to ensure it meets the quality assurance criteria?
 - (A) Defining and understanding
 - (B) Planning and design
 - (C) Implementation
 - (D) Testing and evaluation

4. Which of the following is an example of user documentation?
 - (A) Source code
 - (B) Data dictionary
 - (C) Reference manual
 - (D) System documentation
5. What is a device driver?
 - (A) Software that enables interaction with hardware
 - (B) Hardware which provides an interface to specific software
 - (C) Code which takes the place of a subroutine under development
 - (D) A subroutine written during software development to test another subroutine
6. Which of the following would be considered an inclusivity issue when developing software?
 - (A) Number, currency, and time formats.
 - (B) Alignment of data entry elements.
 - (C) Appropriate use of fonts.
 - (D) Correct and consistent use of user interface elements.
7. Which of the following is part of the process of translating source code into machine code?
 - (A) EBNF
 - (B) Lexical Analysis
 - (C) Source Code Listing
 - (D) Implementing Solutions

8. Which of these does NOT need to be included when documenting a module?
 - (A) Author
 - (B) Purpose
 - (C) Detail of control structures
 - (D) Order and nature of parameters
9. Which of the following should be included in a data dictionary?
 - (A) Storage location in RAM
 - (B) Control structures
 - (C) Interface elements
 - (D) Example data
10. Consider the following algorithm.

```
BEGIN
    Get score
    calledProcess = False
    IF score < 40 THEN
        processScore(score)
        calledProcess = True
    ENDIF
    IF calledProcess = True THEN
        print "processScore was called"
    ENDIF
END
```

Which of the following best describes the role of the variable calledProcess in the algorithm?

- (A) Variable
- (B) Flag
- (C) Control parameter
- (D) Debugging output statement

11. Consider the following algorithm fragment.

```

BEGIN
  a = 10
  b = 20
  c = a
  WHILE b > 2
    a = a + 1
    c = a - 2
    b = b - c
  END WHILE
END

```

a	b	c
10	20	10
11	11	9
12	1	10

What are the values of a, b, c at the conclusion of execution?

	a	b	c
(A)	10	20	10
(B)	11	11	9
(C)	12	2	9
(D)	12	1	10

12. Below is the state of an array after the first two passes of a sorting algorithm.

Original Array:

15	4	22	8	2
----	---	----	---	---

Pass 1:

15	4	22	2	8
----	---	----	---	---

Pass 2:

15	4	2	8	22
----	---	---	---	----

Which sorting algorithm is being used?

- (A) Quick sort
- (B) Bubble sort
- (C) Insertion sort
- (D) Selection sort

Consider the following algorithm when answering questions 13 – 15.

```
1      BEGIN MyAlgorithm
2          last = array.Length
3          swapped = True
4          WHILE swapped = True
5              swapped = False
6              i = 1
7              WHILE i < last
8                  IF array[i] > array[i + 1] THEN
9                      Swap(array[i], array[i + 1])
10                     swapped = True
11                 END IF
12                 i = i + 1
13             END WHILE
14             last = last - 1
15         END WHILE
16         MyAlgorithm = array
17     END MyAlgorithm
```

13. What control structures are used in this algorithm?
- (A) Pre-test iteration, binary selection, sequence
 - (B) Pre-test iteration, multi-way selection, sequence
 - (C) Post-test iteration, binary selection, sequence
 - (D) Post-test iteration, multi-way selection, sequence
14. What is the logic performed by this algorithm?
- (A) Quick sort
 - (B) Bubble sort
 - (C) Insertion sort
 - (D) Selection sort
15. A programmer reviewing the code is concerned about line 9, and thinks it should be Swap(i, i+1). Which of the following is correct?
- (A) The original algorithm is correct.
 - (B) The programmer reviewing the code is correct.
 - (C) Both are incorrect, it should be Swap(array[i+1], array[i]).
 - (D) You cannot tell which is correct unless you examine the code for Swap.

16. A developer is writing a command-line script to batch rename all files within a specified folder. The command takes two parameters: the path to the folder, and a text file with the old filenames and the new filenames – to which the files should be renamed.
What would be the most appropriate type of programming language to use?
- (A) Sequential language
(B) Event-driven language
(C) Database query language
(D) Machine language
17. Consider the following algorithm where `arrayOfMarks` is an array of integers indexed from 0.
- ```
BEGIN CalculateAverage(arrayOfMarks)
 sum = 0
 i = 0
 WHILE i < number of elements in arrayOfMarks
 sum = sum + arrayOfMarks[i]
 i = i + 1
 END WHILE
 IF i >= 0 THEN
 Average = sum / i
 ELSE
 Average = 0
 END IF
 Return Average
END CalculateAverage
```
- There is an error in this algorithm. Which of the following best describes the error?
- (A) Compiler error  
(B) Syntax error  
(C) Logic error  
(D) Runtime error
18. What is used to store the results of processing from the ALU?
- (A) Accumulator  
(B) Instruction Register  
(C) Program Counter  
(D) RAM

Consider the following algorithms when answering questions 19 and 20.

**Small = 5**

**Average = 60**

**BEGIN ClassStatistics**

**FOR Index = 1 TO numberOfClasses**

**Class(Index).Mean = CalcMean(Index)**

**Class(Index).Count = CalcMax(Index)**

**NiceClass(Index) = Class(Index).Count > Small AND Class(Index).Mean > Average**

**NEXT Index**

**END**

*small      Average      index*  
      *5            60            1*

**BEGIN CalcMean(i)**

**RETURN 65**

**END**

**BEGIN CalcMax(i)**

**RETURN 15**

**END**

19. At this stage of development, CalcMean and CalcMax are best described as:

- (A) Stubs
- (B) Drivers
- (C) Functions
- (D) Subroutines

20. Which row gives the correct contents of the variables after the algorithm has been executed?

|     | Class(1).Mean | Class(1).Count | NiceClass(1) |
|-----|---------------|----------------|--------------|
| (A) | 15            | 65             | True         |
| (B) | 65            | 15             | True         |
| (C) | 15            | 65             | False        |
| (D) | 65            | 15             | False        |

## Section II

**Total marks (60)**

**Attempt Questions 21 – 31**

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

**Answer in the spaces provided on this paper.**

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

### Question 21. (3 marks)

XYZ High School is developing a system to allow for cashless payments at their school canteen. All student ID cards will be linked to a centralised payment system. Parents can logon to the web-based interface for the payment system and add money onto their child's student card via online credit card payment. They are then emailed a receipt confirming that the money loading has been successful.

**Marks**

**3**

**3**

The student can go to the canteen to purchase items, swipe their card, and have the relevant funds deducted for that purchase. On swiping, the student's card number is transmitted to the payment system which checks their balance. If funds are available, they are informed that the transaction was successful, the money is debited from their account, and they will be emailed a receipt to their school email address. If insufficient funds are available on the student's card, they are informed that the transaction was unsuccessful.

Describe the responsibilities of the software developer given the information being stored in the system.

Sensitive personal information is being stored. ~~such as~~ As such, the programmer has a responsibility to ensure the security of the system. The reliability of the system is also part of the programmers responsibility as if the system fails, ~~the~~ students will have no food.

Finally, the programmer must consider multicultural families who have parents unable to understand english, by having an option to change language and the units used for currency.

**Question 22. (3 marks)**

**Marks**

Outline TWO reasons why source code may need to be changed.

3

To repair a serious bug that went unnoticed during testing or was caused by outside events, such as for example the Year 2000 problem, or a security vulnerability.

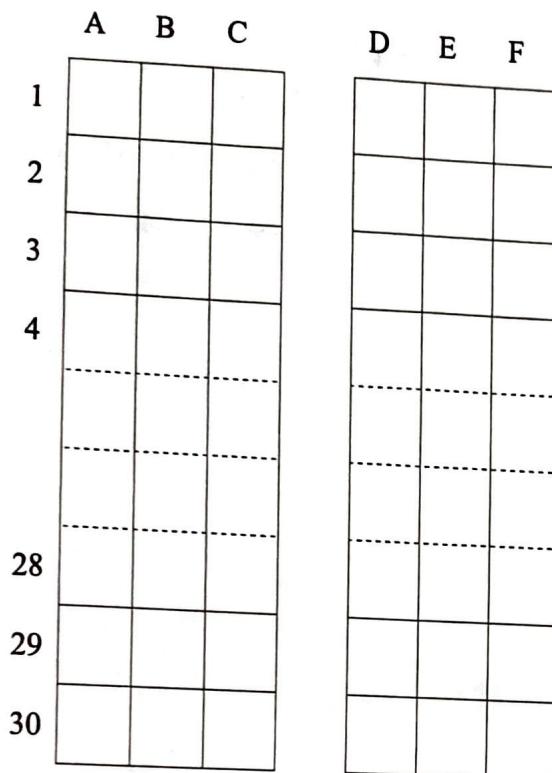
To add functionality. For example to stay competitive with other solutions.

**Question 23. (9 marks)**

*All parts of this question refer to the following information.*

You are writing part of the booking system for an airline, which has a fleet of aircraft in a 3-3 seating configuration. This is illustrated below.

Front of aircraft



The aircraft has 30 rows of seats (denoted with a number), and each row contains six seats (denoted by a letter).

The aircraft seating configuration has been represented within the booking system as a two-dimensional array of Booleans called seatArray. This array is globally defined.

As an example of how to use this data structure, the following code will print the first row of seats (from A to F) and indicate their occupied status.

```
FOR i = 1 to 6 STEP 1
 IF seatArray(1, i) = True THEN
 Print "Occupied"
 ELSE
 Print "Unoccupied"
 ENDIF
NEXT i
```

seatArray is indexed from 1.

*Question 23 continues on the next page.*

## Question 23. (continued)

Marks

- (a) Write an algorithm for a subroutine, rowCount(n), that will return the total number of seats that are currently occupied for the given row, n.

2

Begin rowCount(n)

    rowCount = 0

    FOR i = 1 TO i = 6 STEP 1

        IF seatArray(~~n~~, i) = True THEN

            rowCount + = 1

        ENDIF

    NEXT i

    Return rowCount

END rowCount

2

Question 23 continues on the next page.

**Question 23. (continued)****Marks**

- (b) Airlines often overbook flights – in other words, book more passengers onto a flight than seats on the aircraft. This occasionally results in some passengers having to be removed from the flight to vacate a seat for another passenger – who might have a higher tier / more expensive ticket. 3

Write an algorithm which will randomly find an **occupied** seat on the aircraft and return that seat number (e.g. 2B).

The following functions are available:

**RND(min, max)** which will return a random integer between, and inclusive of, min and max

**seatLetter(n)** which will return the letter of the seat given its numeric value between 1 and 6. e.g if n=3, seatLetter will return 'C'

```

Begin RandSeat()
 Seat Not Found = True
 FOR i = 1 TO i = 30 STEP 1
 WHILE seatNotFound
 row = RND(1, 30)
 seat = RND(1, 6)
 IF seatArray(row, seat) = True
 SeatNotFound = False
 ENDIF
 letter = seatLetter(seat)
 letter = SeatLetter(seat)
 Return (row, letter)
 ENDIF
 END WHILE
END RandSeat

```

return should be after WHILE

Question 23 continues on the next page.

## Question 23. (continued)

Marks

- (c) A customer would like to book  $n$  number of tickets on this aircraft. Write an algorithm which will find and display the  $n$  seats closest to the front, starting on the left, where all those people can sit together, next to each other.

4

3

For example, if 4 tickets are required and the aircraft is empty then the algorithm would display "Seats:1A-D".

You can assume:

- sitting across the aisle (i.e. seat C and seat D) does count as sitting next to each other.
- the customer books no more than six seats.

BEGIN Find-seats ( $n$ )

~~seats~~  $\rightarrow$  output = "none found"  $\leftarrow$  search back to front

FOR i = 3 TO i = 1 STEP -1

FOR j = 1 TO j = 7-n STEP 1

works = True

FOR k = 1 TO k = n STEP 1

IF seatArray(i, j+k-1) = True  
works = False  $\uparrow$  THEN

ELSE

output = "Seats : ", i,  $\leftarrow$

END IF

SeatLetter(j+n)

NEXT k

NEXT j

NEXT i

~~Output output~~

Display output

END Find-seats ( $n$ )

~~Does not check for adjacent seat availability.~~

~~Use WHILE not FOR to exit loops.~~

~~Inner loop can go beyond array limit~~

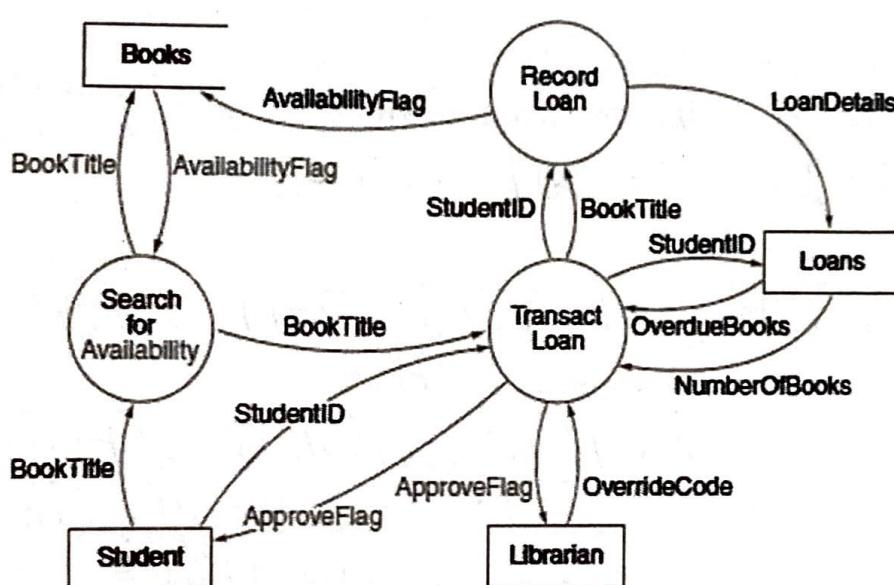
**Question 24 (4 Marks).**

Cheverton Girls' High School is implementing a new computerised system for its library. Once installed, students will need to use a computer terminal to check the availability of a book. The student's library card is then scanned into the system. The system searches through the student database to check the student's borrowing history. The student will be allowed to borrow a book if:

- she has no overdue books; and
- she currently has no more than four books on loan.

If the loan is disallowed, the librarian can still enter a code into the system to allow the loan.

A systems analyst has drawn the following diagram to represent the system.



(a) Identify the processes in the diagram

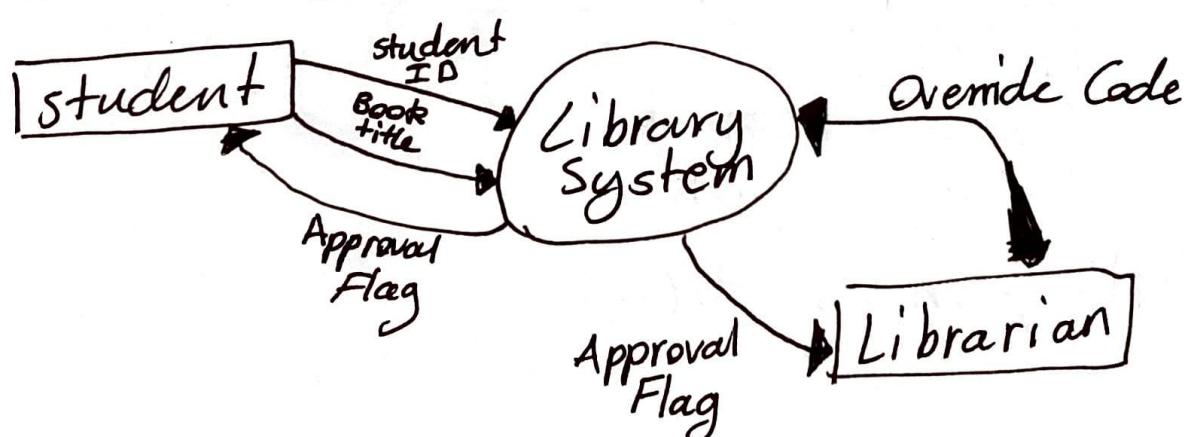
2

Search for Availability, Record Loan,  
Transact Loan

2

(b) Construct a context diagram which describes this system

2



2

## Question 25 (3 Marks).

3

A program requires a search algorithm, and the developer has to choose between a linear search and a binary search. Describe factors that would lead to the developer choosing a linear search instead of a binary search.

3

If the data set being searched is impractical to have sorted by the search key or if it is a data structure with multiple fields such as an array of records, then the developer might choose a linear search instead of needing to first sort the data-set by the search key. Additionally if speed is not a requirement, a linear search might be preferable due to its comparative simplicity to code. Finally if the vast majority of searches are on-

**Question 26 (4 Marks).****Marks**

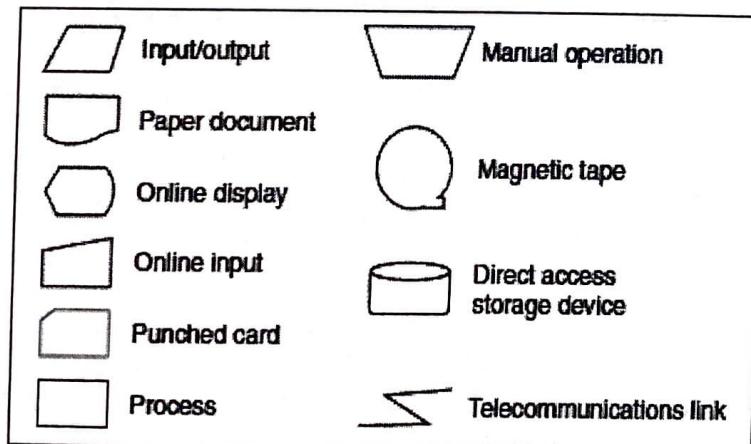
*This question refers to the following information.*

A company is developing a self-serve check-in system for an airline. This allows customers who are travelling with carry-on baggage only to check-in to their flight, anytime between 1 to 24 hours before the flight, and print their boarding pass, on a computerised kiosk at the airport – rather than having to line-up at the counter to speak with an airline customer service agent.

The workflow of the system is as follows:

- The customer arrives at the kiosk and enters the following details: first name, last name, flight number.
- The system queries a database to check whether the details are valid, and the flight departs within the next 1 to 24 hours.
  - If the details are not valid, or the timeframe for the flight is outside those limits, a message appears on screen telling the customer to see a customer service agent for assistance. The system then exits at this point and returns to the first screen.
- Assuming all details are valid, a screen is presented asking the customer to select their seat.
- Once seat selection is complete, the next screen asks the customer to confirm they are not carrying any prohibited goods on the aircraft.
  - If they say yes, a message appears on screen telling the customer to see a customer service agent for assistance. The system then exits at this point and returns to the first screen.
- Assuming the customer is not carrying any prohibited goods their check-in is processed:
  - Their checked-in status and seat allocation are written to a database.
  - Their boarding pass is printed.
- A thank you message appears. The system then exits at this point and returns to the first screen.

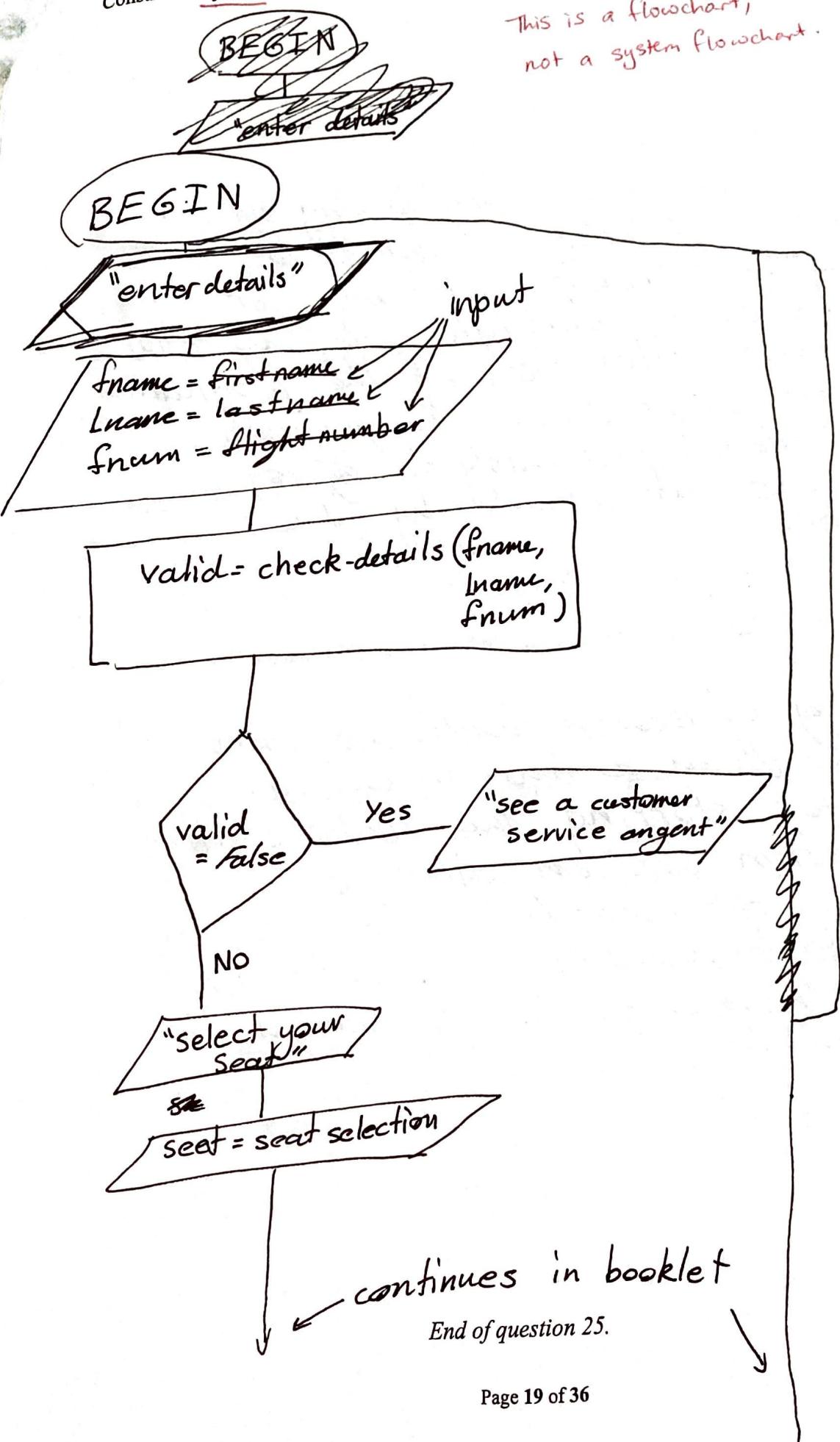
Reference Table



Construct a system flowchart for the above scenario

This is a flowchart,  
 not a system flowchart.

1



Start here

continued from paper

"are you  
carrying  
prohibited  
goods?"

answer = input

"see customer  
service  
agent"

input = True or "Yes"

Yes

No

write  
check-in status  
# and seat  
to database

Print boarding  
Pass

"Thank you"

END

**Question 27 (4 Marks).**

- (a) A software developer decides to distribute their module in a compiled format, such as a DLL, rather than as source code. 2

Justify why the software developer might have made this decision, to distribute a compiled version of the module rather than a source code version.

To prevent the users from looking at the source code. This may be to stop the identification of bugs or security flaws through code inspection. To prevent alteration of the program. This may be to ensure the program is not altered maliciously to bypass restrictions put in place by the developer.

- (b) Describe a scenario where an array of records would be more suitable than a two-dimensional array. 2

An array of records would be more suitable than a two-dimensional array for storing the flight-seating information for an aircraft.

An array of records would allow each seat number to correspond to the name of the passenger in that seat.

A name could be stored as easily in an array as in a record.

**Question 28 (4 Marks).****Marks**

Consider the following assembler code instructions for a CPU:

|                                |                                                                                                                                |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>LOAD RegX Value</b>         | Loads an integer <i>Value</i> into the register <i>RegX</i>                                                                    |
| <b>CPY RegX RegY</b>           | Copies the value in <i>RegX</i> to <i>RegY</i>                                                                                 |
| <b>INC RegX</b>                | Increments the value in <i>RegX</i> by 1                                                                                       |
| <b>JLE Value &lt;label&gt;</b> | Jumps to the top of the code defined by <i>&lt;label&gt;</i> if the value in <i>Reg1</i> is less than or equal to <i>Value</i> |
| <b>HALT</b>                    | Stops execution                                                                                                                |

**Note:**

*Reg0* is a special register. The process of storing a value in *Reg0* causes it to be immediately output to the screen.

*Reg1* can be used as a general-purpose register.

1

- (a) What is a register?

A location to store the output  
of logical operations in the  
CPU

1

- (b) Write a set of assembler instructions which will print the numbers 1 to 5 (inclusive).

3

3

LOAD Reg1 1  
 CPY Reg1 Reg0  
 INC Reg1  
 CPY Reg1 Reg0  
 INC Reg1  
 CPX Reg1 Reg0  
 TNC Reg1  
 CPY Reg1 Reg0  
 INC Reg1  
 CPX Reg1 Reg0  
 HALT

**Question 29 (6 Marks).**

**Marks**

- (a) Outline why software developers use structure charts in the development of software.

2

1

To plan and evaluate the system design. Using a structure chart allows developers to quickly create an overview of the programs logic for analysis and improvement without spending the time to write out the code.

more specific detail is needed about a structure chart.  
The above could apply to various charts.

Question 29 continues on the next page

## Question 29 (continued).

Marks

- (b) An algorithm for the mainline of the game is as follows.

```

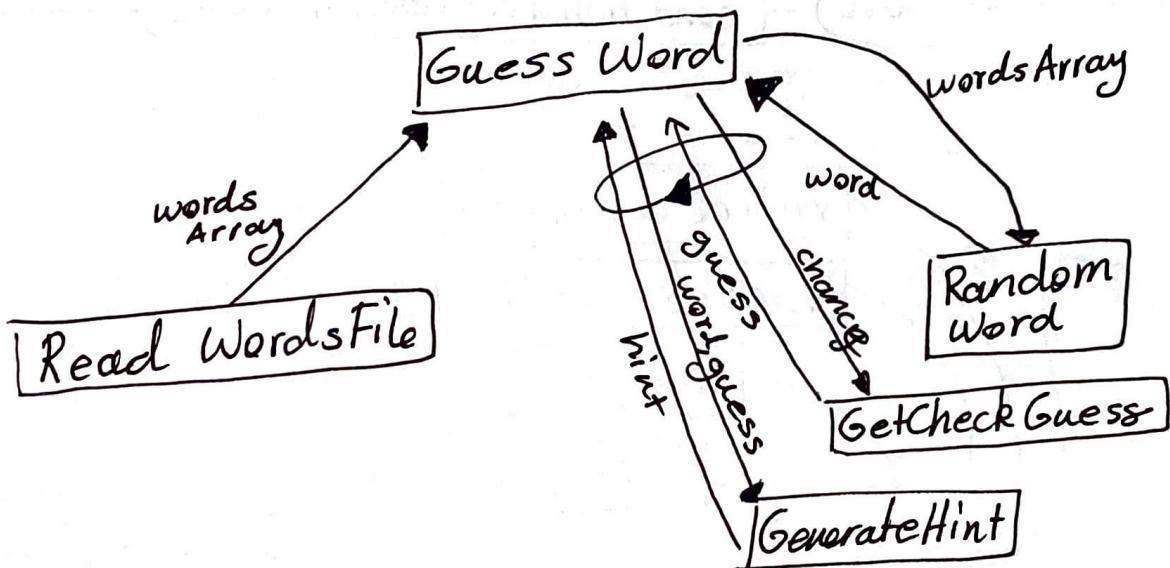
BEGIN GuessWord
 wordsArray = ReadWordsFile
 word = RandomWord(wordsArray)
 chance = 1
 REPEAT
 guess = GetCheckGuess(chance)
 hint = GenerateHint(guess, word)
 Print "Hint: " hint
 Increment chance
 UNTIL guess=word OR chance>10
 IF guess=word THEN
 Print "Got it in " chance " guesses"
 ELSE
 Print "No more chances – the word was " word
 ENDIF
END GuessWord

```

Create a structure chart for the above GuessWord mainline algorithm.

4

2



Order is important.

Random word module should be second.

Lines do not have arrows and only one is needed.

Missing data arrows eg.  $\text{O} \rightarrow$

**Question 30 (6 Marks).****Marks**

Consider the following EBNF description of part of a simple programming language.

```

letter = a | b | c | d | | x | y | z
digit = 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
variable = <letter>{<letter>}
constant = <digit>{<digit>}
characters = { ! | @ | # | $ | % | ^ | & | * | . | \ | <letter> | <digit> }
condition = < | > | = | <= | >=
conditional expression = <condition> <variable> <variable>
variable assignment = define <variable> <constant>
variable mutation = set <variable> (+ | -) <constant> ←
output = print (“<characters>” | <constant> | <variable>)
loop = when <conditional expression> do { <variable assignment> | <variable
mutation> | <output> | <loop> } loop

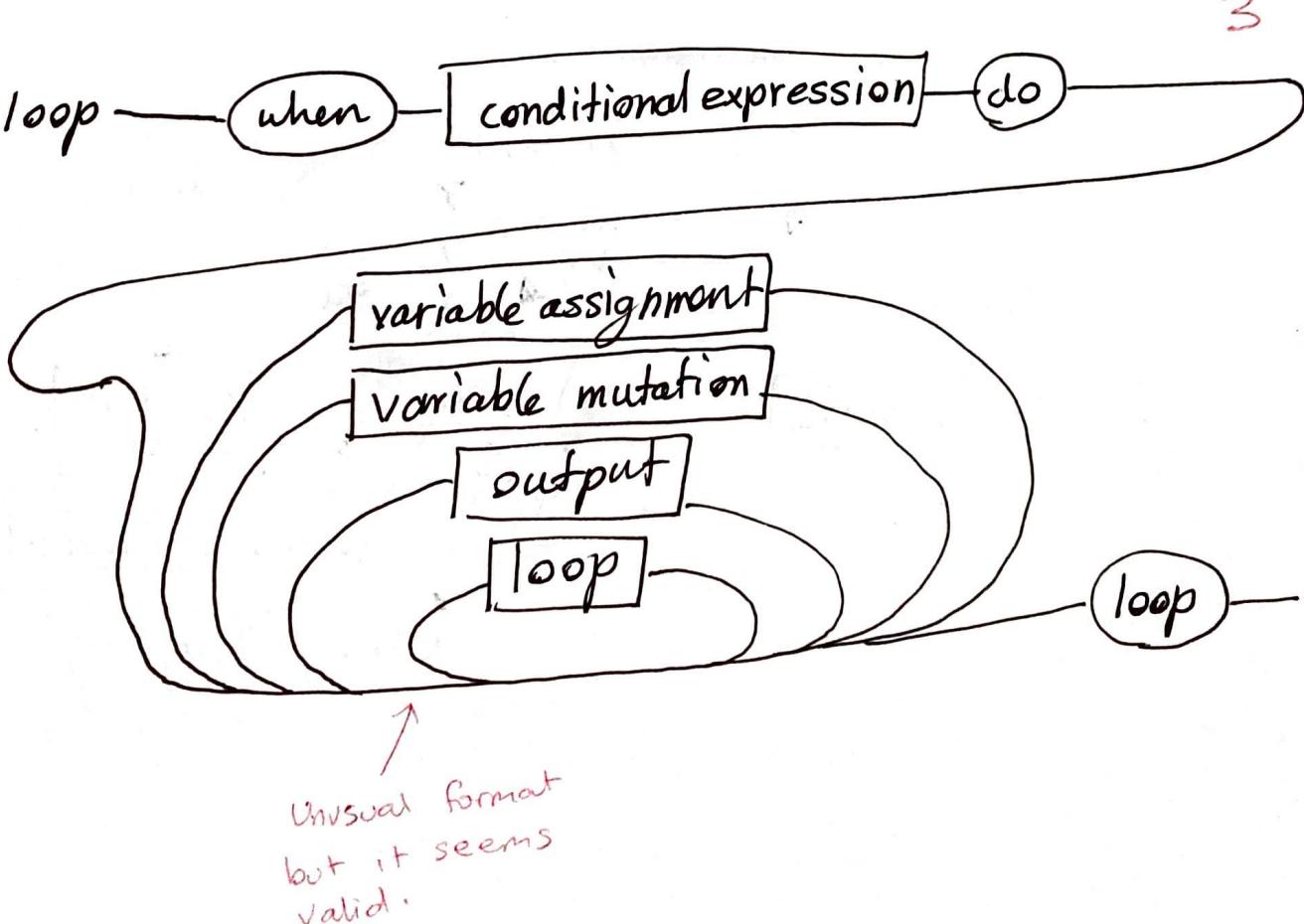
```

Example usage: <= x y  
would evaluate as true if x is less than or equal to y.

Example usage:  
set someVariable + 4 would add 4 onto the current value of someVariable.

(a) Draw a railroad diagram to represent the **loop** statement

3



*Question 30 continues on the next page.*

## Question 30 (continued).

Marks

- (b) This section of source code, written in the above simple programming language, contains syntax errors.

```

1 define height 3
2 define row 1
3 when <= row height do
4 column = 1
5 when <= column row
6 print "#"
7 set column + 1
8 loop
9 print "\n"
10 set row += 1
11 loop

```

Identify and correct the 3 lines that contain syntax errors.

3

0

improper variable assignment✓ in line ④

impossible to print "\n" in line ⑨

No "when" at the beginning of  
the second loop between lines

⑧ and ⑨ Alternatively, can't  
have loop on line ⑪ without  
a "when" before ✗

One Errors have been identified but the lines should  
have been re-written correctly.

## Question 31 (6 Marks).

- (a) Outline ONE project management technique and explain how it contributes to the effective management of a project.

3

The Rad or Rapid Application Development Approach allows for fast delivery of a working version of the application using "off the shelf" software solutions as a template to work with or from.

0

- (b) A golf course wishes to update their membership software. It has the following requirements:

3

- To store details of members, e.g. names, contact details.
- To handle details of visits by each member
- To print gift vouchers

2

A computer upgrade is occurring in 3 months' time and the management of the golf course would like the new software to be ready at the same time.

Recommend a suitable software development approach for the software and justify your choice.

~~Ag. Rad or Rapid Application Development would be the best choice due to the time restriction and the standard requirements that wouldn't require specialty software. This approach works better & is good due to its relatively small budget and fast turnaround time.~~

~~Link back to the scenario~~

**Question 32 (5 Marks).**

Consider the following algorithm when answering parts (a), and (b).

```

1 BEGIN printFileContents
2 Open myFile for Input
3 Read temp from myFile
4 WHILE temp <> zzz
5 Print temp
6 Read temp from myFile
7 ENDWHILE
8 Close myFile
9 END printFileContents

```

- (a) On line 2 the file has been opened for Input. Outline the difference between opening a file for Input, Output and Append.

3

3

Input allows the file to be read in and have its data read into the program. Output allows the program to write to the file, overwriting/clearing what is already there. Append allows the program to add onto the end of the file without overwriting.

- (b) Explain why two separate read statements are used.

2

1

The first read is a priming read to determine if the file only contains the sentinel value of 'zzz'. This allows the contents of the file to be printed, but prevents printing the sentinel value if the file is empty.

The second read is required because ...

**Question 33 (3 Marks)**

The following pseudocode is used to calculate the total receipts for a business (including GST).

## Marks

```

1 BEGIN
2 total = 0
3 gst_total = 0
4 get amount, gst
5 WHILE amount < > -1
6 total = total + amount
7 gst_total = gst_total + gst
8 get amount, gst
9 ENDWHILE
10 output total, gst_total
11 END

```

3

Desk check the algorithm using the following test data

| <i>Amount</i> | <i>GST</i> |
|---------------|------------|
| 22            | 2          |
| 44            | 4          |
| 33            | 3          |
| -1            | 0          |
| 11            | 1          |

End of Section II

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

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

**Marks**

- (a) (i) Compare and contrast the use of ASCII and Unicode when used to transmit data. 2

Ascii and Unicode can both be used to transmit data. Unicode is capable of transferring more variety in characters such as other languages. However, unicode characters would take longer to transmit than ascii characters.

- (ii) Express the decimal number -29 in 8 bit binary, using each of the following systems. Show all working. 2

I. Sign and modulus

II. 2's complement

|                                                                                                                                                                                              |                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| I. $29 \div 2 = 14 \text{ r } 1$<br>$14 \div 2 = 7 \text{ r } 0$<br>$7 \div 2 = 3 \text{ r } 1$<br>$3 \div 2 = 1 \text{ r } 1$<br>$1 \div 2 = 0 \text{ r } 1$<br><br>$\therefore 10011101$ ✓ | II. $1's = 11100010$<br>$2's = 1's + 1$<br>$= 11100011$ |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|

- (iii) Perform the following calculation in Binary, showing all working. 2

$$\begin{array}{r}
29 / 5 \\
\hline
1001 \overline{)100011001} \\
- 100 \\
\hline
01001 \\
- 100 \\
\hline
0000 \\
\end{array}
\quad
\begin{array}{r}
5 \sqrt[4]{10011101} \\
\hline
25 \\
\hline
4 \\
\hline
1 \\
\end{array}
\quad
\begin{array}{r}
5 \sqrt[4]{29} \\
\hline
25 \\
\hline
4 \\
\hline
1 \\
\end{array}$$

*00001001 ← 5 really?*

$$\begin{array}{r}
1001 \overline{)10001101} \\
- 1001 \\
\hline
110 \\
\end{array}
\quad
\begin{array}{r}
1001 \overline{)10001101} \\
- 1001 \\
\hline
01001 \\
\end{array}$$

Question 35 continues on the next page

- (b) Show how  $-\frac{3}{4}$  is converted to an IEEE754 single precision floating point binary number.

$$-\frac{3}{4} = -0.75_{10} = -0.011_2$$

sign bit = 1 (since value is negative)

$$0.11_2 = 1.1 \times 2^{-1}$$

$$\underline{\text{mantissa}} = 1000000\ldots$$

$$\text{exponent} = -1_{10} + 127_{10} = 126_{10}$$

$$\underline{126 \div 2} = 0$$

$$63 \div 2 \text{ r } 1 \quad \therefore 126_{10} = 111110$$

$$31 \div 2 \text{ r } 1$$

$$15 \div 2 = 7$$

2 ÷ 2 r 1

$$3 \div 2 = 1$$

the following ASC

dress 209E in me

209E: 43 6

- (c) The following ASCII character data expressed in Hexadecimal notation is stored at address 209E in memory.

209E: 43 61 67 65

- (i) Express the first TWO bytes in binary.

~~45~~ ~~1000~~ 01000011 01100001

- (ii) The instruction `DSP L, a1` displays the ASCII characters associated with the first  $L$  bytes from the specified memory address  $a1$ . The ASCII code for 'A' in decimal is 65.

What is displayed after executing the instruction DSP 2, 209E?

Show all working.

Show all working.

a

- (d) (i) Explain in words the purpose of an XOR gate and give its truth table.

returns ~~is~~ true when either of its inputs are ~~is~~ true but not both inputs.

2

2

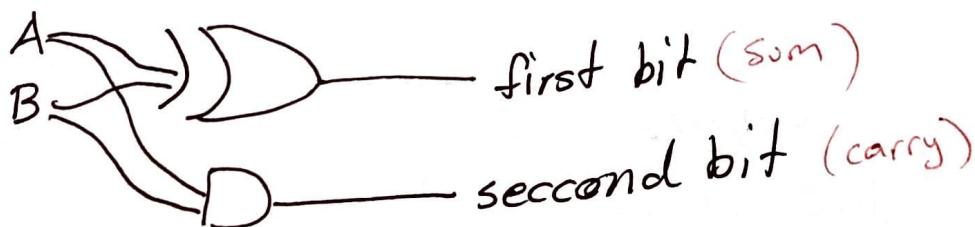
| A | B | $A \oplus B$ |
|---|---|--------------|
| 0 | 0 | 0            |
| 0 | 1 | 1            |
| 1 | 0 | 1            |
| 1 | 1 | 0            |

- (ii) Describe how an XOR gate can be utilised in the construction of a Half Adder.  
Illustrate your answer with a relevant circuit diagram.

2

2

An XOR gate can be used to allow the addition to the relevant place value to only occur if ~~be~~ either but not both inputs are 1. ~~else~~ If both are one, the addition needs to be carried to a higher place value.



Question 35 continues on the next page

- (a) Uncle Bill's Toy Company is producing a computer-controlled toy car. Commands to move the car are sent via an infra-red signal from a device connected to a port on the computer. The data stream sent consists of two consecutive data packets, each of which contains a start bit, a stop bit and eight data bits.

Marks

The eight data bits for the first and second packets represent the movement of the car in the X and Y directions respectively. The first of the eight bits is an instruction for direction (0 is for left or down while 1 is for right or up). The remaining seven bits are for the movement of the car in the required direction, measured in millimetres.

Hence the general format of the two packets in the data stream is:

| Start Bit                      |    |    |    |    |    |    |    |    |  |   | Stop bit |
|--------------------------------|----|----|----|----|----|----|----|----|--|---|----------|
| 0                              | Xd | X7 | X6 | X5 | X4 | X3 | X2 | X1 |  | 1 |          |
| $Xd = 0$ for left, 1 for right |    |    |    |    |    |    |    |    |  |   |          |

| Start Bit                   |    |    |    |    |    |    |    |    |  |   | Stop bit |
|-----------------------------|----|----|----|----|----|----|----|----|--|---|----------|
| 0                           | Yd | Y7 | Y6 | Y5 | Y4 | Y3 | Y2 | Y1 |  | 1 |          |
| $Yd = 0$ for down, 1 for up |    |    |    |    |    |    |    |    |  |   |          |

- (i) The two packets of one such data stream are 0101100101 0110100111. Describe the exact movement that this sequence represents

1

|                        |         |             |                          |
|------------------------|---------|-------------|--------------------------|
| right                  | 1100101 | up 1+       | $\therefore$ moves right |
| $1+4+32+64 = 101_{10}$ | 2       | 50mm        |                          |
| 36 22 32               | 4       | +67mm and 2 |                          |
| 64                     | 32      | up +67mm    |                          |
| 96                     | 128     | 83mm        |                          |
|                        | 167     |             |                          |

1  
2  
16  
64  
83 +

- (ii) Write the contents of the two packets for a data stream where the car moved left for 17 mm and up for 100 mm

2

|                 |                                           |
|-----------------|-------------------------------------------|
| 17 $\div$ 2 r 1 | 8 0 10001 <sub>2</sub> = 17 <sub>10</sub> |
| 4 0             | 0000100011                                |
| 2 0             | 0111001001                                |
| 1 1             |                                           |
| 0               |                                           |

2

End of paper