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A-level COMPUTER SCIENCE

Paper 2

Tuesday 11 June 2019 Morning Time allowed: 2 hours 30 minutes

Materials

For this paper you must have:

· a calculator.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- · Answer all questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.

Advice

- In some questions you are required to indicate your answer by completely shading a lozenge alongside the appropriate answer as shown.
- If you want to change your answer you must cross out your original answer as shown.
- If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.

For Examiner's Use			
Question	Mark		
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TOTAL			



Answer all questions.				Do not write outside the box	
0 1.1	Shade one lozenge checker belongs.	e to indicate to which c	ategory of system softwa	are a virus	
	3			[1 mark]	
		Category	Shade one lozenge		
		Operating systems			
		Translators			
		Utilities			
0 1.2		em is responsible for re	esource management. management that an ope	erating system is	
	responsible for.	ent types of resource i	nanagement that an ope	[2 marks]	
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0 2 . 1	A company is setting up a computer network to help manage its business.	bo
	The company sets up a computer that will act as a server. The server's primary role will be to act as an email server. It will also allow technicians to remotely login so that the server can be managed from other computers.	
	State the names of two application layer protocols that the server must implement and explain what each will be used for.	
	[4 marks]	
	Protocol 1:	
	Use:	
	Protocol 2:	
	Use:	
0 2.2	Explain how the transport layer of the TCP/IP stack determines which application layer software on the server should deal with a received request. [1 mark]	
0 2 . 3	Describe one function of the network layer of the TCP/IP stack. [1 mark]	
		6
	Turn over for the next question	

Turn over ▶



0 3	The paragraph of text in Figure 1 is to be compressed using a dictionary-based compression method.
	Figure 1
	Unfortunately time after time it is the case that programmers fail to put enough effort into commenting their code. Effort put into commenting could make the code easier to maintain when the time comes to do this.
0 3 . 1	Dictionary-based compression is an example of a lossless encryption method.
	Explain the key difference between lossless and lossy compression methods. [1 mark]
0 3 . 2	Explain how the paragraph of text in Figure 1 could be compressed using a dictionary-based method. [2 marks]
0 3.3	After the text in Figure 1 has been compressed it is to be transmitted across a computer network.
	Explain why dictionary-based compression is not very effective for compressing small amounts of text for transmission.
	[1 mark]



A student has attempted to add together the binary numbers $0\,0\,1\,1\,0\,0\,1\,1$ and $1\,0\,1\,1\,0\,1\,1\,0$, but has made a mistake.

The student's calculation is shown in **Figure 2** below.

Figure 2

	Α	В	С	D	Ε	F	G	Н
	0	0	1	1	0	0	1	1
+	1	0	1	1	0	1	1	0
Carry	0	1	1	0	1	1	0	
Result	1	1	0	0	1	0	0	1

Explain what mistake the student has made.

The columns in the addition have been labelled **A** to **H** to help you make your explanation clear.

[1 mark]

1

0 5

A student has written a computer program using an imperative high-level programming language. The program could be translated using either a compiler or an interpreter.

Describe the steps that must be completed to translate and execute the program.

Your description should include:

- why translation is necessary
- the differences between how a compiler and an interpreter would translate the program
- how the machine code instructions that are used to carry out the program will be fetched and executed by the processor from main memory.

	[12 marks]

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A veterinary practice with four different surgeries intends to use a relational database to store the data that it needs to manage its business.

Customers of the practice are pet owners who bring their pets to one of the surgeries for appointments. The surgeries are staffed by vets.

- Each customer is identified by a unique identity number and the customer's forename, surname and telephone number are recorded.
- Each pet is identified by a unique identity number and the pet's name, type and date of birth are recorded.
- Each surgery is identified uniquely by its name. The town in which it is located and the surgery's telephone number are recorded.
- Each vet is identified by a unique identity number and the vet's forename and surname are recorded.

A pet is owned by one or more customers and each customer may own any number of pets. Over their lifetimes, pets may attend many appointments.

To make an appointment for a pet, a customer contacts a surgery. The appointment is made for the pet to take place on a particular date and time at a specific surgery.

Each vet is associated with one surgery which they work at; each surgery is staffed by several vets.

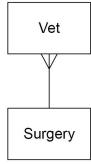
0 6 . 1

Complete the entity-relationship diagram below for a **fully normalised** relational database to store the data required by the veterinary practice.

Some of the entities and relationships have been drawn for you. You need to draw the remaining **three** entities and clearly show the relationships between the entities and their degree.

[3 marks]







	9
0 6.2	Develop a fully normalised design for a relational database to store the information required by the veterinary practice. To help you, the Pet, Surgery and Vet relations have already been defined in Figure 3 .
	Figure 3
	Pet(PetID, PetName, Type, DateOfBirth)
	Surgery(SurgeryName, Town, TelephoneNumber)
	Vet(VetID, VetForename, VetSurname, SurgeryName)
	Using the format shown in Figure 3 list all the other relations that will need to be created, together with the attributes that each will contain.
	Underline the attribute(s) that will form the entity identifier (primary key) in each relation.
	[4 marks]

Question 6 continues on the next page



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0 6 . 3	work at the surgery in the town of Torquay. Some errors have been made in the query.
	Figure 4
	SELECT VetForename, VetSurname FROM Surgery, Vet WHERE Town = Torquay
	Describe two errors that have been made in the query. You should not give the omission of a semi-colon (;) as one of the errors. [2 marks]
	Error 1:
	Error 2:
0 6.4	The database is stored at the practice's head office. Staff at the individual surgeries access it using a client-server database system, which enables the management of concurrent access to the database.
	Describe an example of a problem that could occur if no system were in place to manage concurrent access to the database. [3 marks]



0 6 . 5	Two methods that can be used to manage concurrent access are:	Do n outs
	record lockstimestamp ordering.	
	Select one of these methods and describe how it manages concurrent access. [2 marks]	
	Method selected:	
	How it works:	

Turn over for the next question



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0 7

Figure 5 shows three commonly used mathematical functions: add, square and pred.

Figure 5

$$add(x,y) = x + y$$

$$square(x) = x^2$$

$$pred(x) = x - 1$$

For example:

- add (3,2) evaluates to 5
- square (2) evaluates to 4
- pred(8) evaluates to 7

The domain of the functions square and pred in Figure 5 is the set of integers $\mathbb Z$ and the domain of the add function is $\mathbb{Z} \times \mathbb{Z}$.

0 7 What is the co-domain of the pred function?

[1 mark]

7 2 What is the result of applying square opred to the argument 3?

[1 mark]

0 7 The add function takes two arguments.

> Describe how the add function could be partially applied to the arguments 4 and 6. [3 marks]

5



0 8.1 Complete the truth tables for the OR and NAND gates.

[1 mark]

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OR Gate

Inp	uts	Output
0	0	
0	1	
1	0	
1	1	

NAND Gate

Inp	uts	Output
0	0	
0	1	
1	0	
1	1	

0 8 . 2 Draw a logic circuit for the Boolean expression:

$$Q = \overline{A.\,B + C.\,\overline{B}}$$

[4 marks]



Question 8 continues on the next page





0 8 . 3	Identities are often applied to help simplify Boolean expressions. One such identity is:	Do not write outside the box
	$A.\overline{A}=0$	
	Without using a truth table, explain why this identity is true. [2 marks]	
		- - - - - -
0 8.4	Using the rules of Boolean algebra, simplify the following Boolean expression.	<u> </u>
	$\overline{\overline{\overline{B} \cdot A} \cdot \overline{B}} + A \cdot B$	\$ \$
	You must show your working. [4 marks]	Wiscopiou
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0 9	A data c	commur	nication	syster	n uses	asynch	ronous	serial	commu	ınicatio	n.	
0 9 . 1	Explain	the diffe	erence	betwee	en asyn	ıchrono	us and	synchr	ronous	commu		n. [1 mark]
0 9 . 2	The ASo			_	'0' is	48 in de	ecimal.	In ASC	CII, othe	er digits	follow	on from
	and eve	The digit '4' is to be transmitted in ASCII using asynchronous serial transmission and even parity , with the parity bit stored in the most significant bit of the byte of data containing the ASCII code.										
	Comple	Complete Figure 6 below to show a valid bit pattern for transmitting the digit ' 4 ' [3 marks]										
						Figu	re 6					
		Ston	Parity			90					Start	
		Bit	Bit	1	1				1		Bit	
			Questi	on 9 c	ontinue	es on tl	he nex	t page				



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0 9 . 3	It is proposed that the communication system is modified so that:	0
	 a majority voting system is used instead of the parity bit Unicode is used to encode the characters to be transmitted instead of ASCII. 	
	Discuss the improvements that will occur in the communication system as a result of these changes and any disadvantages that will result from them.	
	[4 marks]	
		L-



The greatest common divisor of two positive integers A and B is the largest positive integer that divides both of the numbers without leaving a remainder.

For example, if A = 4 and B = 6 then:

- 4 has the divisors 1, 2 and 4
- 6 has the divisors 1, 2, 3 and 6

Therefore, the greatest common divisor of 4 and 6 is 2, since this is the biggest number which appears in the list of divisors of both 4 and 6.

The method shown in **Figure 7** is a famous method for determining the greatest common divisor of two positive integers, A and B:

Figure 7

WHILE A
$$\neq$$
 B
IF A > B THEN
A = A - B
ELSE
B = B - A
ENDIF
ENDWHILE

When the procedure described in the algorithm terminates, the value in A (and also B) is the greatest common divisor of A and B.

Question 10 continues on the next page



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Table 1 - standard AQA assembly language instruction set

Load the value stored in the memory location specified by		
<pre><memory ref=""> into register d.</memory></pre>		
Store the value that is in register d into the memory location		
<pre>specified by <memory ref="">.</memory></pre>		
Add the value specified in <pre><pre><pre><pre><pre><pre><pre><pre></pre></pre></pre></pre></pre></pre></pre></pre>		
register n and store the result in register d.		
Subtract the value specified by <pre><pre>operand2> from the value</pre></pre>		
in register n and store the result in register d.		
Copy the value specified by <pre><pre>coperand2> into register d.</pre></pre>		
Compare the value stored in register n with the value		
<pre>specified by <operand2>.</operand2></pre>		
Always branch to the instruction at position <label> in the</label>		
program.		
Branch to the instruction at position <label> if the last</label>		
comparison met the criterion specified by <condition>.</condition>		
Possible values for <condition> and their meanings are:</condition>		
EQ: equal to NE: not equal to		
GT: greater than LT: less than		
Perform a bitwise logical AND operation between the value		
in register n and the value specified by <pre><operand2></operand2></pre> and		
store the result in register d.		
Perform a bitwise logical OR operation between the value in		
register n and the value specified by <pre><pre>operand2> and</pre></pre>		
store the result in register d.		
Perform a bitwise logical XOR (exclusive or) operation		
between the value in register n and the value specified by		
<pre><operand2> and store the result in register d.</operand2></pre>		
Perform a bitwise logical NOT operation on the value		
specified by <pre><pre>specified by <pre><pre>operand2> and store the result in register d.</pre></pre></pre></pre>		
Logically shift left the value stored in register n by the		
number of bits specified by <pre><pre>operand2></pre> and store the</pre>		
result in register d.		
Logically shift right the value stored in register n by the		
number of bits specified by <pre>operand2> and store the</pre>		
result in register d.		
Stops the execution of the program.		

Labels: A label is placed in the code by writing an identifier followed by a colon (:). To refer to a label, the identifier of the label is placed after the branch instruction.

Interpretation of operand2>

<operand2> can be interpreted in two different ways, depending on whether the first character 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.



1 0 . 1	Write a program using the AQA assembly language instruction set, shown on page 18 in Table 1, that uses the method described in Figure 7 to calculate the greatest common divisor of two positive integers.		
	At the start, the positive integer A will be stored in memory location 102 and the positive integer B in memory location 103. Your program should use these values to find their greatest common divisor.		
	• When your program terminates it should store the greatest common divisor of these two numbers in memory location 104.		
	[8 marks]		



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1 1	Questions 11.1, 11.2, 11.3 and 11.4 use a normalised floating point representation with an 8-bit mantissa and a 4-bit exponent, both stored using two's complement .			
1 1.1	Write the smallest positive number that can be represented by the floating poi system in the boxes below.			
1 1.2	Mantissa Exponent The following is a floating point representation of a number: 1 • 0 1 1 0 0 1 0 Mantissa Exponent			
	Calculate the decimal equivalent of the number. You must show your working. [2 marks]			
1 1.3	Answer Write the normalised floating point representation of the decimal value 0.15625 (5/32 as a fraction) in the boxes below. You must show your working. [3 marks]			
	Answer Mantissa Exponent			



1 1.4	The two floating point numbers below are multiplied together.
	0 • 1 0 1 0 0 0 0 0 1 1 1
	Mantissa Exponent
	Mantissa Exponent
	·
	A problem occurs as a result of the multiplication operation.
	Explain what problem has occurred and how the floating point representation could be redesigned to avoid it.
	[3 marks]
1 2	A particular computer system uses a 32-bit address bus and a 32-bit data bus. Each addressed memory location can store one byte of data.
1 2 . 1	What is the maximum amount of memory, in bytes, that could be accessed?
	[1 mark]
	Question 12 continues on the next page





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	Explain how the wider data bus has resulted in this effect.	
	[1 mark]	
1 3	Discuss the advantages and disadvantages of representing an image as a vector graphic instead of as a bitmap.	
	In your answer, include an example for which it would be most appropriate to use a vector graphic and an example for which it would be most appropriate to use a bitmap.	
	[6 marks]	
		6



1 4 . 1

The ciphertext message "BVP" has been received. The message was encrypted using the Vernam cipher and the key "TIN".

Conversion between letters and their equivalent binary patterns was carried out using a special code called the Baudot-Murray code. A version of the Baudot-Murray codes for each letter is shown in **Figure 8**.

Figure 8

Letter	Encoding
Α	11000
В	10011
С	01110
D	10010
Е	10000
F	10110
G	01011
Τ	00101
I	01100
J	11010
K	11110
L	01001
М	00111

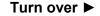
Letter	Encoding
N	00110
0	00011
Р	01101
Q	11101
R	01010
S	10100
T	00001
U	11100
V	01111
W	11001
Х	10111
Y	10101
Z	10001

Decrypt the ciphertext to work out what the original plaintext message was.

Express the plaintext as letters.

You i	must	show	your	working.
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•	[3 marks]
Plaintext	





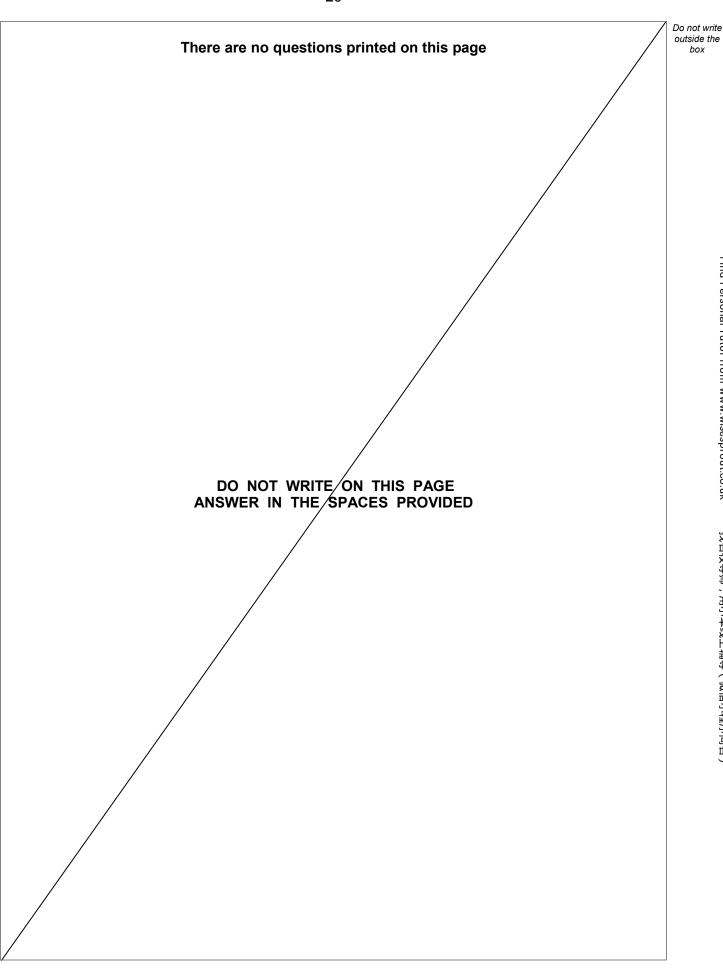
	The Vernam cipher can offer perfect security. Most encrypted transmissions that are made by computers use ciphers that are computationally secure but not perfectly secure.
1 4.2	Explain what it means for a cipher to be described as being computationally secure. [1 mark]
	Many computerised cipher systems use asymmetric encryption methods to resolve the key exchange problem that is associated with symmetric ciphers, such as the Vernam and Caesar ciphers.
1 4.3	Explain what the key exchange problem is, in relation to a symmetric cipher. [2 marks]



1 4 . 4	A message is to be transmitted from computer A to computer B. The message will be encrypted using asymmetric encryption. To enable computer B to authenticate that the message was sent by computer A, a digital signature will also be sent with the message.
	Explain how computer B will decrypt the message and verify that it was sent by computer A.
	In your response you should refer to the specific keys that will be used in this process.
	You do not need to explain how computer A will encrypt the message or create the digital signature.
	[4 marks]

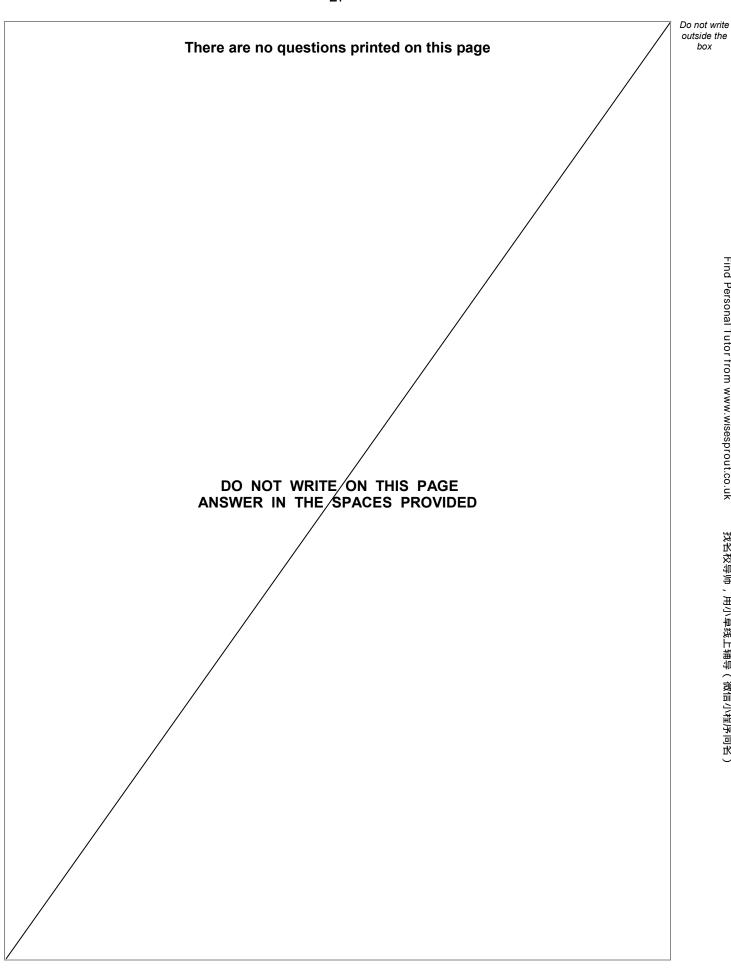
END OF QUESTIONS







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