



80%

DOONSIDE TECHNOLOGY HIGH SCHOOL

COMPUTING FACULTY

2001

HIGHER SCHOOL CERTIFICATE
TRIAL EXAMINATION

Software Design and Development

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Write your student number and/or name at the top of every page

Section I

Total marks (20)

- Attempt questions 1-20
- Allow about 35 minutes for this section
- Mark your answers on the answer sheet provided

Section II

Total marks (60)

- Attempt questions 21-23
- Allow about 1 hour and 50 minutes for this section
- Answer in the spaces provided on this paper

Section III

Total marks (20)

- Attempt either Question 24 or Question 25
- Allow about 35 minutes for this section
- Answer on a *separate* piece of paper

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 major manufacturer of gaming hardware and software has found their market position to be dropping rapidly since the release of new, more powerful machines from one of their competitors. They are aware of the need to create a machine that will revolutionise the gaming market, allowing the company to regain its market share. Which of these feasibility constraints would be of most concern to them:

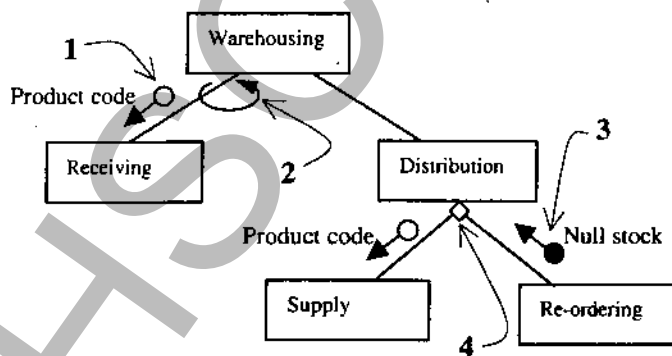
- (A) Budgetary
- (B) Operational
- (C) Scheduling
- (D) Technical

2. A game is currently being developed. From the user’s perspective the game contains 15 levels. From the software developer’s perspective this is not really the case. Levels 1-4 actually execute the same code. Similarly Levels 5-9, Levels 10-14 and Level 15 execute separate unique sub-programs.

The most appropriate control structure for implementing this branching would be:

- (A) pre-test repetition
- (B) post-test repetition
- (C) multiway selection
- (D) binary selection

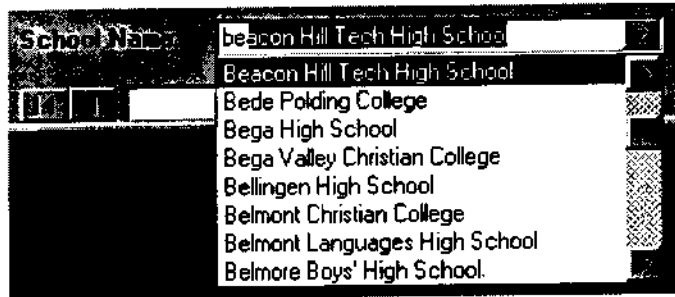
3. The constructs denoted at 1, 2, 3 and 4 on the structure diagram below are:



- ~~(A)~~ 1 – process, 2 – repetition, 3 – parameter, 4 – call line
- (B) 1 – parameter, 2 – repetition, 3 – control parameter, 4 - decision
- (C) 1 – parameter, 2 – call line, 3 – control parameter, 4 - decision
- ~~(D)~~ 1 – flag, 2 – decision, 3 – control parameter, 4 - repetition

4. A file processing technique, which allows the greatest flexibility for variation in file length, is to use a:
- (A) Constant
 - (B) Parameter
 - (C) Sentinel
 - (D) Variable

Refer to the following combination box when answering Questions 5 and 6.



5. The combination box above is used to ensure users only select a school name from those available in the drop down list box. From the developer's viewpoint, which of the following terms best describes the process performed by this combination box?

- (A) Data integrity check
- (B) Data validation
- (C) Data redundancy check
- (D) Menu selection

6. Items can be selected in the above combination box by entering text. If a "b" is entered, all the first school commencing with "b" is selected. If an "e" is then entered the first school commencing with "be" is selected.

The code performing this task would mostly likely be based on a:

- (A) linear search
- (B) binary search
- ~~(C) bubble sort~~
- ~~(D) selection sort~~

*define probl
plan soln
build soln
check soln
modif soln*

7. In which phase of the structured approach to software development is the user interface created and code documentation completed?

- ~~(A) planning and design~~
- (B) implementation
- (C) testing and evaluation
- (D) maintenance

8. A retail business contracts a software development company to design software specific to their needs. This is called:

- ~~(A) end user development~~
- (B) custom design
- (C) outsourcing
- ~~(D) prototyping~~

9. "Keep 'm Quiet Software" is a beginning company and has recently developed a program designed for young children. It decides to distribute this software free on a trial basis. This software would best be described as:
- (A) freeware
 - (B) shareware
 - (C) postcardware
 - (D) public domain
10. A software company introduces a software package into the marketplace. The package is designed for a specific and small portion of the market. The product would be considered to be:
- (A) a market leader
 - (B) a market challenger
 - (C) a market follower
 - (D) filling a market niche
11. The following are all valid forms of the input statement in a particular version of BASIC.

```
INPUT A$
INPUT "Please enter your name..." ; Name$
INPUT "Enter name, age and gender", Name$, Age, Gender
INPUT A$(4, 8)
```

Which of the following EBNF statements best specify the syntax of the INPUT statement?

- (A) statement = INPUT [<prompt>] (;|,) <variable> {,<variable>}
 prompt = "<letter>|<digit>|<symbol>{<letter>|<digit>|<symbol>}"
 variable = <letter>{<letter>|<digit>}[\$] [<dimension>]
 dimension = (<variable>|<number>){,<variable>|<number>})
 - ~~(B) statement = INPUT [<prompt>] <variable>
 prompt = "<letter>|<digit>|<symbol>{<letter>|<digit>|<symbol>}"
 variable = <letter>{<letter>|<digit>}[\$] [<dimension>]
 dimension = (<variable>|<number>)~~
 - ~~(C) statement = INPUT [<prompt>] (;|,) <variable> {,<variable>}
 prompt = "<letter>|<digit>|<symbol>{<letter>|<digit>|<symbol>}"
 variable = <letter>{<letter>|<digit>}[\$] [<dimension>]
 dimension = (<variable>{,<variable>})~~
 - ~~(D) statement = INPUT <variable> {,<variable>}
 prompt = "<letter>|<digit>|<symbol>{<letter>|<digit>|<symbol>}"
 variable = <letter>{<letter>|<digit>}
 dimension = <variable>|<number>{,<variable>|<number>}~~
12. A student examines the source code of an old game she has at home to understand its workings. Her intention is to create a program that will interface with this game. This process is called
- (A) backwards chaining
 - (B) reverse engineering
 - (C) decompilation
 - (D) plagiarism

13. Following are machine code instructions for a particular CPU

- IPT input a 2 byte binary ASCII code from the keyboard into the address specified.
- LR load the specified register with the data held in an address.
- CMR compares the contents of the two registers, and stores the largest value in the first register
- SR copy the contents of the given register into the given address
- PR display the contents of the specified address.

The following machine code fragment is written

```

IPT 2003
IPT 2005
LR 01, 2003
LR 02, 2005
CMR 02, 01
SR 02, 2003
PR 2003
    
```

Handwritten annotations for the machine code fragment:

	2003	2005	B1	B2
	3	2	3	2
			2	A3
	3			

If the data 3, 2 is input, what is the resultant output?

- (A) 2
 - (B) 3
 - (C) 2003
 - (D) 2005
14. The role of the program counter in the fetch-execute cycle is to
- (A) count the number of instructions that have been processed
 - ~~(B)~~ specify the number of bytes to be fetched from RAM
 - ~~(C)~~ count the number of programs currently in RAM
 - (D) hold the address of the next instruction to be executed
15. An inexperienced new user of a recently developed software product would be most likely to need to refer to the
- (A) data dictionary, tutorial and installation guide
 - (B) user manual, system flowcharts and source code
 - ~~(C)~~ algorithms, reference manual and process diary
 - (D) user manual, tutorial and on-line help
16. When developing a new piece of software, the most appropriate order for a variety of testing procedures would be
- ~~(A)~~ structured walkthrough, test data, peer check
 - (B) desk check, peer check, systems test, volume test data
 - (C) eliminate run time errors, remove syntax errors, acceptance testing
 - (D) use of CASE tools, testing report, module test, volume test data

Refer to the flowchart at right when answering Questions 17, 18, 19 and 20.

17. This flowchart is an implementation of a(n):

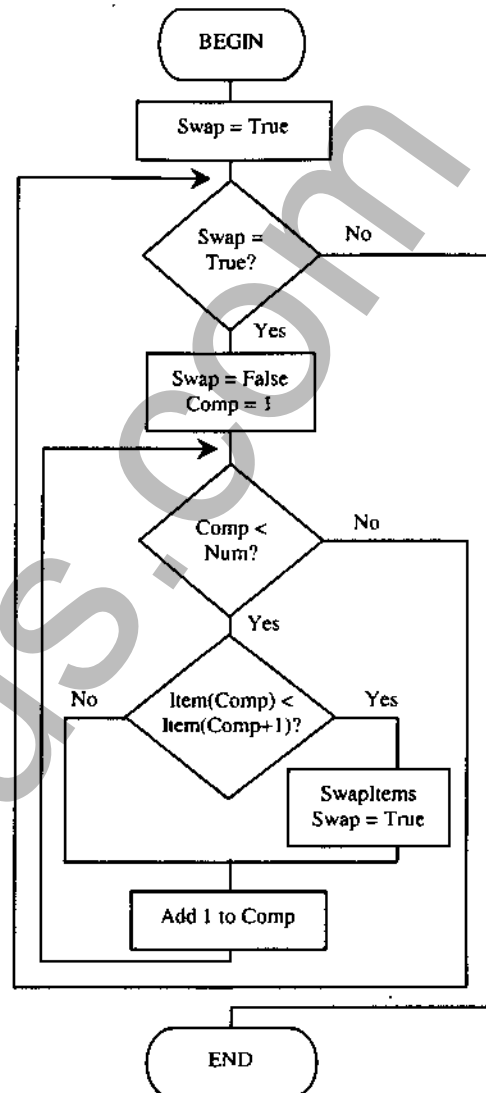
- ~~(A)~~ insertion sort
- (B) selection sort
- (C) bubble sort
- (D) quick sort

18. Which identifier could be classified as a flag?

- (A) Swap
- (B) Comp
- (C) Item
- (D) Num

19. Presumably a subroutine exists to perform the SwapItems process. This process could contain the lines:

- (A) $Item(Comp) = Item(Comp + 1)$
 $Item(Comp + 1) = Item(Comp)$
- (B) $Item(Comp) = Item(Comp + 1)$
 $Temp = Item(Comp)$
 $Item(Comp + 1) = Temp$
- (C) $Temp = Item(Comp)$
 $Item(Comp + 1) = Item(Comp)$
 $Item(Comp) = Temp$
- (D) $Temp = Item(Comp)$
 $Item(Comp) = Item(Comp + 1)$
 $Item(Comp + 1) = Temp$



20. What are the bounds for the index of the array "Items"?

- ~~(A)~~ 0 to Num
- (B) 1 to Num
- ~~(C)~~ 0 to Num + 1
- ~~(D)~~ 1 to Num + 1

Tempo 1 2
 4 6 8

9 10

17

Software Design and Development

Section I. Multiple Choice Answer Sheet.

Place a cross in the box that corresponds to the best answer.

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

Section II

Total marks (60)

Attempt Questions 21 – 23

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. (20 marks)

Marks

(a) PBC High School is currently using a computer system in the administration section of the school. This system is not performing the way the school would like and they now are in the process of developing a new system. A systems analyst has been employed to assist with the development of the new system. As part of the process the analyst discusses with the school the parallel and phased methods of conversion.

(i) Discuss the advantages and disadvantages that the analyst may present for EACH method of conversion. 3

Parallel - Advantages: If new system fails haven't lost all data. Allows new system to be tested thoroughly that it operates as desired

Disadvantages: Requires more staff to work during changeover. Staff need to learn new system in one

Phased - Advantages: Minimal data lost if new system fails. Gradual implementation of new system. Doesn't require as many extra staff. Disadvantages: Some data lost if system fails. Problems between new module not apparent until they are all implemented

(ii) Explain the factors that should be considered when drawing up the licencing agreement between the school and the software development company. 3

• How many computers can use the program.
Is it allowed to run on the network } licence type

• For what purposes (backup for ex) can copies be made.

• Liability of the program limited. Author can't be held responsible for misuse and subsequent damage caused 2

Support?

(iii) Describe the documentation that needs to be created by the analyst's company before the implementation of the solution commences. 3

- Need to create IPO charts to document inputs, outputs and processes needed to achieve outputs.
- Gantt chart to document time allocation to various parts of the program
- ~~• The needs and requirements~~
- Design specification of users needs and requirements of the software.

2

(b) When using CASE tools it is possible to track the changes that are made to a program, this is termed versioning. An operating system has progressed through the following versions: 3

OS8, OS8.1, OS8.1.1, OS8.2, OS9

Discuss the general nature of the changes that have occurred in the software as it has progressed from OS8 to OS9.

- OS8 was the initial version in this case (8th major version overall likely) * OS 8.1 was a moderate update to the program, such as adding a number of new features.
- * OS 8.1.1 was only a minor update, more than likely to fix bugs in the program.
- * OS9 was a dramatic update that changed various parts of the program significantly.

3

(c) An Interstate bus company travels between Sydney and Melbourne. Along the route it collects passenger's at designated terminals. The bus company decides that at each terminal a touch screen will be installed as quickly as possible. The screen will provide the following information:

- a timetable for all their buses
- the estimated time of arrival of all buses currently on-route.

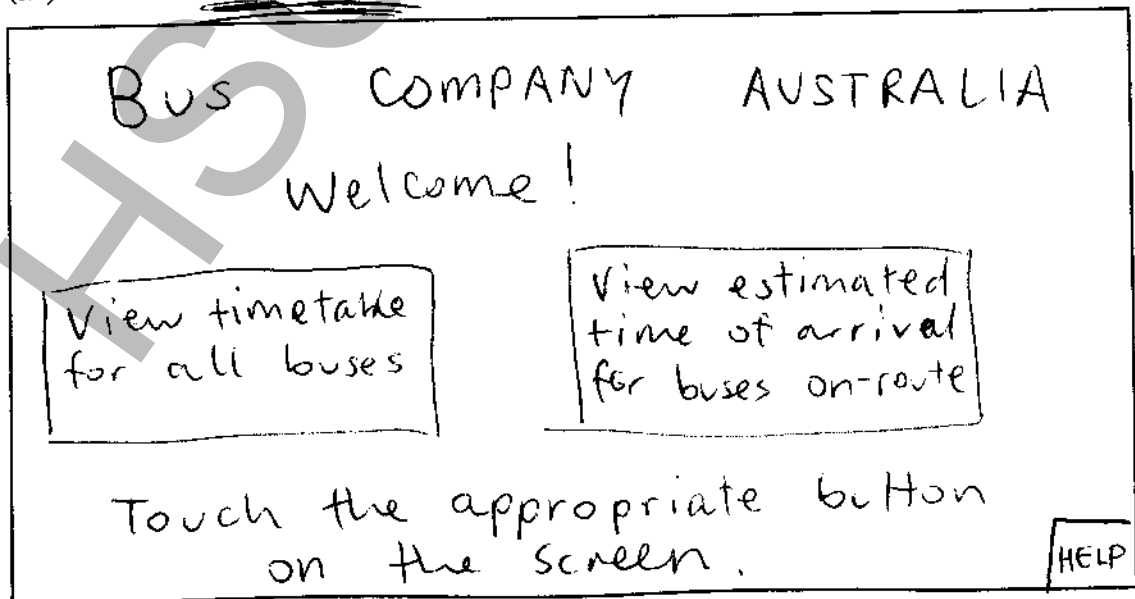
(i) Describe the software development approach that would be most suited to this project. Justify your answer with reasons. 2

Rapid application development.
The solution needs to be created quickly and directly implement. The timeframe and resources are low. There is no need for a ~~large~~ ^{the} structured approach as it is only a small implementation. 2

(ii) Identify the constraints that would need to be considered in determining the technical feasibility of this system. 2

Budgetary - The bus company may only have a limited budget 1
Technical - the programmers would need knowledge of touch screens. Two more significant constraints are: Social - How will the users react? Will they accept the new solution well. Time - As was stated, they need to implement the system as quickly as possible.

(iii) Create a context diagram for one of the touch screen terminals. 2



- (iv) Discuss the methods by which the quality of this product could be assessed. 2

Suitable reaction time - The user
does not want to wait extended
lengths of time for the relevant screen to
come up.

Ease of use - should be easy to use and
straightforward, containing no ambiguity or
technical jargon. Should cater for all users
as much as possible (eg disabled
people).

2

(15)

End of Question 21

HSC FOCUS

Question 22. (20 marks)

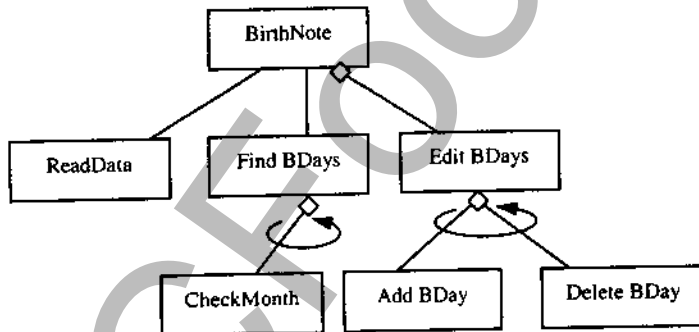
- (a) A birthday notification system is currently under development. Essentially the program will display a list of people who have birthdays within the current month. The data for this system is read from a text file containing names and birthdates. A sample file is reproduced below:

Johnno, 14, 6, 1983
 Smithy, 27, 11, 1984
 Jen, 2, 1, 1990
 Margy, 17, 8, 1977

- (i) Design and describe a possible data structure that could be used to store the data retrieved from the text file. Justify your choice of data structure. 3

An array of records could be used.
The record contains fields on each individual,
incl name, day, month and year of birthday.
Name would be a string, day, month
and year integers. (Constants such
as representation of month in text format
(November rather than 11) could be implemented

- (ii) The following structure diagram is being developed to describe the connection between sub-routines within the program. 4



Describe, in words, the processing modeled by the above structure diagram.

ReadData, Find BDays and Edit BDays are submodules of
main program. Find BDays is searched by month and
results displayed, then returned to Find screen.
Edit BDays allows add BDay and
Delete BDay modules to be called and return
to Edit BDays module when done. Then the
user can add or delete a birthday
once more. They have a decision to make as
to which they do.

(iii) The IPO chart that follows describes the processing required by the "Delete BDay" process.

IPO CHART for the DeleteBDay process		
Input	Process	Output
Name	Find name in array	
	Set flag to true if found or false if not found	True or False
	Store the index of this item	
	Move lower items up 1	
	Decrement number of items	

1. Create an algorithm using either pseudocode or a flowchart to accomplish this task. Your algorithm should use the data structure you designed in part (i).

4

```

begin
make array[1..max] of records
max = max number entries
record:
    name: string[30]
    day, month, year: integer
Subprogram DeleteBDay (name, flag, found, items)
begin
flag = false
get name from user input
for n = 1 to max do
    begin
    if array.name array[n].name = name
    then (flag = true) and (found = n)
    endif
print flag
if flag = true print 'Found user and deleted'
else print 'No found match'
for n = found to max do (max - 1)
    begin
array[n].name
array[n].name = array[n+1].name
array[n].day = array[n+1].day
array[n].month = array[n+1].month
array[n].year = array[n+1].year
end.
list = list - 1
endif
end subprogram.
    
```

4

2. Would the DeleteBDay process be best implemented as a sub-program or as a function? Justify your answer.

2

Subprogram. A function is a small 'sub-program' ~~with simple~~ that takes input via parameters, It's designed to do a simple specific task, not multiple complex tasks that involve many variables such as the DeleteBDays sub-program does.

3. Parameters are vital to "top-down design" methodology. What are parameters and how do they assist the top-down design process? Use the DeleteBDay process to illustrate your answer.

3

Parameters are values and ~~variable~~ variables taken from the mainline (main program) for use in subprocedures of the main program. Top down design involves having a big problem split into smaller and smaller sections that are easier to program. Parameters are created in the main section, such as the record of arrays in the DeleteBDays module and are handed down as needed to subsequent sub programs.

Question 22 continues on the next page

- (b) Testing of software solutions occurs throughout the software development cycle. However, the use of live test data is usually performed once the final product is operational. 2

- (i) What is live test data and how does it differ from other types of test data?

Live test data is "real world" test data that the program is likely to encounter in its everyday operation. It may include greater volumes of data than test data. ^{other} Test data is data that specifically tests certain areas, such as boundary values and other crucial values that may or may not ever be used in real world (but must still be checked).

- (ii) Live test data is often used to test and evaluate particular possible scenarios.

Describe TWO different scenarios that may be tested using live test data. In each case describe the nature of the test data set. 2

test data add test for large purchase at the.
The program maybe for a cash register. The test data could include a very large purchased not tested by the other test data.

Volume
Another scenario could be an admission counter for a theme park, which one thing it records is how many people enter the park in a period of time. There could be an extremely large amount of people enter that weren't imagined by original test data.

End of Question 22

(17)

Question 23. (20 marks)

Marks

The following scenario is to be used for parts (a) to (e).

You have been asked to design and develop a program which will test students in Year 7 on their French vocabulary. There are 40000 words they need to be tested on, categorised into easy, harder, difficult and challenging categories, with 10000 words in each category.

You have been directed to store the words in a relative file on disk (called WORDS), rather than processing them in an array in memory, as there are concerns as to both the memory and processing speed required for an array-based solution.

- (a) Why do you think a relative file has been specified for this task? Describe your choice of structure and order of the records within this WORDS file.

2

A relative file will use less main memory, but is slower to run. In this case speed isn't a great concern as it ^{only retrieves a word at a time.} ~~is an array in memory that doesn't need continuous use~~. I would have ^{an array of} ~~a list~~ records with fields of ^{input.} easy, harder, difficult and challenging, each 10000 places big. They would be of string type.

- (b) Design an algorithm, in pseudocode, to print a random word from the correct category on the screen, and ask for its English equivalent translation. If the translation is correct, print the message "well done", otherwise print the correct translation.

4

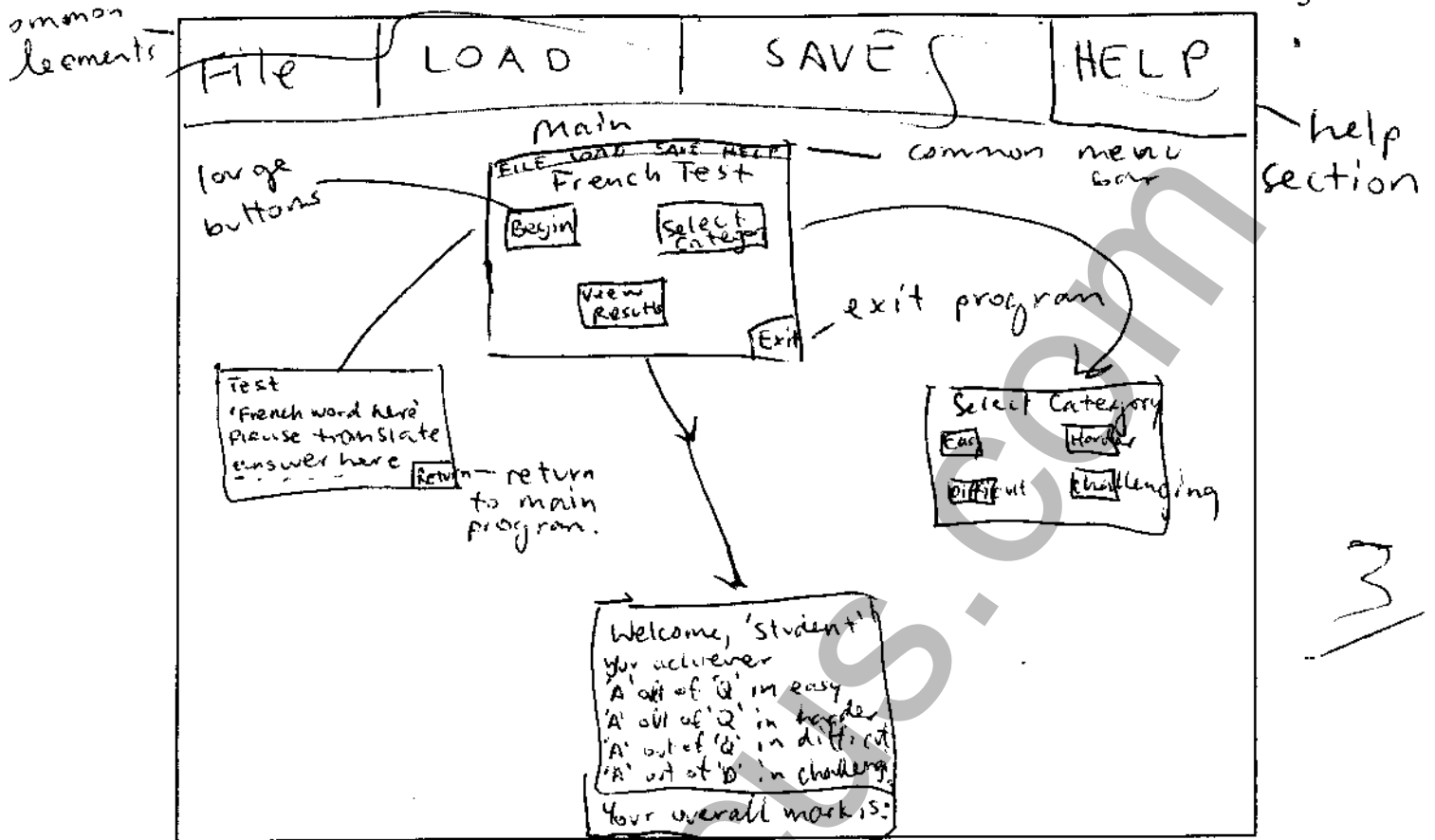
```

Subprogram random-word
get category from program
get random number (random number in format '0.abcd' where
                    abcd are integers)
randomnumber = randomnumber * 10000
print 'translate this word:'
print 'word[1].category[randomnumber]'
read in translation
    if translation = word[2].category[randomnumber]
    then print "well done"
    else print "incorrect, the correct translation was:",
           word[2].category[randomnumber]
    endif
end subprogram.

```


(c) Draw a storyboard for the French program, labelling good design elements.

3



(d) Assume that you now wish to make use of a new hardware device which will 'read' and pronounce the words in a French accent as they are displayed. This device is radically different from current voice synthesisers, and uses quite different logic from any current device.

3

Describe all of the steps and resources required to allow your program to be able to use this device.

You will need most importantly programmers with enough knowledge (if you don't have this knowledge yourself) to integrate this device with your program. Of course you must be able to afford the new hardware, and implement it into your solution within reasonable time. Also it must be taken into consideration that the current hardware may not be sufficient to run the new software, and ~~also~~ to make sure the program actually works properly to pronounce the words correctly.

2

- (e) The following EBNF definitions define the verbs to generate a random number, and to read a relative file in a particular language.

Read a record:

GET <variable> FROM <variable> USING <variable>

where

GET input_rec FROM stock_file USING part_no

reads the part_no'th record from stock_file into the variable called input_rec.

Random number generator:

<variable> = RND(<value>) + <value>

where RND(10) returns an integer value from 1 to 10

Screen display:

OUTPUT <variable> at <value>, <value>

Other required definitions:

Letter = _|. |a|b|c|d|e|f|g|... |x|y|z

variable = <Letter>{<Letter>}

digit = 0|1|2|3|4|5|6|7|8|9

value = <digit>{<digit>}

Write a series of statements to generate the next challenging French word to be displayed at a position 100 across and 250 down.

random = RND(10000) + 30000

GET word FROM word_file USING random

OUTPUT word at 100, 250

Question 23 continues on the next page

- (f) Debugging code can be a frustrating task. Fortunately there are many techniques and tools available to assist programmers to isolate errors in their code. Name and describe the techniques or tools available to assist in the location of errors in source code. 4

Lexical analysis checks the syntax of the code. This ~~code~~ could include checking that there are semicolons at the end of lines, multiple values are enclosed by brackets properly, etc.

Next logical analysis checks the program's logic (parsing). This checks that algorithms have been completed and are in the correct format.

These two are often checked by the compilation or interpretation program.

CASE tools may be used to detect arithmetic errors (such as divide by zero, access illegal array position, etc).

CASE tools can generate test data to test all of the boundary values thoroughly.

Lastly when the program is otherwise free of errors, it can be checked with live data, typical of its everyday use. This could pick up problems that have been missed, such as crashing when processing extremely large amounts of data.

End of Question 23

16

Section III**Total marks (20)****Attempt either Question 24 or Questions 25****Allow about 35 minutes for this section**

Answer the question on a SEPARATE piece of paper.

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

Question 24 – Evolution of Programming Languages (20 marks)**Marks**

(a) In this Option you have studied three new paradigms. Discuss the historical reasons for the development of new programming paradigms. As part of your discussion explain why Object Oriented languages have become so popular when languages based on the Logical and Functional paradigms remain uncommon. 4

(b) The logic paradigm is based on facts and rules. Consider the following series of facts and rules.

Facts

1. mike is a deeg
2. bill is a deeg
3. mary is a roon
4. fran is roon
5. sam is a roon

Rules

1. If A is a deeg and B is a roon then A can joop B
2. If A can joop B then B can joop A
3. If A can joop B and B can joop C then C can joop A

Use the above facts and rules to answer the following. In each case explain your reasoning logically using only the given facts and rules. 6

- (i) Can a roon ever joop a deeg?
- (ii) Who can mike joop?
- (iii) Is it possible for someone to joop themselves?
- (iv) Discuss the meaning of the terms backward and forward chaining. Give an example of each using the facts and rules above.

Question 24 continues on the next page

- (c) Motor vehicles are a good example of object-oriented design. Each time a new car is designed it is not necessary to design new tyres or new brake pads or even a new engine, rather many of the parts are reused from previous vehicles. These parts have been thoroughly tested and can be used in the new model with confidence.

6

Explain the meaning of each of the following object-oriented terms. Use aspects of the design of motor vehicles to provide an example to assist your explanation.

- (i) class
 - (ii) inheritance
 - (iii) encapsulation
 - (iv) polymorphism
- (d) Programs written using functional programming languages are often significantly shorter than similar programs written in other languages.
- (i) Why is this the case? Explain.
 - (ii) If the code is so short then why aren't we all using functional languages? Explain and justify.

4

Question 25 – Software Developer’s View of the Hardware (20 marks)	Marks
(a) The ASCII value for A is 65. What would the text string ‘FaCe’ look like as stored in memory, expressed in hexadecimal format?	3
(b) Using an 8-bit binary system, what decimal value does the bit string 10110111 ₂ represent?	2
(c) What is the maximum range of numbers that can be expressed using a 3 bit two’s complement binary number system? Demonstrate your answer using a table of values.	2
(d) Using the ‘shift and subtract’ method and the binary number system calculate 74 divided by 5.	2
(e) The IEEE single precision floating point standard has been accepted and implemented within the floating point unit (FPU) of most modern microprocessors.	
(i) Convert 24.25 ₁₀ to the IEEE single precision floating point standard representation, and verify your answer by converting it back to its decimal representation.	3
(ii) Explain the role of the exponent and bias	2
(f) Design a circuit with 3 inputs which will only output a 1 value if the third input OR the first two inputs are 1. If all 3 inputs are one, a zero is to be produced. Confirm your answer with a truth table	4
(g) Describe how flip-flops are able to store binary digits.	2

15

END OF EXAMINATION

Question 25

+ 32

- a) $A=65$ $a=97$ $F a C e$
 $C=67$ $c=99$ = decimal: 70, 97, 67, 101
 $E=69$ $e=101$
 $F=70$ $f=102$

dec 16 = hex 10	F	dec = 70 = 64 + 6	hex = 40 + 6 = 46
dec 32 = hex 20	a	dec = 97 = 96 + 1	hex = 60 + 1 = 61
dec 48 = hex 30	C	dec = 67 = 64 + 3	hex = 40 + 3 = 43
dec 64 = hex 40	e	dec = 101 = 96 + 5	hex = 60 + 5 = 65
dec 80 = hex 50			
dec 96 = hex 60			

∴ looks like "46 61 43 65" stored in hex

- b)
- $$128 \ 64 \ 32 \ 16 \ 8 \ 4 \ 2 \ 1$$
- $$1011 \ 0111$$
- $$= 128 + 32 + 16 + 4 + 2 + 1$$
- $$= 160 + 20 + 3$$
- $$= 183$$

1001
= 9

8 4 2 1 5

4 = 0100

8-5 = 3

- c) 3 bits = $2^3 = 8$ values

	3 bit	1's comp	2's comp		
1	000	111	000	-3	0
2	001	110	111	-2	1
3	010	101	110	-1	2
4	011	100	101	0	3
5	100	011	100	0	-4
6	101	010	011	1	-3
7	110	001	010	2	-2
8	111	000	001	3	-1

01011

14, 4 10 = 2

5 (7) 4 1 = 1

8 4 2 1

1262 ✓ 1

2 (25) 25 0.1

2 0.1

∴ range from -3 to +3

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d)

$$\begin{array}{r}
 74 \div 2 = 37 \quad r 0 \\
 37 \div 2 = 18 \quad r 1 \\
 18 \div 2 = 9 \quad r 0 \\
 9 \div 2 = 4 \quad r 1 \\
 4 \div 2 = 2 \quad r 0 \\
 2 \div 2 = 1 \quad r 0 \\
 1 \div 2 = 0 \quad r 1
 \end{array}$$

$$\begin{array}{r}
 5 \div 2 = 2 \quad r 1 \\
 2 \div 2 = 1 \quad r 0 \\
 1 \div 2 = 0 \quad r 1
 \end{array}$$

$$\begin{array}{l}
 74 = 01001010 \\
 5 = 00000101
 \end{array}$$

$$\begin{array}{r}
 \overline{0001110} \\
 101 \overline{) 1001010} \\
 \underline{101} \\
 \\
 \underline{1000} \\
 \\
 \underline{101} \\
 \\
 \underline{111} \\
 \\
 \underline{101} \\
 \\
 100
 \end{array}$$

2

$$\begin{array}{l}
 1001010_2 \div 101_2 = 1110_2 r 100_2 \quad (\text{in dec } 74 \div 5 = 14 r 4) \\
 101_2 \times 1110_2 + 100_2 = 1001010
 \end{array}$$

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e) i) IEEE standard

1 bit

sign Exp 8 bits Mantiss 32 bits

I EEEEEEEE MM → M

$$24.25 = 0.2525 \times 10^2$$

~~$$0.2525_{10} = 0.1010101101_2$$~~

$$252_{10} = 10010101101_2$$

$$0.2525_{10} = 0.10010101101$$

$$= 000000101001010110100000...$$

$$= 0.2525 \times 10^2$$

$$= 25.25$$

$$2525 \div 2 = 1262 \text{ r } 1$$

$$1262 \div 2 = 631 \text{ r } 0$$

$$631 \div 2 = 315 \text{ r } 1$$

$$315 \div 2 = 157 \text{ r } 1$$

$$157 \div 2 = 78 \text{ r } 1$$

$$78 \div 2 = 39 \text{ r } 0$$

$$39 \div 2 = 19 \text{ r } 1$$

$$19 \div 2 = 9 \text{ r } 1$$

$$9 \div 2 = 4 \text{ r } 1$$

$$4 \div 2 = 2 \text{ r } 0$$

$$2 \div 2 = 1 \text{ r } 0$$

$$1 \div 2 = 0 \text{ r } 1$$

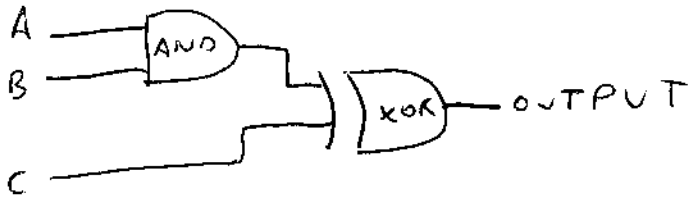
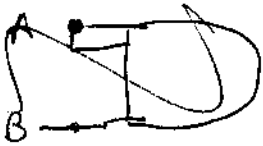
ii)

0

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f)



A	B	C	A AND B	C	Out
0	0	0	0	0	0
0	0	1	0	1	1
0	1	0	0	0	0
0	1	1	0	1	1
1	0	0	0	0	0
1	0	1	0	1	1
1	1	0	1	0	1
1	1	1	1	1	0

0 if
 $AB \oplus BC \oplus CA = 1$

g) Flip flops can store the result of different logic processes on two input bits. The two input bits may come from same source (eg $A \oplus B$) or different sources. A flip flop will store:

- In an OR gate will store a 1 if either/both inputs = 1
- In an AND gate will store a 1 if both inputs = 1
- In an XOR gate will store a 1 if and only if a single input is 1, not both.
- In a NOR gate will store a 1 if both inputs = 0
- In a NAND gate will store a 1 as long as both inputs ~~is~~ = 1
- In a NXOR gate will store a 1 if either both inputs = ~~is~~ 0 or both inputs = 1

When the above cases are not true the flip flop stores a 0.

Diagram?

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