SPECIMEN MATERIAL

AS
COMPUTER SCIENCE
(7516/2)

Paper 2

Date Morning Time allowed: 1 hour 30 minutes

Materials
- There are no additional materials required for this paper.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the bottom of this page.
- Answer **all** questions.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- You may use a calculator.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

Advice
- In some questions you may be required to indicate your answer by shading a lozenge. If you wish to change your answer make sure that the incorrect answer is clearly crossed through with an x.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname

Forename(s)

Candidate signature _____

Answer **all** questions in the spaces provided

0 1 $\mathbb{R}$ denotes the set of real numbers, which includes the natural numbers, the rational numbers and the irrational numbers.

0 1 . 1 Give **one** example of a natural number.

[1 mark]

0 1 . 2 Give **one** example of an irrational number.

[1 mark]

2

0 2

0 2 . 1 What is the decimal equivalent of the hexadecimal number $D6_{16}$? Show your working.

[2 marks]

0 2 . 2 Represent the decimal value 9.375_{10} as an unsigned binary fixed point number, with 4 bits before and 4 bits after the binary point.

[2 marks]

0 2 . 3 Represent the decimal value -67_{10} as an **8-bit two's complement binary integer**.

[2 marks]

Question 2 continues on the next page

0 2 . 4 A computer represents numbers using 8-bit two's complement binary.

Using this representation perform the calculation:

[1 mark]

01001000_2
01100011_2 +

Answer:

0 2 . 5 What problem has resulted from performing the calculation using 8-bit two's complement binary?

[1 mark]

8

0 3 . The ASCII binary code for character a is 1100001_2

0 3 . 1 Explain what is mean by a character code.

[1 mark]

0 3 . 2 Complete **Table 1** to show how the word be would be encoded in the binary form of ASCII.

[2 marks]

Table 1

Character	Binary form of ASCII
b	
e	

A program has been developed to convert a string so that all of its characters are in upper case.

The computer does this by taking each character's ASCII binary code and applying a bitwise AND operation to it, using the mask 1011111_2.

0 3 . 3 Convert the lower case character c, ASCII code 1100011_2, into the upper case character C using the method described above.

[1 mark]

_____

_____

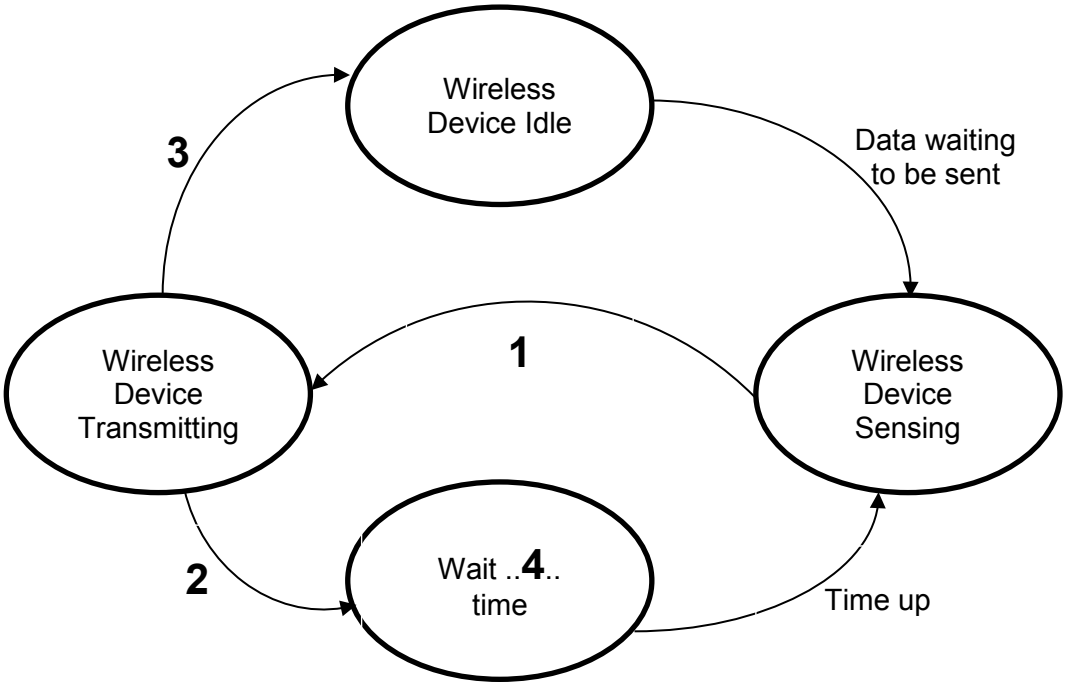
4

Turn over for the next question

0 4 Wireless networks make use of the carrier sense multiple access and collision avoidance (CSMA/CA) method when accessing a wireless network to transmit data.

Figure 1 shows a simplified state transition diagram of the CSMA/CA wireless network access method without use of request to send/clear to send (RTS/CTS).

Figure 1



0 4 . 1 Complete **Table 2** by writing in the descriptions that should appear at positions **1** to **4** in **Figure 1**.

[4 marks]

Table 2

Label	Description
1	
2	
3	
4	

0 4 . 2 Explain the role of a service set identifier (SSID) in wireless networking and why some network administrators turn off SSID broadcasting.

[3 marks]

0 4 . 3 Explain why browsing the Internet might be slower at a public hotspot in a coffee shop than at home on a wireless network.

[2 marks]

9

Turn over for the next question

0 5 The OpenSSL project is a collaborative effort to develop a general purpose cryptography software library for encrypting data transmissions.

In April 2014, a bug known as the 'Heartbleed Bug' was found in the OpenSSL software library. The bug allowed anyone on the Internet to access the memory of systems protected by the vulnerable versions of this OpenSSL software.

According to web server statistics, this bug could have affected around 66% of known web servers.

0 5 . 1 What is encryption?

[2 marks]

0 5 . 2 OpenSSL is an example of open source software and so its source code is freely available for inspection.

Describe **two** benefits of having the source code of software publicly available.

[2 marks]

0 5 . 3 The 'Heartbleed Bug' was introduced into the code on December 31, 2011 but was only discovered in 2014.

State **one** reason why the bug took over two years to find.

[1 mark]

0 5 . 4 Government agencies sometimes require that they are given copies of encryption keys. This allows these agencies to decrypt messages encrypted with these keys.

State **one** reason for and **one** reason against a government having the ability to decrypt any encrypted messages.

[2 marks]

Reason for:

Reason against:

7

Turn over for the next question

0 6

0 6 . 1 What is meant by the term stored-program concept?

[2 marks]

The following registers, listed in alphabetical order, are used in the Fetch-Execute cycle:

- current instruction register (CIR)
- memory address register (MAR)
- memory buffer register (MBR)
- program counter (PC)
- status register (SR).

0 6 . 2 Describe, **using full sentences**, the steps involved in the Fetch-Execute cycle, and how the registers listed above are used. Your description should cover the fetch, decode and execute phases of the cycle.

[6 marks]

0 6 . 3 Explain the term low-level language.

[1 mark]

0 6 . 4 Using the assembly language instruction `CMP R2,R3` explain the term opcode.

[1 mark]

Question 6 continues on the next page

Table 3

Instructions that can be used in question parts **0 6 . 5** and **0 6 . 6**

`LDR Rd, <memory ref>`	Load the value stored in the memory location specified by `<memory ref>` into register `d`.
`STR Rd, <memory ref>`	Store the value that is in register `d` into the memory location specified by `<memory ref>`.
`ADD Rd, Rn, <operand2>`	Add the value specified in `<operand2>` to the value in register `n` and store the result in register `d`.
`SUB Rd, Rn, <operand2>`	Subtract the value specified by `<operand2>` from the value in register `n` and store the result in register `d`.
`MOV Rd, <operand2>`	Copy the value specified by `<operand2>` into register `d`.
`CMP Rn, <operand2>`	Compare the value stored in register `n` with the value specified by `<operand2>`.
`B <label>`	Always branch to the instruction at position `<label>` in the program.
`B<condition> <label>`	Conditionally branch to the instruction at position `<label>` in the program if the last comparison met the criteria specified by the `<condition>`. Possible values for `<condition>` and their meaning are: • EQ: Equal to. • NE: Not equal to. • GT: Greater than. • LT: Less than.
`AND Rd, Rn, <operand2>`	Perform a bitwise logical AND operation between the value in register `n` and the value specified by `<operand2>` and store the result in register `d`.
`ORR Rd, Rn, <operand2>`	Perform a bitwise logical OR operation between the value in register `n` and the value specified by `<operand2>` and store the result in register `d`.
`EOR Rd, Rn, <operand2>`	Perform a bitwise logical exclusive or (XOR) operation between the value in register `n` and the value specified by `<operand2>` and store the result in register `d`.
`MVN Rd, <operand2>`	Perform a bitwise logical NOT operation on the value specified by `<operand2>` and store the result in register `d`.
`LSL Rd, Rn, <operand2>`	Logically shift left the value stored in register `n` by the number of bits specified by `<operand2>` and store the result in register `d`.
`LSR Rd, Rn, <operand2>`	Logically shift right the value stored in register `n` by the number of bits specified by `<operand2>` and store the result in register `d`.
`HALT`	Stops the execution of the program.

Interpretation of `<operand2>`

`<operand2>` can be interpreted in two different ways, depending upon whether the first symbol is a `#` or an `R`:

- `#` - Use the decimal value specified after the `#`, eg `#25` means use the decimal value 25.
- `Rm` - Use the value stored in register `m`, eg `R6` means use the value stored in register 6.

The available general purpose registers that the programmer can use are numbered 0 to 12.

0 6 . 5 Explain what immediate addressing is **and** write an example of the use of the `MOV` assembly language instruction, from **Table 3**, that uses immediate addressing.

[2 marks]

0 6 . 6 **Figure 2** shows a block of program code, written in a high-level language.

Figure 2

```
IF X = 5
  THEN B ← 10
END IF
```

Write a sequence of assembly-language instructions that would perform the same operations as the program code in **Figure 2**. Assume that register `R1` currently stores the value associated with `X`, register `R2` stores the value currently associated with `B` and that register `R3` is available for general use, if necessary.

[4 marks]

16

0 7 A well-established use for robots in industry is the spraying of car bodies on a car production line.

A robotics researcher is investigating the feasibility of developing and installing in a car a computer-based control system to take over completely the driving of the car on public highways.

She has identified some of sources of inputs into the control system already:

- high resolution video camera
- stereoscopic digital camera
- long range radar
- short range radar
- Global Positioning Satellite receiver.

And some of the outputs:

- position of steering wheel (in degrees from the vertical)
- forces on accelerator and brake pedals.

Discuss why automated car control is a harder programming problem to solve than developing programmed control of a robot for spraying car bodies on a car production line, and what processing of input data will be necessary and why to obtain sufficient information to safely and reliably control the driving of the car by computer. Include in your discussion the sources of input that you have used and the information derived from these by processing.

[9 marks]

9

0 8 A flight recorder is an electronic recording device placed in an aircraft for the purpose of facilitating the investigation of aviation accidents and incidents **Figure 3** shows an example of a flight recorder. It is a requirement for every commercial aircraft to have a type of flight recorder called a cockpit voice recorder.

Figure 3

0 8 . 1 Current cockpit voice recorders use solid-state memory chips to store the digital audio data. Alternatively, the data could be stored on a traditional hard disk drive.

Give **two** reasons why cockpit voice recorders store data using solid-state memory instead of using a traditional hard disk drive.

[2 marks]

0 8 . 2 Audio from the cockpit is sampled at a rate of 8000 Hz and 16 bits are allocated to each sample.

How many kilobytes would be needed to store 360 seconds of audio?
Show your working.

[3 marks]

Answer:

0 8 . 3 Explain why the highest audio frequency in the sampled audio from the cockpit cannot be greater than 4000 Hz.

[2 marks]

7

Turn over for the next question

0 9

0 9 . 1 Complete **Table 5** and draw the symbol for an AND gate in the box.

[2 marks]

Table 5 - Truth table for an AND gate

Input A	Input B	Output

AND gate symbol

0 9 . 2 Using the laws of Boolean algebra, simplify the following Boolean expression.

$$A.B.(A + B)$$

[3 marks]

Answer:

0 9 . 3 Using the laws of Boolean algebra, simplify the following Boolean expression.

$$(X + Y).(X + \overline{Y})$$

[3 marks]

Answer:

8

1 0 **Figure 4** shows two versions of the same segment of a program.

Figure 4

Version A

`if x > 0:`
`  y = y + 2`
`else:`
`  y = y - 1`

Version B

`00011100 00110000`
`00101010 10010010`
`11101010 00000010`
`00101100 10010001`

1 0 . 1 Shade in **one** lozenge to indicate which version, **A** or **B**, in **Figure 4** represents object code.

[1 mark]

Version A ⬭ Version B ⬭

1 0 . 2 Describe **two** differences between a compiler and an interpreter.

[2 marks]

1 0 . 3 Explain what intermediate code is **and** why some compilers will produce intermediate code as the final output.

[2 marks]

5

END OF QUESTIONS

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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Question 8: Image of flight recorder © Thinkstock.