OCR
Oxford Cambridge and RSA

# Monday 3 June 2019 – Morning

## A Level Computer Science

**H446/01** Computer Systems

**Time allowed: 2 hours 30 minutes**

**You may use:**
- a ruler (cm/mm)
- an HB pencil

**Do not use:**
- a calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

**INSTRUCTIONS**
- Use black ink. You may use an HB pencil for graphs and diagrams.
- 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 (*).
- This document consists of **28** pages.

**1** A company releases an in-home virtual assistant called 'Bertie Butler'.

The device, when placed in a room, listens out for the phrase "Hey Bertie". When someone says that phrase it then listens to the question that follows and tries to give a relevant answer.

Bertie Butler has a number of built-in input and output devices.

**(a)** Name **one** input device and **one** output device that might be part of Bertie Butler. For each device give a reason for it being built into the virtual assistant.

Input Device Name: .....

Input Device Reason: .....

.....

Output Device Name: .....

Output Device Reason: .....

.....

**[4]**

The Bertie Butler device runs off an embedded operating system.

**(b)** Define the term 'embedded operating system'.

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..... **[2]**

**(c)** Bertie Butler's circuitry is designed to only listen out for "Hey Bertie" under certain circumstances, which are:

The privacy button (**P**) must be off and the microphone must generate a signal (**S**) to say a sound has been heard.

**(i)** Complete the truth table for whether the device is listening (**L**).

| P | S | L |
|---|---|---|
| False | False | |
| False | True | |
| True | False | |
| True | True | |

**[2]**

**(ii)** Draw logic gates to represent the circuitry needed.

**[3]**

**(d)** The Bertie Butler machine uses a multicore processor.

Define the term 'multicore processor'.

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..... **[2]**

**2** A survey is carried out to look at the types of vehicle that travel down a stretch of motorway.

For each vehicle that passes by, a letter is entered into the system.

For a car 'C' is entered.

For a motorbike 'M' is entered.

For a lorry 'L' is entered.

For any other vehicle 'O' is entered.

It is decided to compress the data that has been generated.

**(a)** State what is meant by the term 'compression'.

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..... **[1]**

It is decided that Run Length Encoding will be used.

**(b)** The following sequence has been compressed using Run Length Encoding.

```
3C3M4C
```

Show the result of decompressing the sequence.

.....

..... **[2]**

**(c)** Show the result of using Run Length Encoding to compress the sequence:

```
CCCCOLLLCCCCCMOCCCCC
```

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..... **[3]**

The survey takers want to find out the longest continuous sequence of cars in any given chunk of data. For example, in the data

```
CCMCCCCLLCCC
```

the longest sequence would be 4.

**(d)** Write the function `longest` which takes in a string of characters as an argument and returns an integer representing the longest continuous sequence of Cs.

**[5]**

**3** A program written in the Little Man Computer instruction set is given below.

```
        INP
        STA    num
loop    LDA    total
        ADD    num
        STA    total
        LDA    count
        ADD    one
        STA    count
        SUB    num
        BRZ    end
        BRA    loop
end     LDA    total
        OUT
        HLT
one     DAT    1
num     DAT    0
count   DAT    0
total   DAT    0
```

**(a)** State what the program outputs are for the following inputs.

| Input | Output |
|---|---|
| 1 | |
| 2 | |
| 3 | |

**[3]**

**(b)** State what the purpose of the program is.

.....

..... **[1]**

**(c)** Explain which registers are used and their values when the line `STA count` is **executed** and the accumulator is holding the value 9. The label `count` refers to memory location 16.

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..... **[2]**

Whilst the line `STA count` is being executed, the CPU receives a signal from another process, requiring its attention.

**(d)** State the name for the signal received by the CPU.

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..... **[1]**

**(e)** The code uses direct addressing. Describe **one** other mode of addressing.

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..... **[2]**

**4** Traditionally films have been distributed on optical media such as DVDs.

**(a)** Giving an example other than DVDs, describe what is meant by the term 'optical media'.

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..... **[2]**

**(b)** Give **one** advantage of films being distributed using optical media.

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..... **[1]**

Adding a DVD drive to a computer would often require the installation of a piece of software called a device driver.

**(c)** State the purpose of a device driver.

.....

..... **[1]**

It is now common for people to purchase films which, rather than having a physical copy of, they can stream or download over the internet whenever they want.

**(d)** Explain the advantages and disadvantages of owning films that are streamed or downloaded on demand rather than owning a physical copy.

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..... **[4]**

Being able to stream high resolution films is only possible due to improvements in compression.

**(e)** Explain why compression is important for the streaming of high resolution films.

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..... **[3]**

**5** A programmer is writing software for a firewall. She is writing code so that it keeps a track of websites that users are permitted to visit. The software stores the websites' addresses along with details about who can view them and when.

The following data is also stored about each website:

- Access level needed (`1-4`)
- If it is available all the time (`true`) or just lunch times and out of work hours (`false`).

So a website which is available to users of access level 2 and above, all the time, would have the details `[2, true]` stored.

A website accessible to users of access level 3 and above, only outside of work hours, would have the details `[3, false]` stored.

**(a)** State the name of a data structure that could be used to store a single site's details.

.....

..... **[1]**

The address of each website, along with the relevant details, are stored in a hash table.

The hash table's hash function is carried out on the website's address (which acts as the key). The hash function works in the following way:

1. Discard the characters up to and including the first dot.
2. Discard the characters including and to the right of the remaining leftmost dot.
3. Convert the characters to uppercase.
4. Add the ASCII values of the characters together.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |

For example www.ocr.org.uk gets hashed in the following manner:

Step 1:

```
ocr.org.uk
```

Step 2:

```
ocr
```

Step 3:

```
OCR
```

Step 4:

```
79+67+82 = 228
```

giving a hashed value of 228.

**(b)** State what hashed value would be given by the website www.foo.co.uk

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..... **[1]**

**(c)** Complete the function `hash` which takes in a string and returns the hashed value.

You can assume you have access to the following three functions.

- `asc()` – this takes in a character and returns its ASCII value. For example `asc("A")` returns 65.
- `locate()` – this takes in a string and character and returns the location of the first instance of the character (with the string starting at character 0). For example `locate("electricity","c")` returns 3.
- `upper()` – this takes in a string and returns the UPPERCASE version. For example `upper("hello")` returns "HELLO".

You should also assume that all given website names use letters but no numbers or symbols.

You will be given credit for the readability of your code.

```
function hash(siteName)



endfunction
```

**[5]**

A flaw with the current hash function is it tends to generate lots of collisions (addresses that compute to the same hash). Below is a diagram of part of the hash table. The address www.rnd.com with details `[2, true]` is being added to the hash table.

**(d)** Explain how a hash table can be used to handle collisions, referring to the example below.

| | |
|---|---|
| 227 | |
| 228 | `www.ocr.org.uk : [1, true]` |
| 229 | |
| 230 | `www.ppf.nz : [2, false]` |
| 231 | |
| 232 | `www.ntf.biz : [4, true]` |
| 234 | |
| 235 | |

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..... **[4]**

The hash function is changed so there are no longer high numbers of collisions.

During busy periods the firewall is expected to check several addresses a second. It is anticipated that roughly 10 new addresses will be added to a whitelist (list of acceptable addresses) each day.

There is a debate as to whether a hash table (with the new hash function) is the best approach, or if the whitelist would be better stored in a linked list.

**(e)** *Discuss whether a hash table or linked list is better to store acceptable websites. You should compare how each structure can be searched and has data added and come to a recommendation as to which is better for the whitelist. **[12]**

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**6** A company makes anti-virus software.

Anti-virus software is an example of a utility.

**(a)** Define the term 'utility'.

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..... **[2]**

**(b)** State how an application differs from a utility.

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..... **[1]**

In order to keep up to date with the latest virus threats, the company is continually updating their software.

The programmers use an Extreme Programming approach when developing the updates.

**(c)** Explain what is meant by Extreme Programming and why it is a suitable approach in this case.

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..... **[4]**

**(d)** Explain why the programmers of anti-virus software may make use of virtual machines when developing the updates.

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..... **[3]**

When running the anti-virus software, an operating system uses a scheduling algorithm to determine an allocation of CPU time to the anti-virus software.

**(e)** Explain why a First Come First Served scheduling algorithm would **not** be suitable in this situation.

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..... **[2]**

In the late 1990s the CIH virus hit headlines because it was able to overwrite and destroy the contents of a computer's BIOS.

**(f)** Describe what the effect would be of a computer having its BIOS overwritten.

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..... **[2]**

**7** RestaurantReview is a website that allows users to leave reviews and ratings for different restaurants.

The website uses a database with the following structure.


The database management system ensures referential integrity is maintained.

**(a)** Explain what is meant by referential integrity, giving an example which refers to the database described above.

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..... **[3]**

**(b)** Each review includes a score out of 5. When the score is entered on the website it is checked in the browser to ensure a number no higher than 5 has been entered. It is then checked again on the server.

**(i)** State what is meant by the term 'server'.

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..... **[1]**

**(ii)** Explain why it is important that the review score that the user entered is also checked server-side.

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..... **[2]**

Whenever a review is added to the system, the restaurant's average rating is updated. This transaction is ACID.

The A in ACID refers to Atomic.

**(c)** Describe what is meant by the term 'Atomic' in the context of ACID transactions. You should refer to the example of a review being added.

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..... **[2]**

**(d)** State what the letters CID refer to in ACID.

C .....

I .....

D .....

**[3]**

The database previously stored reviews using the ASCII character set. ASCII uses 1 byte per character. It is decided to switch to the Unicode UTF-32 character set which uses 4 bytes per character.

**(e)** Give an advantage and disadvantage of changing character sets from ASCII to Unicode UTF-32.

Advantage .....

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Disadvantage.....

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**[2]**

**8** A simple program is shown below.

```
//Program to calculate number of times
//a number goes into 100
count = 0
num = int(input("Enter a number"))
while (count*num)<=100
       count=count+1
endwhile
count=count-1 //Take one off as gone over

print(str(num) + " goes into 100 " + str(count) + " times.")
```

**Fig. 8.1**

**(a)** State the output of the program when the number 30 is entered.

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..... **[1]**

**(b)** State the most suitable data type of the variable **`count`**

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..... **[1]**

**(c)** State the data type of the result of the expression **`(count*num)<=100`**

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..... **[1]**

**(d)** State the data type of the result of the expression

```
str(num) + " goes into 100 " + str(count) + " times."
```

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..... **[1]**

**(e)** Write extra code so the program also displays the remainder.

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..... **[2]**

The program is compiled. The first stage is Lexical Analysis.

**(f)** Referring to examples in the code in Fig. 8.1, explain what happens in Lexical Analysis.

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..... **[3]**

**(g)** State the name of the stage of compilation that directly follows Lexical Analysis.

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**9*** Discuss the positive and negative impacts computers are having on the environment.

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**10** **(a)** Show how the binary number 01011110 is represented in hexadecimal.

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..... **[1]**

**(b)** Show how the hexadecimal number 9B is represented in denary.

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..... **[2]**

**(c)** Show how the denary number −87 is represented in sign and magnitude binary.

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..... **[2]**

**(d)** Complete the following binary subtraction. Show your working.

```
01001001-
00101111
```

**[2]**

**(e)** The floating point binary number 010011 011 consists of a 6-bit mantissa and 3-bit exponent, both represented in two's complement. Convert the number to denary, showing your working.

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..... **[3]**

**(f)** Show the denary number −5.25 in floating point binary form representing the mantissa and exponent in two's complement, using as few bits as possible. Show your working.

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..... **[4]**

**11** A web development company makes its money building websites for other companies.

**(a)*** The web development company is looking to recruit a programmer to build websites.

Discuss the technologies the programmer would need to know and use and the importance of each one.

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..... **[9]**

**(b)** Part of a website's code is shown below.

```
<head>
     <title>Orville's Oranges</title>
     <link rel="stylesheet" type="text/css" href="mainStyle.css">
</head>
```

Explain the meaning of the code.

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..... **[2]**

**(c)** The site also contains the following code.

```
<div class="offer">All oranges 50% off.</div>
```

Complete the CSS code that would make any div elements of the class `offer` have an orange border.

```
.....{
                 border-style: solid;
                 .....
                }
```

**[2]**

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