

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
A LEVEL
H446/01
COMPUTER SCIENCE
Computer Systems
MONDAY 11 JUNE 2018: Morning
TIME ALLOWED: 2 hours 30 minutes
plus your additional time allowance
MODIFIED ENLARGED 24pt

First name						Last name					
Centre number						Candidate number					

YOU MUST HAVE:
a ruler (cm/mm)
an HB pencil
Loose Sheet for Question 3

DO NOT USE:
a calculator

DO NOT USE A CALCULATOR

READ INSTRUCTIONS OVERLEAF



INSTRUCTIONS

Use black ink. You may use an HB pencil for graphs and diagrams.

Complete the boxes on the front page with your name, centre number and candidate number.

Answer ALL the questions.

Write your answer to each question in the space provided. Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).

INFORMATION

The total mark for this paper is 140.

The marks for each question are shown in brackets [].

Quality of extended responses will be assessed in questions marked with an asterisk (*).

Answer ALL the questions.

1 A digital coffee making machine has a CPU that uses the Little Man Computer Instruction Set.

(a) Little Man Computer operates on a computer system based on the Von Neumann Architecture.

(i) State TWO features of the Von Neumann architecture.

1 _____

2 _____

[2]

(ii) Describe ONE feature, NOT part of the standard Von Neumann Architecture, which contemporary CPUs may have in order to improve performance.

[2]

- (b) Part of the coffee making machine's code asks the user to press a button to select strength. The code outputs 1 which will switch on a green light to indicate a valid selection or outputs 0 to indicate an invalid selection.

The code is shown below:

FIG. 1

	INP	
	STA	entry
	LDA	max
	SUB	entry
	BRP	accept
	LDA	redLight
	BRA	printAndEnd
accept	LDA	greenLight
printAndEnd	OUT	
	HLT	
greenLight	DAT	1
redLight	DAT	0
max	DAT	5
entry	DAT	

- (i) Tick the appropriate boxes below to indicate which inputs will result in a green light (i.e. code outputs 1) and which with a red light. [2]

Input	Green Light	Red Light
1		
2		
3		
4		
5		
6		
7		
8		
9		

(ii) Explain which registers and buses are used, and the values they store/carry, when the line `LDA redLight` is executed (after it has been fetched and decoded). You should assume the address `redLight` refers to memory location 11. [6]

(iii) Write code in a high-level language or pseudocode that has the same functionality as the code in Fig. 1.

[3]

when each approach might be used

[illegible]

2 A software company decides to build an operating system for OCR smart watches.

(a) Memory management is one of the functions of an operating system.

(i) List THREE functions, other than memory management, of an operating system.

1 _____

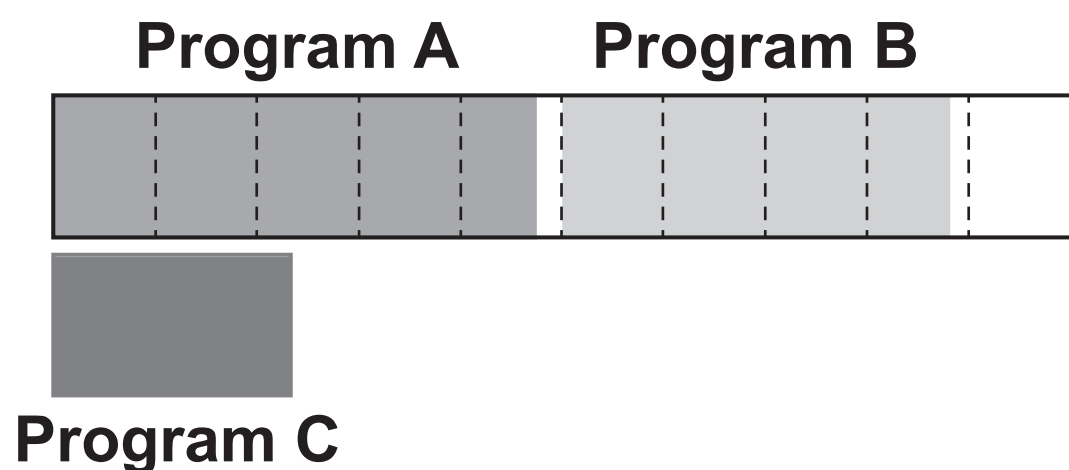
2 _____

3 _____

[3]

Part of a computer's memory is represented below (Fig. 2). The operating system divides the memory into equally sized chunks.

FIG. 2



(ii) State the name of the type of memory management used in Fig. 2.

_____ **[1]**

(iii) The operating system needs to load program C into memory but there is not enough space. Describe how the operating system would use virtual memory to load program C.

_____ **[3]**

(ii) Explain what happens when a search engine indexes the page. You do NOT need to discuss ranking.

(iii) Explain why using a RISC processor rather than a CISC processor is likely to result in increased battery life.

- 3 An airport holds details of flights in a database using the table `Flight`. An extract of the table is shown on the Loose Sheet.

(a) Describe what the SQL statement below does.

```
SELECT FlightNumber FROM Flight WHERE  
DestinationCode='JFK'
```

[2]

The airport cancels all its flights to Heathrow on 4th July 2018.

(b) The SQL statement below shows all the data for flights going to Halifax. Rewrite it so it instead removes all flights to Heathrow on 4th July 2018.

```
SELECT * FROM Flight WHERE  
DestinationName='Halifax'
```

[3]

(c) Tables often have primary and secondary keys.

(i) State why `DestinationCode` would NOT be a suitable primary key for the `Flight` table.

[1]

(ii) State why `DestinationCode` would be a suitable secondary key for the `Flight` table.

[1]

(d) The airline wishes to ensure the database is normalised.

(i) Describe why the database can be considered to be in First Normal Form.

[2]

(ii) Describe why the database can be considered to be in Second Normal Form.

[2]

(iii) Describe why the database can NOT be considered to be in Third Normal form.

[2]

(e) The airport wishes to allow airlines to be able to access the data it has on flights via the internet.

Describe ONE format or method the airport could use to provide the data to the airlines so they can use it in their own applications.

[2]

4 The internet can be considered an example of a WAN.

(a) Describe what is meant by the term 'WAN'.

[2]

(b) The internet uses a set of protocols referred to as the TCP/IP stack. The TCP/IP stack consists of four different layers, each with its own set of protocols.

(i) Explain why protocols are important on a network.

[2]

(ii) State the name of the FOUR layers of the TCP/IP stack.

1

2

3

4

[4]

- 5 A software company is producing software that allows users with severe mobility issues to input data into a computer.**

The software flashes up letters on the screen one at a time. The user sends a signal to the computer when the letter they want appears on the screen.

- (a) State the name of an input device and describe how it could be used by a user with very limited mobility in their hands and arms to send a signal to the computer.**

Device name: _____

How it would be used: _____

_____ **[2]**

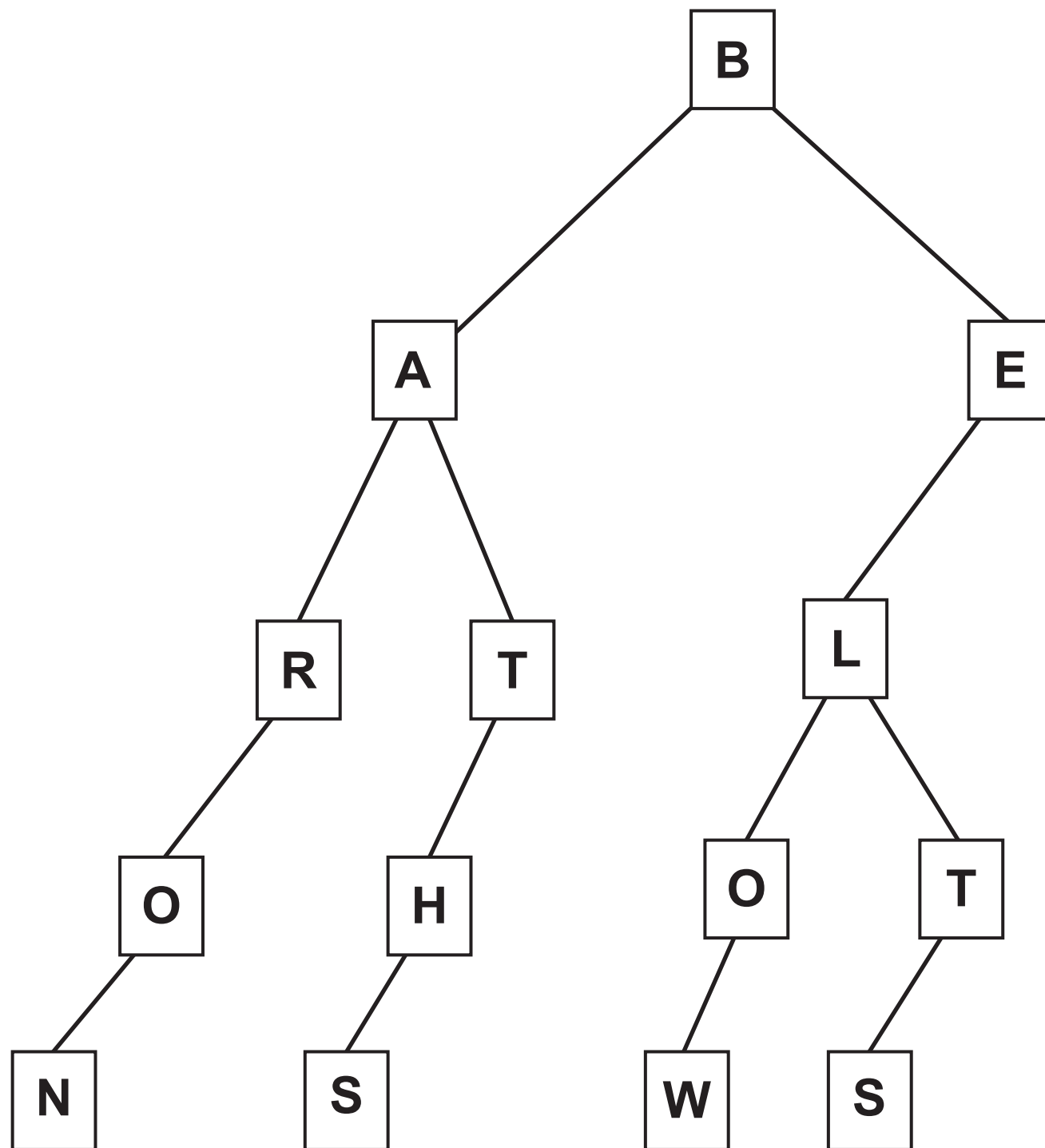
- (b) Rather than displaying the whole alphabet, once the first letter has been entered, the program only shows letters that could be possible according to words in its dictionary. All possible words are stored in a tree data structure.**

The program is tested on a sample dictionary of four words, represented as a tree in Fig. 3:

**BARON
BATHS
BELOW
BELTS**

- (i) Annotate Fig. 3 to show how the word BELTS would be removed from the tree. [2]**
- (ii) Annotate Fig. 3 to show how the words BEACH and BONE would be added to the tree. [2]**

FIG. 3



(c) The developer decides she wants to make the software program open source.

Explain the benefits to the users of the software being open source.

[2]

6* “Technology is changing too quickly for the law to keep up.”

Discuss to what extent you agree with the statement above. In your discussion you should explain which laws regulate the use of technology and how advancements in technology have made the laws difficult to enforce/implement. [12]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

7 A taxi firm is investigating replacing its drivers with self-driving cars.

(a) Explain why the self-driving system will use a real-time operating system.

[3]

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- (b) The code for the self-driving system has been written using an object-oriented programming language.

It recognises obstacles in the road and then classifies them.

The class for `Obstacle` is shown below.

```
public class Obstacle
    private moving //Boolean value
    private distance //Real number given in
    metres
    private direction //Integer given as
    between 1 and 360 degrees

    public procedure new(givenMoving,
        givenDistance, givenDirection)
        moving=givenMoving
        distance=givenDistance
        direction=givenDirection
    endprocedure

    public procedure
        updateDistance(givenDistance)
        distance=givenDistance
    endprocedure

endclass
```

- (i) Write a line of code to create an object called `bollard` of type `Obstacle` which is not moving and is 7.8 metres away in a direction of 8 degrees.

[2]

(ii) Describe an example of encapsulation in the class definition code above.

[2]

(iii) Describe the advantages of using encapsulation.

[2]

- (c) The self-driving program recognises people as a special type of obstacle and the class `Person` should inherit the methods and attributes of `Obstacle`. People are treated like other obstacles except:
when the `updateDistance` method is called, if the person is more than 2 metres away but is 5 metres (or less) away, the method `Controls.beepHorn()` is called.

when the person is 2 metres away (or closer), the method `Controls.applyBrakes()` is called as well as `Controls.beepHorn()`.

Complete the class `Person`. [5]

```
class Person _____
```

```
    public procedure  
    updateDistance(givenDistance)
```

```
        distance=givenDistance
    endprocedure
endclass
```

- (d) Give ONE advantage and ONE disadvantage to the customers of the taxi using self-driving cars rather than drivers.

Advantage

Disadvantage

[2]

8 A student writes a program to apply a symmetric encryption algorithm to work on messages of up to 25 ASCII characters.

(a) Describe what is meant by the term ‘ASCII’.

[2]

The encryption algorithm works in the following way. A message of up to 25 characters (spaces and punctuation are not included) is placed in a 5×5 array. Any leftover spaces are filled with random letters. The message I LOVE COMPUTER SCIENCE becomes:

I	L	O	V	E
C	O	M	P	U
T	E	R	S	C
I	E	N	C	E
T	O	W	R	M

The key is a sequence of ten numbers. In this example we will use 1 2 3 4 5 1 2 3 4 5. The first 5 numbers state how many spaces the rows 0 to 4 must be rotated right.

A key with the first 5 digits 1 2 3 4 5 would result in

E	I	L	O	V
P	U	C	O	M
R	S	C	T	E
E	N	C	E	I
T	O	W	R	M

The next 5 digits state how many spaces down the columns 0 to 4 should be rotated.

Applying the last 5 digits 1 2 3 4 5 to the grid above would give

T	N	C	O	V
E	O	C	T	M
P	I	W	E	E
R	U	L	R	I
E	S	C	O	M

Part of the pseudocode for the algorithm is written below.

```
global array grid[5,5]
addMessage()
// letters and random letters have been entered
// into the 2D array, grid

for i = 0 to 4
    x = getNextDigitInKey()
    shiftRow(i,x)
next i

for i = 0 to 4
    x = getNextDigitInKey()
    shiftColumn(i,x)
next i

//Now reassemble array back into string.
```

(b) Show the result of running the algorithm on the grid and key below. [2]

KEY: 3 3 3 3 3 1 1 1 1 1

T	O	P	S	E
C	R	E	T	M
E	S	S	A	G
E	Y	R	P	L
U	O	G	G	Q

Grid after only the rows are shifted:

Grid after columns have also been shifted:

[illegible]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

- 9 (a) Demonstrate how the bytes below are added together. Show your working. [2]

01101010
00111111+

- (b) Demonstrate how the bottom byte below is subtracted from the top byte. Show your working. [2]

11001111
00111001 -

- (c) Convert the binary number shown below to hexadecimal.

0011011100001111

[2]

- (d) The number below is represented in floating point format with a 5-bit mantissa in two's complement followed by a 3-bit exponent in two's complement. Calculate the denary value of the number, showing your working.

01001 010

[3]

- 00011 0010**

[2]

11100 0110

[2]

- | | | | | | | | | |
|---------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Byte | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| AND | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Result | | | | | | | | |

- | | | | | | | | | |
|---------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Byte | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| OR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Result | | | | | | | | |

10 (a) Draw a logic gate diagram to represent the Boolean expression

$$Q \equiv \neg A \vee B \quad [2]$$

(b) Find the Boolean expression represented in the Karnaugh Map below. Show your working. [5]

		AB			
		00	01	11	10
CD	00	1	1	1	1
	01	0	0	1	1
	11	0	0	0	1
	10	0	0	0	1

END OF QUESTION PAPER

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