

**AQA**

**A LEVEL**

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2015 specification

first exams in 2017

**Topic Tests**

*for A Level AQA Computer Science*

*Paper 2 Topics 4.5 – 4.12*

Computer Science A Level | AQA | 7517



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Teacher’s Introduction

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This resource is designed to support teaching and learning of the A Level AQA specification (for first teaching in September 2015; first exams from June 2017).

These end-of-topic tests are designed as factual tests to check your students’ understanding as they complete each topic\*. Their primary focus is not to provide exam-style practice, but instead to test the knowledge, skills and understanding required by the AQA specification in a variety of styles and complexities – ranging from simple short-answer questions through to longer essay-style questions.

*\*The tests could also be used for homework or revision, but their best use is as summative assessments.*

There are a total of 15 tests covering the prescribed specification content for *Paper 2* of the A Level AQA specification – each provided in worksheet format (with answer lines) and a more photocopy-friendly format (without answer lines), to give you flexibility of use. The majority of tests are worth around 30-40 marks each, so that they can be completed within a single one-hour lesson.

Example answers are provided for every test. *Note that credit should also be given for any valid responses that are not explicitly included in this resource.*

Tests

# Topic Tests

4.5. Data Representation – Test 1

1. a) Describe the representation of unsigned denary integers in binary format. [1]

b) Fill in the table below with the binary and hexadecimal representations of the given denary numbers: [4]

|  |  |  |
| --- | --- | --- |
| **Denary** | **Binary** | **Hexadecimal** |
| 0 |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |
| 11 |  |  |
| 12 |  |  |
| 13 |  |  |
| 14 |  |  |
| 15 |  |  |
| 16 |  |  |

2. Calculate the result of each following binary expressions. Show your working and give the result in binary.

a) 0111 + 0010 [1]

b) 1011 \* 111 [3]

3. a) Use the even-parity bit given to state whether an error has occurred during the transmission of the following numbers:

i. 0100101011 parity 1 [1]

ii. 010111011 parity 0 [1]

iii. 11111111 parity 1 [1]

b) Explain how a checksum is used for error detection. [3]

4. a) Explain why it is necessary to sample sounds when recording them to a computer. [2]

b) Explain the difference between .wav, .midi and .mp3 files for storing music. [3]

c)Explain the difference between lossy and lossless compression for sound files, commenting on the resulting file sizes and quality of the resulting file. Which form will most likely be used for streaming music over the Internet? [3]

5. a) Convert the following unsigned binary numbers into denary.

i. 01100110 [1]

ii. 10111001 [1]

iii. 11000101 [1]

b) Convert the following denary numbers into 8-bit unsigned binary.

i. 78 [1]

ii. 123 [1]

iii. 228 [1]

c) Convert the following 8-bit two’s complement binary numbers into denary.

i. 00101101 [1]

ii. 10100111 [1]

iii. 11111111 [1]

d) Convert the following binary fractions into denary decimal numbers.

i. 0100.1100 [1]

ii. 0011.1110 [1]

ii. 1011.1001 [1]

6. Run-length encoding is a form of lossless compression. A simple way of representing run-length encoded data is as a series of pairs of bytes, with the first byte in each pair representing a character and the second byte in each pair representing the number of times the character is repeated.

Example: "HHHEEEELLLLOOOOOOOO" would be encoded as ['H', 3, 'E', 4, 'L', 4, 'O', 8].

a) Encode the string "GGOOOOODDBYYYEEEEE" using the format described above. [2]

b) Run-length encoding on its own does not compress text well. Give an example of a type of compression that is better suited to compressing text and describe how it works. [3]

Total marks = /40

4.5. Data Representation – Test 2

1. The following questions should be carried out without using a calculator. Show your working.

a) Convert 204 (base 10) to binary and hexadecimal.

i. Binary: [1]

ii. Hex: [1]

b) Convert 11000111 (base 2) to denary and hexadecimal.

i. Binary: [1]

ii. Hex: [1]

c) Convert E7 (base 16) to denary and binary.

i. Binary: [1]

ii. Hex: [1]

d) What is in two’s complement notation? [1]

e) If 1100.1100 is a two’s complement fraction, what is it in denary? [2]

f) Binary fractions can be inaccurate. To demonstrate this use a binary floating-point number with a two’s complement exponent 4-bits wide and a two’s complement mantissa 5-bits wide to represent the number 1.4. Explain how this inaccuracy could be reduced and any further difficulties you may run into.

[4]

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
| Exponent | | | | Mantissa | | | | |

2. ASCII and Unicode are both methods of storing characters in a computer.

a) Knowing that A is character 65 (base 10) in the ASCII table, give the ASCII codes for the following letters:

i. F [1]

ii. M [1]

iii. X [1]

b) How many ASCII characters are in the following phrase? Explain how you arrived at your answer.

**I love AQA Computer Science!** [2]

c) The ASCII code for the letter ‘E’ is 100 0101. State the ASCII binary for the letter J. [1]

d) Give an advantage of ASCII over Unicode. [1]

e) Give an advantage of Unicode over ASCII. [1]

f) How many characters can 7-bit ASCII represent? [1]

3.a) Using an example, describe how bit patterns may represent other forms of data, such as graphics or sound. [2]

b) You are given a photo which has a resolution of 640 pixels by 480 pixels. It has a size of 1200KB. Assuming the file is a simple raw bitmap (i.e. it contains no header or other extras), calculate the  
colour depth of the photo (show your working). [3]

c) You are designing a logo for a new website. Part of the logo is made from an existing photo.  
Explain, giving reasons, why you should use bitmap rather than vector graphics for the logo.   
As part of your answer you should explain the differences between these two file formats. [3]

d) Give examples of two pieces of information typically found in the metadata of a bitmapped graphic. [2]

1 2

4. Encryption is incredibly important in the modern age. Two popular methods of encryption are the Caesar Cipher and the Vernam Cipher.

a) Encrypt the phrase ‘I love computing’ using the Caesar Cipher and a key of 5. [2]

b) Decrypt the phrase ‘kwux akq zwksa’ using the Caesar Cipher and a key of 8. [2]

c) Give two disadvantages of a standard Caesar cipher as a method of encryption. [2]

d) The Vernam Cipher is highly regarded – why is that? [1]

e) Explain how the Vernam Cipher works. You may assume a computer is carrying out the encryption, and binary is being used to represent each character. [4]

f) Aside from keeping the key text safe and secure, what other two rules must be followed to preserve the security of this Vernam Cipher? [2]

1

2

Total marks = /45

4.6. Computer Systems – Test 1

1. Identify which of the following are hardware and which are software? [4]

a) Hard disk

b) Windows operating system

c) A graphics card

d) Monitor

2. List five different programming languages, indicating what each is generally used for.  
(Note that no marks will be gained if you only list the name of the language.) [5]

1

2

3

4

5

3. a) What is the difference between imperative and declarative languages? [2]

b) Broadly speaking, there are five generations of computer language. Indicate which of the first four generations are machine dependent and why. [4]

c) Which level does assembly language fall under? [1]

d) Here is an extract from a programming language. What level of language is it and what  
limitations does this level of language offer? [3]

FD 71 431F 4153

F3 63 4267 4321

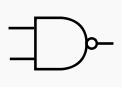
96 F0 426D

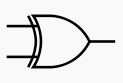
F9 10 41F3 438A

47 40 40DA

47 F0 4050

4. a) What are the functions of the following logic gates?

i. [1]

ii. [1]

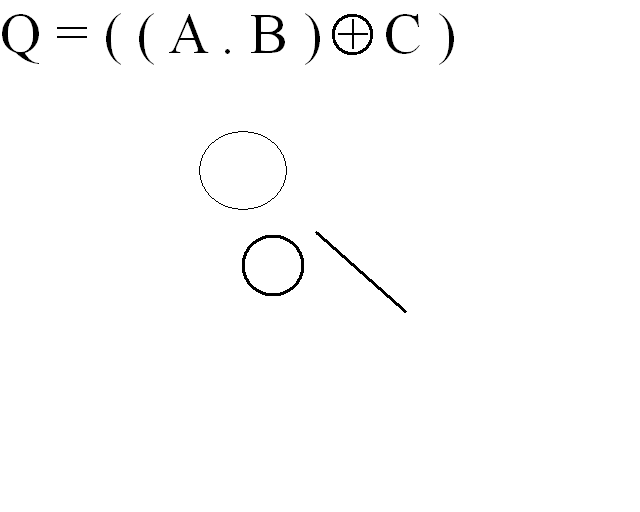
b) What are the results of the following Boolean algebra equations?

i. 0 + 1 + 1 + 0 [1]

ii. 1 . 0 [1]

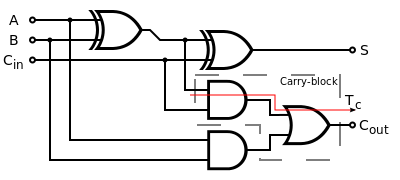
iii. (0 + 0 + 0) + (0 + (1 . 1)) [1]

c) Construct the logic circuit that represents the following expression: [3]



5. a) What is an adder circuit used for? [1]

b) Does the following image represent a full adder or half adder? [1]



c) Draw the other type of adder circuit not shown in part b). [4]

d) D-type flip-flops can be used in memory. Explain what the ‘D’ represents in the name? [2]

Total marks = /35

4.6. Computer Systems – Test 2

1. a) Briefly explain, using an example for each, the difference between system software and   
application software. [4]

b) Say for each of the following whether they are application- or system-software packages. [4]

i. Unix

ii. Word processor

iii. Virus scanner

iv. Computer game

2. You are working as a project manager for a company. Describe *four* different factors you would consider when selecting a programming language for a major project to be written in. Assume that you have  
a good working knowledge of all languages. [4]

1

2

3

4

3. Name and briefly describe the three different types of translator programs. [6]

Type:

Description:

Type:

Description:

Type:

Description:

4. a) Describe the function of applying the following logical operators to a condition. [2]

i. NOT

ii. OR

b) Complete the following truth table for the XOR operator. [4]

|  |  |  |
| --- | --- | --- |
| **Condition A** | **Condition B** | **A XOR B** |
| True | True |  |
| True |  | True |
|  | True | True |
| False | False |  |

5. a) What are the two De Morgan’s laws? [2]

1

2

b) Why are De Morgan’s laws important in designing circuit boards? [2]

c) Show that one of these laws is consistent by producing the truth table for each side of the equation. [4]

|  |  |  |  |
| --- | --- | --- | --- |
| **A** | **B** | **A AND B** | **NOT ( A AND B )** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **A** | **B** | **NOT A** | **NOT B** | **NOT A OR NOT B** |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |

Total marks = /32

4.7. Computer Organisation and Architecture – Test 1

1. Explain, using an example, what is meant by a ‘peripheral’. [2]

2. A motherboard is often referred to as the ‘heart’ of the computer system. This is because it sends signals and electricity around the computer system to the various components, in a similar way that the heart does with blood in the body.

a) Name three hardware components that can be physically connected to a motherboard. [3]

1

2

3

b) Give three technological factors to consider when choosing a motherboard for a computer system. [3]

1

2

3

3. a) Briefly explain the functional role of each of the following.

i. CPU

ii. ROM [1]

iii. RAM [1]

b) What does the ALU (Arithmetic Logic Unit) do? [2]

c) Modern computers often contain chips with multiple cores. Explain what is meant by ‘multiple  
cores’ and describe two scenarios where increasing the number of cores will improve the  
performance of a system. [3]

4. Explain the difference between a Von Neumann architecture and a Harvard architecture. For each architecture give an example of an application the architecture is typically used for. [3]

5. Name three basic-assembly / machine-code instructions and briefly describe what they are used for. [6]

Instruction:

Description:

Instruction:

Description:

Instruction:

Description:

6. The financial sector requires robust backup systems that can be relied upon not to fail. A particular company has been offered two alternative configurations – one containing a solid-state disk and the other containing a traditional hard disk drive. Give two reasons why a solid-state disk may be chosen over the hard disk drive. [2]

1

2

7. Explain, with reasoning, each step of the Fetch–Execute Cycle in detail. [10]

Total marks = /36

4.7. Computer Organisation and Architecture – Test 2

1. a) Explain why RAM is primary storage and a hard disk is secondary storage. [2]

b) Explain the concept of ‘addressable memory’. [2]

2. Fill in the missing details on the following: [3]

|  |  |
| --- | --- |
| **Name** | **Role** |
| Data bus |  |
|  | Carries the details that are required in order to keep operations running at the correct time |
| Address bus |  |

3. Explain how the following can affect the performance of a processor.

a) Clock speed [2]

b) Word length [2]

4. Use the following list of machine-code instructions to answer the next two questions.

|  |  |
| --- | --- |
| 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. |

a) Explain what 'immediate addressing' is and show how immediate addressing is used by giving an example that uses the CMP instruction. [2]

Example:

b) Consider the following code written in a high-level language:

IF X < 7

THEN B 🡨 15

END IF

Write a sequence of assembly-language instructions that would perform the same operations as the program code above. 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]

5) This diagram shows memory used by the processor.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General-purpose registers | | | | ALU | PC | CIR | MAR | MBR | control unit |
|  |  |  |  |

**Main memory**

What do the following abbreviations stand for?

a) PC [1]

b) CIR [1]

c) MAR [1]

d) MBR [1]

6. Common secondary storage devices used by computers include hard disk drives (HDD), optical discs, and solid state drives (SSD).

Give one advantage and one disadvantage for each type. [6]

|  |  |  |
| --- | --- | --- |
| Storage Device | Advantage | Disadvantage |
| HDD |  |  |
| Optical discs |  |  |
| SSD |  |  |

7. A school is considering changing from using paper registers to storing all the register information on a computer.

a) Briefly describe two technologies that could be used to help enter data into the computer. [2]

1

2

b) Outline the potential advantages and disadvantages of storing the information on a computer rather than in a register. [4]

8. Some computer systems allow processes to put themselves to sleep for a set period of time. Programs can use this functionality to add a delay between function calls. For example the following code will print '...' every 60 seconds:

|  |
| --- |
| while true  sleep(60)  print("...")  endwhile |

Explain how interrupts could be used to implement this sleep(*n*) system call. Assume that the processor contains a programmable circuit that can raise an interrupt after a given period of time has expired. Ensure that your system can cope with situations where the timer circuit raises an interrupt earlier than expected. [5]

Total marks = /39

4.8. Consequences of Uses of Computing – Test 1

1. a) Define the term ‘hacking’. [1]

b) Describe what is meant by the terms ‘black hat hacker’ and ‘white hat hacker’. Give an example of why each of these does what they do. [4]

2. Developments in Computer Science have led to the use of drones in warfare. Debate the ethics of the use of drones.

You may wish to consider areas such as their accuracy, alternatives, the legality of their use and the lower cost of engagement. [12]

3. There has been a huge push in recent years in the development of commercial facial-recognition software by companies such as Google, Facebook and Apple.

If a human is shown two pictures, they will be able to identify with an accuracy of 97.53% on average if the same person is shown in both pictures. Facebook has developed an algorithm with an accuracy of 97.25%.

Discuss the uses of this technology and any ethical issues surrounding its use in a commercial setting.

You may wish to consider what the technology would be used for, privacy concerns, who holds the information and the impact of wearable technology. [12]

Total marks = /29

4.8. Consequences of Uses of Computing – Test 2

1. a) Peer-to-peer networks are frequently used to share files on the Internet.

i. Explain what a peer-to-peer network is. [1]

ii. Give two reasons why peer-to-peer networks are more popular than traditional client-server networks for distributing pirated videos. [2]

b) Explain what digital rights management (DRM) is. [1]

c) Give four ways DRM might restrict the way a video file can be used. [4]

2. Robots have long been used in manufacturing facilities; however, until recently they had not made a significant impact in other industries.

a) Explain why it is easier to make a robot that works on an assembly line in a factory than it is to make a robot that cleans someone’s house. [2]

b) Robots are now commonly used in distribution warehouses, picking and packing orders for customers. Describe two advantages and two disadvantages of using robots for this purpose. [4]

c) Self-driving cars have huge potential to change the way people travel; however, they present legislators with a number of challenges. Describe two challenges that legislators will need to overcome before self-driving cars can become commonplace. [2]

3. In January 2015 the British Prime Minister David Cameron announced new legislation designed to limit the use of strong forms of encryption. He said:

*‘Are we going to allow a means of communication which it simply isn't possible to read? My answer to that question is no, we must not.’*

Discuss the advantages and disadvantages of having strong forms of encryption readily available to members of the public. Provide examples of the sorts of communication that people might want to encrypt for positive or negative reasons. [6]

4. ‘According to a well-written and thorough article in the*Virginia Journal of Law & Technology*, what we've been saying for over three years has been determined to be true: WarDriving is not a crime.’

In September 2004, this statement was written by Marius Milner. Marius was the engineer who developed NetStumbler, which is a tool used to map Wi-Fi networks using a Wi-Fi card and GPS. This process is known as ‘WarDriving’.

Marius Milner also worked for Google and his code for gathering this information was implemented on the street-view cars which were used to gather data on mapping networks and to directly ‘snoop’ data from open networks as street-view information was being gathered.

Discuss the ethics and legality of WarDriving. You may wish to consider how easy it is nowadays to do WarDriving yourself, what information could be gathered, what the end goal may be of gathering such information, what happens to the information later, and where it is stored. [12]

Total marks = /34

4.9. Communication and Networking – Test 1

1. a) Define the following types of communication link:

i. Serial [1]

ii. Parallel [1]

b) A company wishes to connect sites which are a considerable distance apart with their WAN. Which sort of cabling would you advise them to use, serial or parallel, and why? [2]

2. A printer is connected to a computer via a USB (universal serial bus) link.

a) USB uses asynchronous transmission.

i. What is asynchronous transmission? [1]

ii. Asynchronous transmissions often use special bits to control the flow of data. What are these bits called and exactly what is it they do? [2]

b) The alternative to asynchronous transmission is synchronous transmission.

Describe how synchronous transmission differs from asynchronous transmission and give an advantage of using synchronous transmission. [3]

3. Describe what is meant by the following terms:

a) Client-server networking [2]

b) Peer-to-peer networking [2]

c) Internetworking [1]

4. A home user is trying to set up a local area network which is connected to the Internet. They have drafted you in to help them set it up.

a) What is a gateway and why will they need one to connect to the Internet in this example? [2]

b) They have bought a router. The router has an internal IP address of 192.168.1.1. The external IP address is provided by their Internet Service Provider.

i. Explain what a router is and why it is necessary. [2]

ii. The router they have bought has a built-in wireless access point. Explain why it is better for the access point to use the Wi-Fi standard rather than other alternatives and what the security implications of a wireless network are. [2]

c) They have a printer with a network port. Suggest an appropriate static IP address for the printer, assuming a subnet mask of 255.255.255.0. [1]

d) Laptop computers connect to the network using Wi-Fi. They use carrier sense multiple access with collision avoidance (CSMA/CA) to determine when to transmit data.

Describe how the CSMA/CA method is used. [6]

Total marks = / 28

4.9. Communication and Networking – Test 2

1. You are assessing an experimental high-speed communications link for use by your company.

a) If the link has a bit rate of 200Gbps and a baud rate of 100Gbps, how many bits must be sent per signal change? [1]

b) The link uses even parity bits to check for errors. There is one parity bit for every seven data bits.

i. Explain what an even parity bit is and how it is used to check for errors. [2]

ii. Does the byte 10110111 contain an error? [1]

iii. What is the limitation of using only parity bits for error checking? [1]

c) The link has been described to you as low latency. What does this mean? [1]

2. Increasingly, applications are being delivered to users’ computers via networks, both over local business networks and over the Internet.

a) What is a thin client? [1]

b) Give an advantage and disadvantage of having a server take on more ‘work’ than its clients? [2]

Advantage:

Disadvantage:

c) What is a web service? Give a benefit of a web service. [2]

3. The Internet is a very useful thing. However, connecting a computer to it exposes it to a number of threats.

a) What is a firewall and how does it protect a computer? [2]

b) Two capabilities of a firewall system can be packet filtering and a proxy server. Describe what each of these capabilities are and what they try to achieve. [4]

1

2

c) Define the term ‘virus’ and explain briefly how viruses work. [3]

d) Define the term ‘worm’ and describe how it differs from a virus. [2]

e) Define the term ‘Trojan horse’ and describe how it differs from a virus. [2]

4. Online shopping is made possible by a variety of encryption and security measures.

a) Name and briefly describe the three main security procedures which should be followed to prevent or subsequently detect unauthorised access to a server. [6]

1

2

3

b) Explain the concept of public/private key encryption and give a brief description of digital certificates and signatures. [6]

5. Networks can be formed in a number of topologies. Describe how bus and star network topologies   
work and compare the advantages and disadvantages of each. [6]

Total marks = /42

4.10. Databases – Test 1

1. Consider the following entity-relationship diagram:

Students

Teachers

Each student has only one teacher, and there are usually about 30 students per class. Each class has only one teacher. Each student and teacher also belongs to a single college.

a) What is the relationship between colleges and teachers? [1]

b) Extend the entity-relationship diagram to include collegesand update all the relationships. [2]

2) Define each of the following terms:

a) Primary key [1]

b) Foreign key [1]

c) Composite key [1]

3. SQL is a language commonly used to create, maintain and query databases.

a) Consider this data definition language (DDL) statement:

CREATE TABLE db.users

(

UserName VARCHAR(20),

FirstName VARCHAR(20),

LastName VARCHAR(20),

Password VARCHAR(20),

PRIMARY KEY (UserName),

UNIQUE INDEX (UserName)

);

i. What is the purpose of this statement? [3]

ii. Why can’t the primary key be *LastName*? [1]

b) Explain what each of the following SQL statements would do when applied to the database *db*:

i. SELECT \* FROM users [1]

ii. SELECT UserName, Password FROM users ORDER BY UserName DESC [2]

iii. SELECT FirstName, LastName FROM users WHERE UserName = ‘Bilbo33’ [2]

4. Consider the following table, ‘Players’, from an online fantasy role-playing game:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PID** | **GivenName** | **Surname** | **Character** | **Level** | **Race** | **Items** |
| 001 | Alan | Smith | Alzabeck | 32 | Orc | Potion, Armour, Axe |
| 002 | Yvette | Jones | Thornzon | 2 | Dwarf | Armour, Sword |
| 003 | Ibrahīm | Hassan | Teylar | 12 | Dwarf | Staff, Potion |
| 004 | Lili | Yu | Axethorn | 6 | Human | Axe, Horse |
| 001 | Alan | Smith | Tamto | 24 | Elf | Potion, Horse |

a) Create an entity definition for the above table. [2]

b) What is the purpose of database normalisation? [2]

c) Place this table into third normal form (3NF). You may assume that all character names are unique, and that race and items only need to be stored as attributes, and do not need tables of their own. Each PID is unique to a real person. [5]

Total marks = /24

4.10. Databases – Test 2

1. Consider the following entity description for a flat-file shop orders database.

Order(OrderNum, CustNum,Title, FirstName, Surname, Address, PostCode, StockNum, StockName, Price, Manufacturer, OrderDate, OrderTime, Dispatched)

a) Normalise the above database into 3NF by writing the entity descriptions for the new tables.   
You may assume at this stage that you only need to order one item at a time. [4]

b) i. Identify the primary keys. [1]

ii. State the purpose of a primary key. [1]

iii. Identify the foreign keys and their location. [1]

iv. State the purpose of a foreign key. [1]

c) Draw an entity-relationship diagram for your database. [3]

d) Complete a data dictionary for your database, using the column headings below for each table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Field | Data Type | Format | Validation Rule / Input Mask / Default Value | Key Field |

Note that not all fields will have an entry for every column. You should aim to suggest at least one sensible validation rule or input mask or default value in each table. Under the Key Field column you can enter ‘Primary’, ‘Foreign’ or leave it blank as appropriate. [12]

e) Answer the following SQL questions based on the structure you have used in part d).

i. Write an SQL statement to return all information on every item of stock. [1]

ii. Write an SQL statement to return the title, first name, surname and postcode of all customers in alphabetical order of surname. [2]

iii. Write an SQL statement to return a list of order numbers, dates and times of orders of every item that has not been dispatched. The list should be in ascending order of date ordered. [3]

f) i. Assuming a three-table structure has been used to represent the flat-file database described in this question, what restriction does this place on the database that would be an issue in the day-to-day running of a shop? [2]

ii. Describe a possible solution to this problem. [2]

iii. Draw an entity-relationship diagram for your new structure. [4]

Total marks = /37

4.11. Big Data – Test 1

1. It has been calculated that 90% of the world’s data has been gathered and created in the last two years. This explosion in the amount of data we gather and need to store has led to new possibilities and problems in the modern world. This phenomenon is known as Big Data.

a) The ‘big’ in Big Data represents the scale of the data in terms of the demands it puts on our systems. Other than the large volume of data (and the necessary storage capacity required to host it), describe two other demands Big Data may have. [4]

1

2

b) The main challenges that Big Data brings are due to its lack of structure. Why does this lack of structure pose a problem? [2]

c) The huge size of data being stored often means it cannot be stored on one server. Why is this a problem and what method can be used to help use data that is distributed across multiple servers? [2]

d) Describe three developments in technology in recent years that have led to the creation of the Big Data phenomenon. [6]

1

2

3

e) George Lee (CIO at Goldman Sachs) referenced the fact that for years society has used ‘experiential wisdom’ (learning from and gaining wisdom from one’s experiences) to make decisions in many areas of our lives. How does Big Data contribute to this way of thinking? Explain how Big Data can potentially be used in Medicine, Agriculture and Manufacturing (you may choose any area of manufacturing to talk about). [14]

Total marks = /28

4.11. Big Data – Test 2

1. Functional programming languages are widely used to process Big Data.

a) Map is a common function in Big Data applications. Map is an example of a higher-order function. What is meant by a higher-order function? [1]

b) Big Data frameworks such as Apache Spark can distribute higher-order functions across multiple physical servers. Explain why it is possible for this to be done safely when a purely functional programming language is used. [2]

2. Stock exchanges update their prices every few microseconds. The following table gives some example data that might be produced by a stock exchange.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Timestamp** | **Stock Name** | **Min Price** | **Average Price** | **Max Price** |
| 612090 | MGX | 102 | 105 | 108 |
| 612094 | MGX | 102 | 104 | 108 |
| 612097 | APP | 80 | 83 | 85 |
| 612099 | MGX | 100 | 102 | 108 |
| 612102 | GTP | 3 | 3 | 3 |
| 612108 | APP | 80 | 84 | 86 |

a) What is meant by a fact-based model? [2]

b) Give an example of a fact from the table above. [1]

c) Describe the elements that make up a graph schema. [3]

d) Draw a graph that represents the stock exchange data above. [3]

e) Stocks may be listed on more than one stock exchange at a time. Describe how you would need to modify your graph schema to represent the relationships that stocks have with the multiple stock exchanges. [3]

3. Smartphones, networked sensors and video surveillance are three modern sources of Big Data. Describe what kind of data these devices generate and describe why this data can be so difficult to store. [5]

4. Search-engine companies such as Google, Bing and Yahoo! generate a huge amount of data. Google alone responded to 1.2 trillion search requests in 2012. Discuss the types of data a search engine might collect and how the search engine could use this information to improve its accuracy or the effectiveness of its advertising. [12]

Total marks = /32

4.12. Functional Programming

1. A recursively defined function named map and a function named double are defined as follows:

map f [] = []

map f (x:xs) = f x : map f xs

double x = 2 \* x

The function map has two parameters, a function f , and a list that is either empty, indicated as [], or non-empty, in which case it is expressed as (x:xs), in which x is the head and xs is the tail; which is itself a list.

a) In the table below, write the values that are the head and tail of the list [2, 4, 6, 8, 10]. [2]

|  |  |
| --- | --- |
| **Head** |  |
| **Tail** |  |

b) Calculate the result of the following function call map triple [2, 4, 6, 8, 10] [2]

c) Explain how you arrived at your answer to part b) and the recursive steps that you followed. [3]

2. In functional programming, the higher-order function filter is defined as:

filter :: (a -> Bool) -> [a] -> [a]

filter \_ [] = []

filter p (x:xs) | p x = x : filter p xs

| otherwise = filter p xs

a) Describe what this function does. [3]

b) Calculate the answer of making the function call filter even [1..10]. [2]

c) Calculate the answer of making the function call filter (not . even) [1..10]. [1]

3. Assume you have two functions, f and g, that both perform a given mathematical calculation on a given integer argument.

f: A 🡪 B

g: B 🡪 C

a) What does g ○ f mean? [2]

b) For the function g ○ f, complete the table below. [2]

|  |  |
| --- | --- |
| **Domain** |  |
| **Codomain** |  |

c) If the function f(x) = (x – 5) and g(y) = y2, calculate what the resultant function g ○ f would be. [2]

4. A commonly used higher-order function in functional programming is the fold function (otherwise known as reduce).

a) Explain what the fold function does. [4]

b) Explain how the following function (which uses the fold function to calculate the factorial of a number n) works. [3]

factorial n, where n <= 0 := 1

factorial n := fold \* 1 take n [1..]

Total marks = /26

# Answers

4.5. Data Representation – Test 1

1. a) Denary numbers are each represented by a pattern of bits which progress sequentially. For example: 0000, 0001, 0010, 0011 [1]

b) *1 mark for five correct answers and 2 marks for a complete set of correct answers in each column* [4]

|  |  |  |
| --- | --- | --- |
| **Denary** | **Binary** | **Hexadecimal** |
| 0 | 0000 | 0 |
| 1 | 0001 | 1 |
| 2 | 0010 | 2 |
| 3 | 0011 | 3 |
| 4 | 0100 | 4 |
| 5 | 0101 | 5 |
| 6 | 0110 | 6 |
| 7 | 0111 | 7 |
| 8 | 1000 | 8 |
| 9 | 1001 | 9 |
| 10 | 1010 | A |
| 11 | 1011 | B |
| 12 | 1100 | C |
| 13 | 1101 | D |
| 14 | 1110 | E |
| 15 | 1111 | F |
| 16 | 10000 | 10 |

2. a) [1]

|  |
| --- |
| 0111  + 0010 |
| 1001 |

b) *3 marks only if all working is shown* [3]

|  |
| --- |
| 1011  \* 111 |
| 1011  + 10110  + 101100 |
| 1001101 |

3. a) Correct

b) Correct

c) False [3]

b) A checksum is a count of the number of bits in a transmission unit that is included with the unit (1) so that the receiver can check to see whether the same number of bits arrived (1). If the counts match, it's assumed that the complete transmission was received (1). [3]

4. a) Sounds are analogue signals (1). In order to record them to the computer, the sound wave must be converted to a discrete form that can be represented on a computer (1). [2]

b) A midi file is a set of instructions that can be executed by some compatible device to produce a certain piece of music (1). There are no details of the actual sound stored, simply the ‘recipe’ for how to create the sound (1). A wave file is a digitised version of the wave form that is produced (1). It has a constant sampling rate and is not compressed in any way; this is why it is often called the raw sound file by computer musicians (1). MP3s are compressed WAV files (1). [max 3]

c) Lossy compression results in the loss of some of the sound when it is decompressed for playback. This results in a smaller file size but worse sound quality (1). Lossless does not require any sound information to be lost; however, it results in much larger file sizes (1). A lossy compression scheme will generally be used for data streaming as it results in much faster buffering times for the user, and reduces the bandwidth used by the server for each user significantly (1). [3]

5. a) i. 102

ii. 185

iii. 197 [3]

b) i. 01001110

ii. 01111011

iii. 11100100 [3]

c) i. 45

ii. –89

iii. –1 [3]

d) i. 4.75

ii. 3.875

iii. 11.5625 [3]

6. a) [‘G’, 2, ‘O’, 5, ‘D’, 2, ‘B’, 1, ‘Y’, 3, ‘E’, 5] [2]

b) Dictionary coding (1). A table containing sequences of symbols that occur in the source is built (1).   
Every time a sequence of symbols is detected it is replaced with an index into the table (1). [3]

4.5. Data Representation – Test 2

1. a) i. 11001100

ii. CC [2]

b) i. 199

ii. C7 [2]

c) i. 231

ii. 11100111 [2]

d) 1111.1101 [2]

e) *2 marks for:*

[2]

f) *2 marks for the correct binary, 1 mark for adding more digits, 1 mark for a possible restriction, e.g.*

The number 1.4 is:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| **Exponent** | | | | **Mantissa** | | | | |

This actually only equals 1.375 (11 \* 2-3). The way to fix this would be to add more digits to the mantissa so that you can more closely represent the number but it may slow down calculations/use a lot of memory to use lots of digits. [4]

2. a) *1 mark for each correct answer*

i. F – 70

ii. M – 77

iii. X – 88 [3]

b) *1 mark for the correct answer and 1 mark for the explanation mentioning spaces and punctuation*

28 – 4 spaces, 1!, and 23 letters. You may accept 29 if the student mentions an EOL character at the end of the line in the explanation. [2]

c) 100 1010 [1]

d) Each character uses fewer bits so it takes up far less memory than Unicode. [1]

e) You are limited with ASCII as to the number of characters that can be represented. Unicode can cope with the characters from alphabets other than the Latin alphabet (e.g. Chinese letters). [1]

f) 128 [1]

3. a) Bytes can also represent colours, for example black = 0, white = 255, or points on a sound wave. [2]

b) *3 marks for correct answer*

(1200\*8\*1024)/(640\*480) = 32 bit [3]

c) *One mark for each:*

• A bitmapped image stores pixel values for each pixel in the image.

• A vector graphic stores details about what makes up the image, such as lines, circles, etc. and these are used to calculate pixel values when the image is rendered.

• The photo will be in a bitmap format as opposed to a vector format, meaning that for the logo and the picture to be combined into one file, the file will have to be a bitmap file. [3]

d) *Any two correct pieces of information – examples below (this is not an exhaustive list)*

• Height

• Width

• Dimensions *(acceptable only if a mark hasn’t been gained for Height or Width)*

• Colour/bit depth

• Resolution

• Compression used [2]

4. a) *1 mark for five characters correct and both marks for a completely correct ciphertext*

N qtaj htruzynsl [2]

b) *1 mark for five characters correct and both marks for a completely correct ciphertext*

Comp sci rocks [2]

c) *1 mark per disadvantage*

You are limited to using the letters of the alphabet. Punctuation, etc. are not accepted using the standard cipher.

It is easy to break – you only have to try rotating the cipher text through numbers 1–25. [2]

d) It is the only encryption method ever devised that has been mathematically proven to be completely secure. [1]

e) *1 mark for each point*

The plain text is compared against a key text of the same length

An XOR operation is carried out on each bit of each character of both the plain and key text

This creates the output cipher text

To decrypt, the same XOR operation is carried out between the cipher text and the key text to return to plain text [4]

f) *1 mark per rule*

The key must be comprised of truly random data

The key must only ever be used once [2]

4.6. Computer Systems – Test 1

1. *1 mark for each of the following:*

a) Hardware

b) Software

c) Hardware

d) Hardware [4]

2. *5 marks for any five correctly named languages with appropriate indication of use. Separate marks gained for differentiating between C and C++, and between BASIC and VB only if the differences are made clear.*

E.g. C – Applications/Low-level operations, C++ – System Applications, C# – server and client side apps/Web, VB – Office Automation, Educational Applications, Java – Mobile Development/Server Side/Web [5]

3. a) Declarative languages only define what is to be computed not how to compute it, whereas imperative languages have to define each step of the program for solving the problem. [2]

b) *1 mark for each of the following:*

• First-generation languages are machine dependent and only work with that processor

• Second-generation languages are machine dependent and may work with a class of machines

• Third-generation languages are machine dependent only in that they require a separate compiler for each class of machine

• Fourth-generation languages are not machine dependent at all because if the supporting program works, then they will too [4]

c) Second generation/level (Accept low level) [1]

d) *1 mark for each of the following:*

Representation of machine code in hexadecimal, first generation (1).

Limitations are that it takes longer to write than code written in a higher-level language (1), it is difficult to read so programs become very complex the larger they get (1), poor facilities for self-documentation (1) and it does not offer any automatic optimisations (1). [max 3]

4. a) *1 mark for each of the following:*

i. NAND

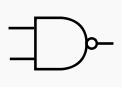
ii. XOR [2]

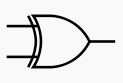
b) *1 mark for each of the following:*

i. 0 + 1 + 1 + 0 = 0

ii. 1 . 0 = 0

iii. (0 + 0 + 0) + (0 + (1 . 1)) = 1 [3]

**** c) *3 marks if completely correct, 1 mark for correct gates:* [3]



A

B

C

5. a) It is a digital circuit used for the addition of numbers. [1]

b) Full [1]

c) *1 mark for two inputs*

*1 mark for outputs S and C*

*1 mark for correct gates*

*1 mark for completely correct layout and design*



[4]

d) *1 mark for delay and 1 mark for the expansion*

Delay/Data – the circuit only captures and stores the input for a particular clock event – the rest of the time any changes of input are ignored. [2]

4.6. Computer Systems – Test 2

1. a) *1 point for each of the following up to a max of 4 points. Examples have to be named to get maximum marks.*

• System software allows access to the hardware for the user, and application software provides a service

• System software is comprised of operating systems, utility programs, library programs and translator programs

• Application software is designed to allow a user to perform a specific task

• Application software will receive instructions from the user and communicate these with the system software which will interact with hardware

• Application software can be general purpose, special purpose or bespoke [4]

b) *One mark for each of the following:*

i. System

ii. Application

iii. System

iv. Application [4]

2. *1 mark each for four of the following:*

• Availability of programmers in that language to construct programming team

• The need to interface with existing programs; if two programs are to work together, it is easiest if they are written in the same language

• Suitability for the task – for example, a business program that handles large files may best be written in a language that has database facilities included

• If a program is to be run on different computers, it must be written in a language that is portable so that the program need be written only once

• You may be limited by the availability of the language – not all languages are available in all installations or on all computers

• Any other reasonable factor [4]

3. a) *1 mark for each of the following:*

Assembler, compiler and interpreter [3]

b) *Max 2 marks for each of the three types (1 mark for the name, 1 mark for description)*

Assembler – translates assembly language into machine code

Compiler – translates a high-level language into object code all at once

Interpreter – translates a high-level language to object code line-by-line. [6]

4. a) *1 mark for each:*

i. This gives the negation (or opposite response)

ii. This shows whether either of the two conditions is true including when both are true [2]

b) *1 mark for each of the following:*

|  |  |  |
| --- | --- | --- |
| Condition A | Condition B | A XOR B |
| True | True | False |
| True | False | True |
| False | True | True |
| False | False | False |

[4]

5. a) *1 mark for each of the following (accept any suitable notation for NOT/AND/OR):*

(A OR B)’ = (A’) AND (B’)

*and*

(A AND B)’ = (A’) OR (B’) [2]

b) *Up to 2 marks for any of the following:*

They provide a means for simplifying certain circuits (1), reducing the number of logic gates that are required to be lower, which in turn means that the board will potentially be cheaper (1), quicker and use less power (1). [max 2]

c) *4 marks for showing either of the following:* [4]

|  |  |  |  |
| --- | --- | --- | --- |
| A | B | A AND B | NOT ( A AND B ) |
| 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A | B | NOT A | NOT B | NOT A OR NOT B |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 |

*or*

|  |  |  |  |
| --- | --- | --- | --- |
| A | B | A OR B | NOT ( A OR B ) |
| 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A | B | NOT A | NOT B | NOT A AND NOT B |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |

4.7. Computer Organisation and Architecture – Test 1

1. *1 mark for the explanation and one mark for the example:*

An external device that connects to the computer – these are often the things that a user will use to control the computer, for instance a keyboard or mouse. [2]

2. a) *1 mark for any of the following (accept any other valid answer):*

CPU, RAM, discrete graphics/ sound cards, power supply unit, hard drive, SSD, CD/DVD drive [3]

b) *1 mark for any of the following to a maximum of 3 marks (accept other valid technical factors):*

Availability and quality of integrated graphics/audio; chipset used; expansion ports/slots;   
overclocking potential; compatibility with other components e.g. CPU  
  
*Do not accept non-technological factors (e.g. cost or reputation)* [3]

3. a) *1 mark for each of the following:*

i. This is the part of the computer that carries out the processing. It receives instructions, carries them out and then returns the result.

ii. This holds permanent instructions that are installed when the computer is manufactured. These are often the first instructions that are necessary to boot up the computer.

iii. This is the memory where data that is currently being processed by the processor is held, it is very fast to access but is volatile, so its contents must be written to hard disk in order to be recovered after the computer has been turned off and then on again. [3]

b) *2 marks for saying the following:*

The Arithmetic Logic Unit (ALU) carries out arithmetic operations such as addition, multiplication, subtraction and division. It also makes logical comparisons between items of data (e.g. determining whether one value is greater than another). [2]

c) *1 mark for each of the following:*

• Multicore chips contain more than one processor

• They boost performance when running multiple tasks simultaneously (multitasking)

• They boost performance when a task can be spread over more than one processor (multi-threaded applications) [3]

4.Von-Neumann: Instructions are stored in the same memory-address space as the data. (1)

Harvard: Instructions are stored in a separate memory-address space to the data. (1)

Von Neumann is used for general-purpose computers; Harvard is used for DSPs and some embedded   
systems. (1) [3]

5. *1 mark per correct instruction and 1 mark for an accurate description from the following list. Instruction names can be in the coded form (like in the table below) or in their full name form (e.g. Subtract as opposed to SUB).*

|  |  |
| --- | --- |
| 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. |

[6]

6. *1 mark each for any of the following:*

• Solid-state memory chips are more robust

* No reliance on mechanical parts that could fail
* No corruption of data due to magnetic fields

• Faster write speed so more data could be recorded [2]

7. Full marks to be given for a clear description of the Fetch–Execute Cycle. To gain full marks, the description must include the following points:

i. When a new instruction is to be executed (1), the PC contains the address of this instruction (1).

ii. The computer does not read straight from the PC, so this address is copied into the MAR (1).

iii. The PC is now incremented (1) so that it contains the next instruction to be executed when this one is finished (1).

iv. The MAR contains the address of the current instruction to be carried out (1), the CPU copies the contents at this address (an instruction word) into the MBR (1).

v. The computer does not execute instructions straight from the MBR, so this instruction is copied into the CIR (1).

vi. The instruction in the CIR is a code for one of the computer’s basic functions, which is then run (1).

vii. If the instruction is a STOP instruction, then execution of this sequence is halted, otherwise back to step i. (1). [10]

4.7. Computer Organisation and Architecture – Test 2

1. a) *Up to 2 marks for saying the following:*

RAM is immediately accessible by the processor and is not permanent whereas a hard disk stores data permanently but has to be loaded into RAM before the processor can access it. [2]

b) *Up to* *2 marks for saying the following:*

Processors need to be able to distinguish between different parts of main memory, as different parts will  
contain different data. Addressable memory allows the processor to access each ‘chunk’ of data via its own unique numeric code by placing the code onto the address bus. [2]

2. *1 mark for each of the following:*

|  |  |
| --- | --- |
| Name | Role |
| Data bus | *Carries the actual data that needs to be processed in binary form* |
| *Control bus* | Carries the details that are required in order to keep operations running at the correct time |
| Address bus | *This contains the details of where the data needs to be sent to or retrieved from* |

[3]

3. a) The clock speed is the frequency at which the processor carries out instructions; the faster the clock speed, the faster the processors can carry out a given task. [2]

b) The word length is the length of the binary word that can be processed within the computer; the longer the word, the faster that data can be passed around, hence the faster the machine is. [2]

4. a) *1 mark for the addressing explanation and 1 for the CMP instruction*

Immediate addressing: the operand value is part of the instruction OR no need to go to any memory address

CMP RX, #Y; [where X is 0–12 and Y is a decimal value] [2]

b) *1 mark for the comparison instruction to replicate an IF function*

*1 mark for comparing R1 against 7*

*1 mark for moving 15 to R2*

*1 mark for ending statement:*

CMP R1, #6

BGT endif

MOV R2, #15

endif: [4]

5. *1 mark for each of the following:*

• PC – Program Counter

• CIR – Current Instruction Register

• MAR – Memory Address Register

• MBR – Memory Buffer Register [4]

6. *1 mark for a valid advantage/disadvantage for each type. Examples:* [6]

|  |  |  |
| --- | --- | --- |
| Device | Advantages | Disadvantages |
| HDD | *• Large storage capacities* | *• Prone to faults, resulting in data loss* |
| Optical discs | *• Very cheap (per megabyte)*  *• Light and portable* | *• Very limited capacity*  *• Slow read and write speeds*  *• Easily damaged, resulting in data loss* |
| SSD | *• Reliable (due to lack of any moving parts)*  *• Fastest read and write speeds* | *• Expensive (per megabyte)* |

7. a) *1 mark for each device with valid description, e.g.:*

• Keyboard

• Mouse

• Barcode / QC code reader

• Optical mark reader (OMR)

• Optical character recognition (OCR)

• RFID

• Magnetic stripe reader [2]

b) *1 mark for each of the following, max of 4 marks:*

Advantages [max 3 marks]:

• The information will be accessible to all staff with access to a computer, rather than one form tutor

• Late pupils can all be entered at a central location

• Trends can be spotted for persistently late pupils

• Statistics can be produced for parents

Disadvantages [max 2 marks]:

• Data privacy/security issues

• Cost of setting up

• Cost of maintaining equipment [4]

8. *1 mark for each of the following steps. Full marks should also be given if a valid alternative outline is provided.*

• Provide an interrupt service routine (ISR) that will add the process back into the operating system scheduler.

• Register the ISR so that it will be called when the given time period has elapsed.

• Remove the process from the operating system scheduler.

• Yield the process to stop executing.

• When the process resumes, check to see if the given time period has elapsed. If it has then continue,   
if not then repeat the process, subtracting the time elapsed from the delay required. [5]

4.8. Consequences of Uses of Computing – Test 1

1. a) *1 mark for the following:*

Gaining unauthorised access to a system [1]

b) *1 mark each for explaining what they are and 1 mark each for an example motivation*

Black Hat Hacker

• The more ‘traditional’ type of hacker who gains unauthorised access to a system

• Usually for personal gain or to steal/change/delete information

White Hat Hacker

• An ‘ethical hacker’ or a security expert who hacks a system to check and evaluate its level of security

• Will do it to find vulnerabilities or weaknesses in a system so that they can be fixed to help protect against black hat hackers.[4]

2.

|  |  |  |
| --- | --- | --- |
| Level | Description | Mark Range |
| 4 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all four areas indicated in the guidance below and in at least three of these areas there is sufficient detail to show that the student has a good level of understanding of the technologies required. A good level of understanding would be indicated by expanded points showing both sides of relevant arguments in each section. Submitted answer uses an excellent range of technical vocabulary and there are not more than a few spelling or grammar mistakes in the answer. | 10–12 |
| 3 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response but the response may only cover three of the areas indicated in the guidance below, with two or three substantiated points being made per area. Submitted answer uses a good range of technical vocabulary but there are more than a few spelling or grammar mistakes in the answer. | 7–9 |
| 2 | A limited attempt has been made to follow a line of reasoning by covering at least two of the topic areas in the guidance below. Overall, at least four valid points must have been made which can relate to any of the topic areas in the guidance.  Submitted answer uses some technical vocabulary and there are several spelling or grammar mistakes in the answer. | 4–6 |
| 1 | A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the four areas from the guidance or may be made in a superficial way with little substantiation. Submitted answer contains very little if any technical vocabulary and the spelling or grammar are poor. | 1–3 |

Indicative content –accept other valid considerations

*Lower cost of engagement*

Overuse due to cost effectiveness (financial and human cost)

Playstation mentality – disconnected from the act of killing makes killing easier

Isn’t the lower human risk a good thing?

*The alternatives*

Could non-lethal force be used more? Capture rather than bombing? Diplomacy?

Viability of these options in a real-world scenario (e.g. people being too far behind enemy lines)

Quite often drones are used against people who are not affiliated to a country – are they willing to negotiate?

Does the fact that an enemy can now have a strike made against them when previously force wouldn’t have been considered make the method morally justifiable?

*Accuracy*

More accurate than nearly all other weapons

Due to ‘loiter time’ – their ability to hover over targets for hours waiting for the exact moment to strike to minimise collateral damage

No weapon is 100% accurate

*Legality*

The ‘enemy’ is often no longer a nation and nor does it wear a uniform

Targets are now out of reach of an army and use anonymity as a weapon – drones are a way of combating this new de-localised threat

*Civilians in the area*

Psychological trauma of constantly having a drone hovering overhead never knowing if it is about to fire

The use of ‘signature strikes’ which target ‘patterns of behaviour’ rather than specific individuals has led to weddings being targeted [12]

3.

|  |  |  |
| --- | --- | --- |
| **Level** | **Description** | **Mark Range** |
| 4 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all four areas indicated in the guidance below and in at least three of these areas there is sufficient detail to show that the student has a good level of understanding of the technologies required. A good level of understanding would be indicated by expanded points showing both sides of relevant arguments in each section.  Submitted answer uses an excellent range of technical vocabulary and there are not more than a few spelling or grammar mistakes in the answer. | 10–12 |
| 3 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response but the response may only cover three of the areas indicated in the guidance below, with two or three substantiated points being made per area.  Submitted answer uses a good range of technical vocabulary but there are more than a few spelling or grammar mistakes in the answer. | 7–9 |
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| 1 | A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the four areas from the guidance or may be made in a superficial way with little substantiation.  Submitted answer contains very little if any technical vocabulary and the spelling or grammar are poor. | 1–3 |

Indicative Content

*What the technology would be used for*

Facial unlock of devices

Security (e.g. the bouncer who knows you in a crowd of people before you get to the door)

Targeted advertising – Tesco announced plans for screens that identify your gender and age on your way to a checkout and target you with specific advertising

The more companies like Facebook and Google know about you, the better they can target you for advertising, etc. Facial recognition allows them to create a kind of diary of your life from publically available pictures on the Internet to create a personal history

TVs are being made that can measure your engagement with a programme/advert and feed the data back to companies directly

Benefits include targeted adverts that you may actually find relevant and significant, saving on wastage

*Privacy concerns*

When is the data being collected?

Always-on technologies

Do the brands have the right to know anything and everything about their customers? Do they ‘deserve’ to have such information?

Who can this data then be shared with? (SceneTap is a company in America which has put cameras in 400 bars. It allows users to identify real-time information on gender ratios and average age of patrons for when they wish to decide where to go on a night out. The company has since filed a patent for a plan that would link identified people with their social networking profiles. This would then be used to determine ‘relationship status, intelligence, education and income’ – is this information then going to be searchable by others?

Most information that is currently collected by companies through data mining is anonymous – facial recognition by definition is designed to be exactly the opposite.

Plans for use in public places means people don’t get the choice to ‘opt in’ – is it even possible they could ‘opt out’?

*Who holds the information?*

Who has given permission for the data to be taken in the first place?

Who can the data be passed/sold to?

What country is the data stored in? Implications of the Data Protection Act

*The impact of wearable technology*

Google Glass and other such technologies herald an age where someone could walk down the street and identify you on the street without ever meeting them.

As soon as Google Glass was announced, an app called NameTag was created that works on the premise that you are able to start a conversation with a stranger, it would take a picture and search for the person on the Internet to find out who it is. Google Glass said they wouldn’t use facial recognition with Glass but is it just a matter of time before someone else does – would Google then change its mind?

*Obviously the specific use of Google Glass is not required – even though the project is discontinued it is still the easiest example to call upon and has only been discontinued so that Google can develop the next generation of the technology.* [12]

4.8. Consequences of Uses of Computing – Test 2

1. a) i. A group of computers connected together with equal status that can both produce and consume data [1]

ii. Any two of the following: [2]

• difficult to shut down (need to shut down all the peers rather than just one server)

• lower cost as upload bandwidth is shared

• harder to trace the original source of the files

• faster, as upload bandwidth is equal to the combined upload bandwidth of all the peers.

b) DRM uses hardware or software and encryption to restrict the usage of a file. [1]

c) *1 mark for each of the following (up to a maximum of 4 marks):*

DRM might prevent a video file being:

• viewed on multiple computers

• copied to different computers

• viewed more than a set number of times

• played using anything other than a particular proprietary program

• played on portable devices

• played in an unsanctioned country [4]

2. a) *1 mark for each valid point made up to a maximum of 2 marks. Example answer:*

A factory is a tightly controlled environment (1) where the robots are expected to do simple repetitive tasks (1). A house is an uncontrolled enviroment that is more difficult to navigate (1), cleaning tasks require an understanding of the context in which they are done (1) and require robots to manipulate complex objects (1). [2]

b) *1 mark for each but max of two advantages and two disadvantages:*

Advantages

• Robots can work in a wider range of environments (e.g. they don’t necessarily need air conditioning)

• Robots can operate at a consistent speed all day and all night

• Robots do not need breaks

• Robots can be cheaper than humans

• It does not matter if a robot suffers an injury, it can just be repaired

• Robots do not steal

Disadvantages

• Robots are very expensive to set up

• Robots are unable to work well in changing environments

• Robots can be difficult to maintain without the relevant expertise

• Robots may take jobs from low-skilled employees who find it difficult to get other work

• Robots can increase the monotony experienced by the people still working in the warehouse [4]

c) *1 mark for each legal challenge up to a maximum of 2 marks.*

• Who should accept the liability for accidents a self-driving car causes?

• Who should accept the liability for traffic offences (e.g. going through a red light) that a self-driving car might commit?

• How should the safety of a self-driving car be assessed?

• How should self-driving cars be insured?

• Do self-driving cars need a competent driver who is able to take over if required? [2]

3. *1 mark for each advantage and each disadvantage. One mark for each example (max 1 per adv./disadv.).*

Advantages:

• reduced risk of personal data being stolen by criminals (e.g. credit-card information)

• reduced risk of privacy being invaded by governments

• reduced risk of privacy being invaded by companies (e.g. media, advertisers)

Disadvantages:

• easier for criminals to operate in secrecy, e.g. to:

• share illegal media (e.g. pirated videos)

• buy or sell illegal goods (e.g. drugs, weapons)

• plot criminal acts (e.g. terrorist attacks, bank robberies) [6]

4.

|  |  |  |
| --- | --- | --- |
| Level | Description | Mark Range |
| 4 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all four areas indicated in the guidance below and in at least three of these areas there is sufficient detail to show that the student has a good level of understanding of the technologies required. A good level of understanding would be indicated by expanded points showing both sides of relevant arguments in each section.  Submitted answer uses an excellent range of technical vocabulary and there are not more than a few spelling or grammar mistakes in the answer. | 10–12 |
| 3 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response but the response may only cover three of the areas indicated in the guidance below, with two or three substantiated points being made per area.  Submitted answer uses a good range of technical vocabulary but there are more than a few spelling or grammar mistakes in the answer. | 7–9 |
| 2 | A limited attempt has been made to follow a line of reasoning by covering at least two of the topic areas in the guidance below. Overall, at least four valid points must have been made which can relate to any of the topic areas in the guidance.  Submitted answer uses some technical vocabulary and there are several spelling or grammar mistakes in the answer. | 4–6 |
| 1 | A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the four areas from the guidance or may be made in a superficial way with little substantiation.  Submitted answer contains very little if any technical vocabulary and the spelling or grammar are poor. | 1–3 |

Indicative content:

*How easy it is nowadays to do WarDriving yourself?*

The ability to map nearby Wi-Fi networks using GPS data is now a common feature of mobile phones with many able to complete the task without a third-party app.

When using these inbuilt apps, who has control over that data? Where is it going and why is it being used?

*What information could be gathered?*

At the most basic level, a map would be created with an overlay of Wi-Fi coverage in the area along with an indication of the security level of each network so that open/public networks can be identified for use.

As Google did during the Street View project, though, other data can also be collected. Open networks were then connected to and any information on the network that could be accessed was saved and then uploaded to the Google servers.

Google argued any information store on an individual was only ever very minimal due to the timeframe of the car driving past the house/building.

*What may be the end goal of gathering such information?*

The main argument for WarDriving is to identify open networks for the convenience of the public so they know where they can go to get Wi-Fi access if required (e.g. in a café).

WarDrivers can be broken down into three groups:

• ‘They innocently wish to gain free wireless access in their neighbourhoods, perhaps at a local coffee shop.’

• ‘They have commercial motivations and hope to sell security services.’

• ‘They have dishonest motives and hope to surreptitiously access networks’ information, send anonymous spam, or acquire illegal data.’

*What happens to the information later; where is it stored?*

Who has given permission for the data to be taken in the first place?

Who can the data be passed/sold to?

What country is the data stored in? Implications of the Data Protection Act [12]

4.9. Communication and Networking – Test 1

1. a) i. A serial connection is one where only one bit can be sent at a time. [1]

ii. A parallel connection is one where multiple bits are sent simultaneously. [1]

b) Serial would be a better choice because in a long-distance parallel cable, cross talk and skew degrade the signal meaning that data transmission has to be slowed right down (1). The number of wires in a parallel cable also means that it costs significantly more (1). [2]

2. a) i. Asynchronous transmission is transmission without a shared clock between the two parties. [1]

ii. Start and stop bits. These mark the beginning and end of a transmission and allow the receiver to synchronise with the transmitter. [2]

b) Two of the following three description points followed by the advantage:

Synchronous transmission uses one long bit stream or block to send the data

The data is sent one bit straight after the other so there are no gaps in transmission

There are no ‘start bits’ and ‘stop bits’

Advantage – faster transmission because fewer bits have to be transmitted [3]

3. a) Client-server networking uses a computer known as a server to provide services to clients. Clients make requests to the server and the server responds. [2]

b) Peer-to-peer networking is where there is no central computer taking on the role of a server; instead computers communicate directly with each other on an equal footing. [2]

c) Internetworking is where multiple networks are joined together with routers. [1]

4. a) A gateway is a device which converts between two different types of network technology (1). In this example, it is required in order to convert between the ADSL/cable connection to the Internet and the Ethernet system used in the local network (1 mark). [2]

b) i. A router passes packets to destinations outside of the local network. It also distributes incoming packets from other routers to the appropriate computer on the local network. It is necessary to allow communication to computers that the user’s computers are not directly connected to. [2]

ii. The Wi-Fi standard is faster and has a longer range than Bluetooth, making it more appropriate for Internet and local network access. Wi-Fi means that the network can potentially be accessed outside of the physical boundaries of a property meaning that it needs to be properly encrypted and secured using the most appropriate technology. [2]

c) Any IP address in the range 192.168.1.2–192.168.1.254 such as 192.168.1.100 [1]

d) *This would be a banded question.*

|  |  |  |
| --- | --- | --- |
| Level | Description | Mark Range |
| 3 | A detailed, coherent, description of the basic mechanism that shows a good level of understanding. To score six marks, either the description of the basic mechanism must be comprehensive, or there may be one or two minor errors or omissions in the description of the basic mechanism but these are compensated for by also describing some aspects of CTS/RTS or the back-off mechanism. | 5–6 |
| 2 | An adequate description, including at least three points from the lists below. Some aspects of the basic mechanism may be missed out. The description is logically organised so that it makes sense when read as a whole and therefore demonstrates a reasonable understanding of how the system works. | 3–4 |
| 1 | A small number of relevant points. | 1–2 |

Indicative content

*Basic mechanism:*

• computer monitors/listens for (data signal)

• if (data) signal present / another transmission in progress then continue to wait

• when no (data) signal present start to transmit

• wait to receive acknowledgement packet (to confirm data received and not corrupted)

• if no acknowledgement received (within reasonable time period) then:

• wait a random time period

• then retransmit

*CTS/RTS (if implemented):*

• before starting to transmit, computer sends a Request to Send (RTS) to access point

• access point will respond with a Clear to Send (CTS) signal to only one computer at a time

• only the computer that receives the CTS signal will transmit

*Back-off mechanism:*

• waiting period is random to reduce likelihood of two computers transmitting at the same time again / to reduce likelihood of another collision

• if a collision occurs again then wait a longer random time before attempting to transmit again

• use of exponential back-off algorithm to determine wait time [6]

4.9. Communication and Networking – Test 2

1. a) 2 bits per signal change [1]

b) i. An even parity bit is appended to a bit pattern (1). If the bit pattern has an odd number of 1s then the parity bit will be 1, else it will be 0. This means that the final bit pattern (including the even parity bit) will always have an even number of 1s (1). If a bit pattern arrives with an odd number of 1s then the bit pattern must have been corrupted (1). [2]

ii. No [1]

iii. Can only guarantee detection when there is an odd number of errors – if two bits ‘flip’, for example, then the bit pattern will still pass the error-detection check. [1]

c) This means that it takes a small amount of time for 1 bit to go from one end of the link to the other end. [1]

2. a) A thin client is a low performance computer designed to do minimal processing and rely on a server for most processing tasks. [1]

b) The advantages are that resources can be used more efficiently since users tend to use resources sporadically rather than constantly and most maintenance is server based, so, for example, programs can be updated without user intervention (1). On the downside, the server might get overloaded at peak times and slow everyone using it down. It is also a single point of failure unless backup systems are properly thought through and implemented (1). [2]

c) A web service is a server application which gives clients’ applications information. They can be   
updated with dynamic content, which they could not otherwise get, for example TV listings. [2]

3. a) A firewall is either a piece of software or a piece of hardware which sits between the Internet connection (or local network connection) and filters incoming packets. Malicious or otherwise unwanted packets should be rejected by the firewall so they can’t affect the computer. [2]

b) Packet filtering – When using the packet-filtering method, the firewall will analyse any packets received from the Internet and will then use a set of rules to filter those packets.

This set of rules will be used to determine whether or not the packet is allowed to go through the firewall.

Proxy server – Proxy servers act as a barrier to stop the users on a private network communicating directly with a computer that hosts a web page on the Internet.

The proxy server requests the information from the web server and then passes it on to the user on the private network. [4]

c) A virus is a small computer program (attached to another file or piece of software) and is created to cause damage or harm to the target computer system.

The first thing that will be done when the program is executed is it will copy itself to the local disk and then hide itself to help prevent detection.

After being copied to the local disk the virus can reside in memory and reconfigure the system so it carries out the intended disruption/damage, e.g. displaying messages to the user, destroying or corrupting files or wiping/formatting the entire hard disk. [3]

d) A worm is a program designed to copy/replicate itself to spread across a computer network such as the Internet.

A worm is a complete program as opposed to a virus which gets attached to a program. A worm can also run and travel without any human action. [2]

e) The Trojan will appear to be a useful software application but will actually do damage once installed or run on your computer.

Trojans, therefore, are usually run because they trick the user into running it as it appears to be legitimate software or files from a trustworthy source.

Trojans do not spread by infecting other files and they do not self-replicate – this a key difference between trojans and viruses or worms. [2]

4. a) *1 mark for naming each of the following:*

• Authentication – This means verifying that someone is who they claim to be (not necessarily a person, however, it could be a computer). A username and password is common for this purpose.

• Authorisation – This means only giving access to the things which an entity should have access to. For example, online shoppers should not have the ability to change store prices!

• Accounting – This means keeping a record of who did what, when and where. This allows breaches in security to be identified.

• Accept any other correct/reasonable measures. [6]

b) *2 marks per section – 1 mark for a section where a good but incomplete understanding has been demonstrated.*

Each party in using a public/private key encryption scheme has two keys: a private key, known only to them, and a public key, which is freely available. These keys are related to each other: the private key can decode messages encoded by the public key and the public key can decode messages encrypted with the private key. Importantly, however, the public key cannot be used to decode messages encoded by itself and the same goes for the private key. To send an encrypted message to another party, the transmitter will encode the message using the public key of the receiver. Only the correct receiver has the private key to decode the message and so only they can decode it. [2]

Digital certificates are an extra layer of authentication. They are used to verify that an entity is who they claim to be. They are issued by certification authorities which are trusted third parties and contain the public key of the sender. [2]

Digital signatures are appended to a message by the sender. A hash is taken of the data and encoded using the sender’s private key. They then append the signature to the message and encode the entire thing using the receiver’s public key. The receiver then decrypts the message using their private key, and using the public key of the sender (verified using a digital certificate) decrypts the signature. They then generate a hash from the data and compare it to the one decoded from the signature. [2] [6]

5. *1 mark for a valid feature, advantage and disadvantage for each type, e.g.:*

*Bus:* topology where all the devices are connected together using a single communication medium (1).

They require less cabling and do not require a central server/switch, potentially making them cheaper (1). However, only one device can transmit at once and conflicts may occur making them slower under load.

*Star:* topology where all the devices are connected directly to a central server or switch (1). They are quicker in general (1). However, if the central server/switch breaks then the entire network goes down so they may be less resilient (1). It is, however, easier to track down errors with star networks, and bus networks are not as secure since all the devices on the network can ‘see’ the data being transmitted (1). [6]

4.10. Databases – Test 1

1. a) One to many [1]

b) [2]

Students

Teachers

Colleges

2. a) A primary key is an attribute which uniquely defines a tuple/row. [1]

b) A foreign key is an attribute which is found in multiple tables. It must be the primary key in one of the tables. [1]

c) A composite key is a primary key made up of multiple attributes, used when one single attribute is not enough to uniquely ID a tuple. [1]

3. a) i. It sreates a table called *users* in the database *db* with the fields *UserName*, *FirstName*, *LastName* and *Password*.

It sets the primary key and unique index of the new table to be *UserName*. [3]

ii. Last names can be the same between different people. The primary key must be unique. [1]

b) i. Selects the whole table *users* [1]

ii. Selects the *UserName* and *Password* fields from *users*

Displays them in descending order by *UserName* [2]

iii. Selects the *UserName* and *LastName* of the person with the *UserName* Bilbo33 from *users* [2]

4. a) *1 mark for the table name outside the brackets and 1 mark for the correct list of fields in the brackets*

Players(PID, GivenName, Surname, Character, Level, Race, Items)[2]

b) Database normalisation minimises repetition and ensures that all the attributes in a table depend on one another. This avoids, for example, the need to update multiple database entries when changing a single attribute, which reduces the chance of mistakes creeping in. [2]

c) *All three entities must be present for full marks. 1 mark for each entity with fields being correct, 1 mark for one table having the correct data, 1 mark for all three tables having the correct data. Credit can also be given for alternate ways of representing the solution (e.g. entity definitions) or alternate but correct table layouts.* [5]

|  |  |
| --- | --- |
| *Character* | Items |
| Alzabeck | Potion |
| Alzabeck | Armour |
| Alzabeck | Axe |
| Thornzon | Armour |
| Thornzon | Sword |
| Teylar | Staff |
| Teylar | Potion |
| Axethorn | Axe |
| Axethorn | Horse |
| Tamto | Potion |
| Tamto | Horse |

|  |  |  |
| --- | --- | --- |
| PID | GivenName | Surname |
| 001 | Alan | Smith |
| 002 | Yvette | Jones |
| 003 | Ibrahīm | Hassan |
| 004 | Lili | Yu |

|  |  |  |  |
| --- | --- | --- | --- |
| *PID* | Character | Level | Race |
| 001 | Alzabeck | 32 | Orc |
| 002 | Thornzon | 2 | Dwarf |
| 003 | Teylar | 12 | Dwarf |
| 004 | Axethorn | 6 | Human |
| 001 | Tamto | 24 | Elf |

4.10. Databases – Test 2

1. a) *Table names can vary from the suggestions below but should be sensible.*

*1 mark for each of the three tables with an extra mark for correctly having the CustNum and StockNum in the Order table for the relationships*

Order(OrderNum, CustNum, StockNum, OrderDate, OrderTime, Dispatched)

Customers(CustNum, Title, FirstName, Surname, Address, PostCode)

Stock(StockNum, StockName, Price, Manufacturer) [4]

b) i. *All primary keys must be present to get the mark and must match the names used in part a).*

*Don’t penalise twice for mistakes in part a).*

OrderNum, CustNum, StockNum [1]

ii. A primary key is an attribute which uniquely defines a tuple/row. [1]

iii. *Both foreign keys must be present to get the mark and must match the names used in part a).*

*Don’t penalise twice for mistakes in part a).*

CustNum and StockNum in the Orders table [1]

iv. A foreign key is an attribute which is found in multiple tables. It must be the primary key in one of the tables. [1]

c) *1 mark for all tables being present*

*1 mark for the correct ordering and connections between them*

*1 mark for identifying the one–many relationships*

*Tables may differ from below but must match pupil’s answer for part a).* [3]

Orders

Customers

Stock

d) *1 mark for all fields being defined in each table*

*1 mark for a sensible Data Type and Format for each field*

*1 mark for sensible Validation Rules / Input Masks / Default Values used*

*1 mark for correct identification of keys*

*The items below are suggestions only – any logical answers can gain credit*

*Tables must match the pupil’s earlier database format.*

Customer Table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Field | Data Type | Format | Validation Rule / Input Mask / Default Value | Key Field |
| CustNum | AutoNumber |  | “CUST”00000 | Primary |
| Title | Text | Length = 4 |  |  |
| FirstName | Text | Length = 15 |  |  |
| Surname | Text | Length = 15 |  |  |
| Address | Text | Length = 30 |  |  |
| PostCode | Text | Length = 8 | >LL09 0LL |  |

Stock Table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Field | Data Type | Format | Validation Rule / Input Mask / Default Value | Key Field |
| StockNum | AutoNumber |  | “STCK”00000 | Primary |
| StockName | Text | Length = 25 |  |  |
| Price | Currency | £0.00 | Default: 0  Validation: >=0 |  |
| Manufacturer | Text | Length = 25 |  |  |

Order Table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Field | Data Type | Format | Validation Rule / Input Mask / Default Value | Key Field |
| OrderNum | AutoNumber |  | “ORDR”00000 | Primary |
| CustNum | Number | Long Integer |  | Foreign |
| StockNum | Number | Long Integer |  | Foreign |
| OrderDate | Date/Time | Short Date | Default: Now()  Validation: <=Date() |  |
| OrderTime | Date/Time | Short Time | Default: Now()  Validation: <=Now() |  |
| Dispatched | Yes/No |  |  |  |

e) i. SELECT \* FROM Stock [1]

ii. *1 mark for the correct fields and table being used*

*1 mark for the ordering by surname*

SELECT Title, FirstName, Surname, PostCode FROM Customers ORDER BY Surname ASC [2]

iii. *1 mark for correct fields and table used*

*1 mark for correct criteria of the search*

*1 mark for correct sorting*

SELECT OrderNum, OrderDate, OrderTime FROM Orders WHERE Dispatched = -1 ORDER BY OrderDate ASC [3]

f) i. *1 mark for the problem and 1 mark for the knock-on effect*

An order can only have one item of stock assigned to it.

So if a customer wants to buy more than one thing, several entries in the database would need to be created. [2]

ii. *1 mark for identifying a fourth table could be created*

*1 mark for further explanation*

Create a fourth table

That can store multiple entries of StockNum for the same OrderNum [2]

iii. *1 mark for link between Orders and Stock being broken* [4]

*1 mark for new table added with sensible name*

*1 mark for correct one–many relationship between Orders and new table*

*1 mark for correct one–many relationship between Stock and new table*

Orders

Customers

Stock

OrderStock

4.11. Big Data – Test 1

1. a) *1 mark for each demand and 1 mark for a further expansion*

Velocity – the speed that data is required with response times needing to be as short as seconds or even milliseconds

Variety – the data can be in a variety of formats, including structured, unstructured, text and/or multimedia [4]

b) If the data isn’t structured it becomes a lot more difficult to analyse.

Relational databases would usually be used to store huge amounts of data but these are no longer suitable as a lot of this data can’t be stored in columns and rows. [2]

c) It is a problem because relational databases do not scale well across multiple machines.

Functional programming provides a solution because it makes it easier to write correct and efficient distributed code. [2]

d) *1 mark for a relevant advancement and 1 mark for further expansion*

*Accept any relevant technology that requires/creates huge amounts of data and/or is constantly connected and exchanging data with very fast response times being required, e.g.*

• Smartphones – constantly connected with data constantly being sent and received, including data tracking whereabouts (using GPS/location data) and usage statistics

• Networked sensors – sensors being used in industry, gathering information on a range of tasks – this data needs to be stored and organised so that it can be used properly with data from other areas

• CCTV – huge volumes of video footage is being collected all of the time – this needs to be stored so that it can be used effectively [6]

e) *First 2 marks for some explanation of how Big Data contributes to experiential wisdom*

With the data now being gathered we have an amount of historical data that is unprecedented. This level of information will better inform our decisions in the future and only serve to broaden and improve our ability to utilise our ‘experiential wisdom’.

*12 marks then awarded from the table below.*

|  |  |  |
| --- | --- | --- |
| Level | Description | Mark Range |
| 3 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all three areas indicated in the guidance below and in at least two of these areas there is sufficient detail to show that the student has a good level of understanding of the impact of Big Data. To reach the top of this mark range, a good level of understanding must be shown of all three areas. | 9–12 |
| 2 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response but the response may only cover two of the areas indicated in the guidance below. | 5–8 |
| 1 | A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the four areas from the guidance or may be made in a superficial way with little substantiation. | 1–4 |

Indicative content:

*Any sensible suggestions that involve huge volumes of data being gathered and that then influencing future decisions, processes or strategies are creditworthy.*

*Agriculture*

• Data being gathered on cultivation techniques and how they can be refined and improved due to the huge volume of data on the success and statistics of different methodologies

• Benefits of this could be increased levels of food production with an obvious impact on reduced hunger/starvation around the world and cheaper food.

*Medicine*

• An indication of data regarding patients, illnesses, cures and symptoms

• Coordination of historical data to discover new trends and links between demographics of patient, successful cures, etc.

• Linking the benefits to improved training of doctors, medical guidelines, feeding directly into medical expert systems for improved diagnosis

*Industry (can be an industrial or a business example)*

• Data gathered on an industrial stage is massive – a jet engine will generate 1 TB of data on a flight, for example. This data can be used to affect the manufacturing process and evaluate the end-result efficiency of different industrial processes

• Historical data to feed into cost v quality, sales patterns, industrial techniques and their effectiveness (both efficiency on the industrial level and coordinating with data regarding how well the product does down the line)

• Can improve industrial techniques, advertising and marketing strategies and generally improve and streamline business [14]

4.11. Big Data – Test 2

1. a) A higher-order function is a function that takes one or more functions as parameters.[1]

b) No side effects / state (1), data is immutable so source data cannot be modified (1). [2]

2. a) A model where data is divided into the smallest possible (1) meaningful (1) units called facts [2]

b) Any timestamp, stock name and individual price, e.g.: 612090, MGX has average price 105 [1]

c) Graph schema model entities as nodes (1) with properties (1) and edges that represent relationships (1) [3]

d) A graph similar to the following (1 mark for nodes, 1 for properties and 1 for the correct edges): [3]

3 *1 mark for the explanation of each technology, max 3 marks.*

*1 mark for referencing a lack of structure in the data*

*1 mark for referencing the issue with relational databases not being suitable*

Accept any relevant expansion of the use of the technology, e.g.

• Smartphones – constantly connected with data constantly being sent and received, including data tracking whereabouts (using GPS/location data) and usage statistics

• Networked sensors – sensors being used in industry, gathering information on a range of tasks – this data needs to be stored and organised so that it can be used properly with data from other areas

• CCTV – huge volumes of video footage is being collected all of the time – this needs to be stored so that it can be used effectively

If the data isn’t structured it becomes a lot more difficult to analyse.

Relational databases would usually be used to store huge amounts of data but these are no longer suitable as a lot of this data can’t be stored in columns and rows. [5]

Avg. Price

Max. Price

Min. Price

Avg. Price

Max. Price

Min. Price

Avg. Price

Max. Price

Min. Price

e) Each stock exchange would be a node (1) with an edge to each stock it contained (1). The properties representing the prices of each stock would need to be modified to include information about the exchange that they relate to (1) [3]

4. *12 marks awarded from the table below.*

|  |  |  |
| --- | --- | --- |
| Level | Description | Mark Range |
| 3 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all three areas indicated in the guidance below and in at least two of these areas there is sufficient detail to show that the student has a good level of understanding of the impact of Big Data. To reach the top of this mark range, a good level of understanding must be shown of all three areas. | 9–12 |
| 2 | A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response but the response may only cover two of the areas indicated in the guidance below. | 5–8 |
| 1 | A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the four areas from the guidance or may be made in a superficial way with little substantiation. | 1–4 |

Indicative content:

*Students should identify the types of data that could be collected and how they might be used.*

*Data that could be collected from users’ search requests includes:*

• Most frequent search requests – more valuable for ads

• Advertising-link clicks – more valuable search term for ads or better ad

• Search-result clicks – good search result

• Last search result clicked in session – best search result

• More than one page of results looked through – links on the first page may not be good results

• Search terms that match certain demographic – target ads at that demographic

• Geographic data – tailor search results to a region, e.g. a French site is likely to be more relevant in France than in the UK

*Data that could be collected by trawling websites includes:*

• Information on the number of times a website is linked to (PageRank)

• The number of pages that make up a website

• The number of images on a website

• The last time a website changed

*A good answer will make reference to the use of machine learning to slowly adjust the parameters of the search algorithms. Students could also discuss the use of experimentation to gather data on what ads / search results best suit a particular search request.* [12]

4.12. Functional Programming

1. a) *1 mark for the Head and 1 mark for the Tail*

|  |  |
| --- | --- |
| **Head** | 2 |
| **Tail** | [4, 6, 8 ,10] |

[2]

b) *1 mark for a list being output and 1 mark for the correct list*

[4, 8, 12, 16, 20] [2]

c) *1 mark per point*

Explaining that map applies the function double to each list element

Explaining that map applies double to the head of the list

And then a recursive call is made on the tail of the list [3]

2. a) *1 mark per point*

The filter function processes a data structure/list

And produces a new data structure/list

Of values from the original structure that satisfy a criteria / for which a given predicate or condition returns a true value [3]

b) *1 mark for a list being output and 1 mark for the correct list*

[2, 4, 6, 8, 10] [2]

c) [1, 3, 5, 7, 9] [1]

3. a) *1 mark per point*

This is functional composition.

It combines two functions to get a new function. [2]

b) *1 mark for the domain and 1 for the codomain*

|  |  |
| --- | --- |
| **Domain** | A |
| **Codomain** | C |

[2]

c) g ○ f = (x – 5)2 [2]

4. a) *1 mark per point*

The fold function analyses a recursive data structure/list/tree/ hierarchical data structure

Applying a function to each element

Before recursing onto the next element

To return a final output value [4]

b) *1 mark per point*

The function takes a list of the first n numbers starting from 1 (take n [1..])

Then find their product

With 1 as the identity [3]

# Non-write-on Topic Tests

4.5. Data Representation – Test 1

1. a) Describe the representation of unsigned denary integers in binary format. [1]

b) Use a two-column table to write the binary and hexadecimal representations of denary numbers 0 – 16. [4]

2. Calculate the result of each following binary expressions. Show your working and give the result in binary.

a) 0111 + 0010 [1]

b) 1011 \* 111 [3]

3. a) Use the even-parity bit given to state whether an error has occurred during the transmission of the following numbers:

i. 0100101011 parity 1 [1]

ii. 010111011 parity 0 [1]

iii. 11111111 parity 1 [1]

b) Explain how a checksum is used for error detection. [3]

4. a) Explain why it is necessary to sample sounds when recording them to a computer. [2]

b) Explain the difference between .wav, .midi and .mp3 files for storing music. [3]

c)Explain the difference between lossy and lossless compression for sound files, commenting on the resulting file sizes and quality of the resulting file. Which form will most likely be used for streaming music over the Internet? [3]

5. a) Convert the following unsigned binary numbers into denary.

i. 01100110 [1]

ii. 10111001 [1]

iii. 11000101 [1]

b) Convert the following denary numbers into 8-bit unsigned binary.

i. 78 [1]

ii. 123 [1]

iii. 228 [1]

c) Convert the following 8-bit two’s complement binary numbers into denary.

i. 00101101 [1]

ii. 10100111 [1]

iii. 11111111 [1]

d) Convert the following binary fractions into denary decimal numbers.

i. 0100.1100 [1]

ii. 0011.1110 [1]

ii. 1011.1001 [1]

6. Run-length encoding is a form of lossless compression. A simple way of representing run-length encoded data is as a series of pairs of bytes, with the first byte in each pair representing a character and the second byte in each pair representing the number of times the character is repeated.

Example: "HHHEEEELLLLOOOOOOOO" would be encoded as ['H', 3, 'E', 4, 'L', 4, 'O', 8].

a) Encode the string "GGOOOOODDBYYYEEEEE" using the format described above. [2]

b) Run-length encoding on its own does not compress text well. Give an example of a type of compression that is better suited to compressing text and describe how it works. [3]

Total marks = /40

4.5. Data Representation – Test 2

1. The following questions should be carried out without using a calculator. Show your working.

a) Convert 204 (base 10) to binary and hexadecimal. [2]

b) Convert 11000111 (base 2) to denary and hexadecimal. [2]

c) Convert E7 (base 16) to denary and binary. [2]

d) What is in two’s complement notation? [1]

e) If 1100.1100 is a two’s complement fraction, what is it in denary? [2]

f) Binary fractions can be inaccurate. To demonstrate this use a binary floating-point number with a two’s complement exponent 4-bits wide and a two’s complement mantissa 5-bits wide to represent the number 1.4. Explain how this inaccuracy could be reduced and any further difficulties you may run into.

[4]

2. ASCII and Unicode are both methods of storing characters in a computer.

a) Knowing that A is character 65 (base 10) in the ASCII table, give the ASCII codes for the following letters:

i. F [1]

ii. M [1]

iii. X [1]

b) How many ASCII characters are in the following phrase? Explain how you arrived at your answer.  
**I love AQA Computer Science!** [2]

c) The ASCII code for the letter ‘E’ is 100 0101. State the ASCII binary for the letter J. [1]

d) Give an advantage of ASCII over Unicode. [1]

e) Give an advantage of Unicode over ASCII. [1]

f) How many characters can 7-bit ASCII represent? [1]

3.a) Using an example, describe how bit patterns may represent other forms of data, such as graphics or sound. [2]

b) You are given a photo which has a resolution of 640 pixels by 480 pixels. It has a size of 1200KB. Assuming the file is a simple raw bitmap (i.e. it contains no header or other extras), calculate the  
colour depth of the photo (show your working). [3]

c) You are designing a logo for a new website. Part of the logo is made from an existing photo.  
Explain, giving reasons, why you should use bitmap rather than vector graphics for the logo.   
As part of your answer you should explain the differences between these two file formats. [3]

d) Give examples of two pieces of information typically found in the metadata of a bitmapped graphic. [2]

4. Encryption is incredibly important in the modern age. Two popular methods of encryption are the Caesar Cipher and the Vernam Cipher.

a) Encrypt the phrase ‘I love computing’ using the Caesar Cipher and a key of 5. [2]

b) Decrypt the phrase ‘kwux akq zwksa’ using the Caesar Cipher and a key of 8. [2]

c) Give two disadvantages of a standard Caesar cipher as a method of encryption. [2]

d) The Vernam Cipher is highly regarded – why is that? [1]

e) Explain how the Vernam Cipher works. You may assume a computer is carrying out the encryption, and binary is being used to represent each character. [4]

f) Aside from keeping the key text safe and secure, what other two rules must be followed to preserve the security of this Vernam Cipher? [2]

Total marks = /45

4.6. Computer Systems – Test 1

1. Identify which of the following are hardware and which are software? [4]

a) Hard disk

b) Windows operating system

c) A graphics card

d) Monitor

2. List five different programming languages, indicating what each is generally used for.  
(Note that no marks will be gained if you only list the name of the language.) [5]

3. a) What is the difference between imperative and declarative languages? [2]

b) Broadly speaking, there are five generations of computer language. Indicate which of the first four generations are machine dependent and why. [4]

c) Which level does assembly language fall under? [1]

d) Here is an extract from a programming language. What level of language is it and what  
limitations does this level of language offer? [3]

FD 71 431F 4153

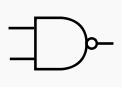
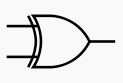
F3 63 4267 4321

96 F0 426D

F9 10 41F3 438A

47 40 40DA

47 F0 4050

4. a) What are the functions of the following logic gates?

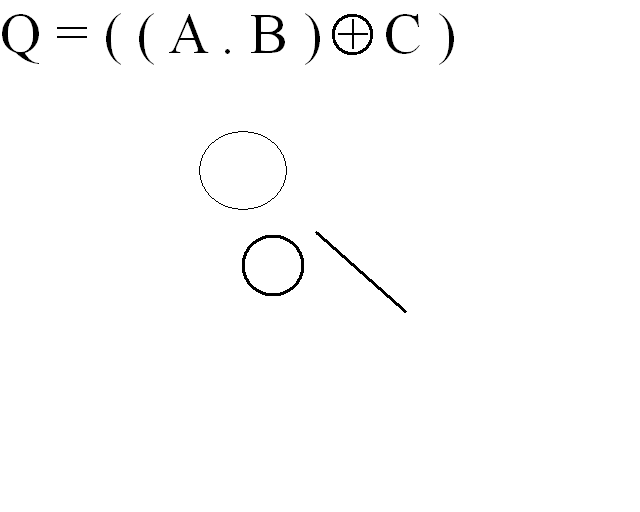
i. [1] ii. [1]

b) What are the results of the following Boolean algebra equations?

i. 0 + 1 + 1 + 0 [1]

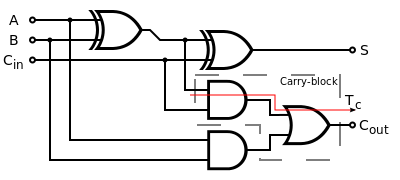
ii. 1 . 0 [1]

iii. (0 + 0 + 0) + (0 + (1 . 1)) [1]

c) Construct the logic circuit that represents the following expression: [3]

5. a) What is an adder circuit used for? [1]

b) Does the following image represent a full adder or half adder? [1]



c) Draw the other type of adder circuit not shown in part b). [4]

d) D-type flip-flops can be used in memory. Explain what the ‘D’ represents in the name? [2]

Total marks = /35

4.6. Computer Systems – Test 2

1. a) Briefly explain, using an example for each, the difference between system software and   
application software. [4]

b) Say for each of the following whether they are application- or system-software packages. [4]

i. Unix

ii. Word processor

iii. Virus scanner

iv. Computer game

2. You are working as a project manager for a company. Describe *four* different factors you would consider when selecting a programming language for a major project to be written in. Assume that you have  
a good working knowledge of all languages. [4]

3. Name and briefly describe the three different types of translator programs. [6]

4. a) Describe the function of applying the following logical operators to a condition. [2]

i. NOT

ii. OR

b) Copy and complete the following truth table for the XOR operator. [4]

|  |  |  |
| --- | --- | --- |
| **Condition A** | **Condition B** | **A XOR B** |
| True | True |  |
| True |  | True |
|  | True | True |
| False | False |  |

5. a) What are the two De Morgan’s laws? [2]

b) Why are De Morgan’s laws important in designing circuit boards? [2]

c) Show that one of these laws is consistent by producing the truth table for each side of the equation. [4]

Total marks = /32

4.7. Computer Organisation and Architecture – Test 1

1. Explain, using an example, what is meant by a ‘peripheral’. [2]

2. A motherboard is often referred to as the ‘heart’ of the computer system. This is because it sends signals and electricity around the computer system to the various components, in a similar way that the heart does with blood in the body.

a) Name three hardware components that can be physically connected to a motherboard. [3]

b) Give three technological factors to consider when choosing a motherboard for a computer system. [3]

3. a) Briefly explain the functional role of each of the following.

i. CPU

ii. ROM [1]

iii. RAM [1]

b) What does the ALU (Arithmetic Logic Unit) do? [2]

c) Modern computers often contain chips with multiple cores. Explain what is meant by ‘multiple  
cores’ and describe two scenarios where increasing the number of cores will improve the  
performance of a system. [3]

4. Explain the difference between a Von Neumann architecture and a Harvard architecture. For each architecture give an example of an application the architecture is typically used for. [3]

5. Name three basic-assembly / machine-code instructions and briefly describe what they are used for. [6]

6. The financial sector requires robust backup systems that can be relied upon not to fail. A particular company has been offered two alternative configurations – one containing a solid-state disk and the other containing a traditional hard disk drive. Give two reasons why a solid-state disk may be chosen over the hard disk drive. [2]

7. Explain, with reasoning, each step of the Fetch–Execute Cycle in detail. [10]

Total marks = /36

4.7. Computer Organisation and Architecture – Test 2

1. a) Explain why RAM is primary storage and a hard disk is secondary storage. [2]

b) Explain the concept of ‘addressable memory’. [2]

2. Fill in the missing details on the following: [3]

|  |  |
| --- | --- |
| **Name** | **Role** |
| Data bus |  |
|  | Carries the details that are required in order to keep operations running at the correct time |
| Address bus |  |

3. Explain how the following can affect the performance of a processor.

a) Clock speed [2]

b) Word length [2]

4. Use the following list of machine-code instructions to answer the next two questions.

|  |  |
| --- | --- |
| 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. |

a) Explain what 'immediate addressing' is and show how immediate addressing is used by giving an example that uses the CMP instruction. [2]

b) Consider the following code written in a high-level language:

IF X < 7

THEN B 🡨 15

END IF

Write a sequence of assembly-language instructions that would perform the same operations as the program code above. 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]

5) This diagram shows memory used by the processor.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General-purpose registers | | | | ALU | PC | CIR | MAR | MBR | control unit |
|  |  |  |  |

**Main memory**

What do the following abbreviations stand for?

a) PC [1]

b) CIR [1]

c) MAR [1]

d) MBR [1]

6. Common secondary storage devices used by computers include hard disk drives (HDD), optical discs, and solid state drives (SSD).

Give one advantage and one disadvantage for each type. [6]

7. A school is considering changing from using paper registers to storing all the register information on a computer.

a) Briefly describe two technologies that could be used to help enter data into the computer. [2]

b) Outline the potential advantages and disadvantages of storing the information on a computer rather than in a register. [4]

8. Some computer systems allow processes to put themselves to sleep for a set period of time. Programs can use this functionality to add a delay between function calls. For example the following code will print '...' every 60 seconds:

|  |
| --- |
| while true  sleep(60)  print("...")  endwhile |

Explain how interrupts could be used to implement this sleep(*n*) system call. Assume that the processor contains a programmable circuit that can raise an interrupt after a given period of time has expired. Ensure that your system can cope with situations where the timer circuit raises an interrupt earlier than expected. [5]

Total marks = /38

4.8. Consequences of Uses of Computing – Test 1

1. a) Define the term ‘hacking’. [1]

b) Describe what is meant by the terms ‘black hat hacker’ and ‘white hat hacker’. Give an example of why each of these does what they do. [4]

2. Developments in Computer Science have led to the use of drones in warfare. Debate the ethics of the use of drones.

You may wish to consider areas such as their accuracy, alternatives, the legality of their use and the lower cost of engagement. [12]

3. There has been a huge push in recent years in the development of commercial facial-recognition software by companies such as Google, Facebook and Apple.

If a human is shown two pictures, they will be able to identify with an accuracy of 97.53% on average if the same person is shown in both pictures. Facebook has developed an algorithm with an accuracy of 97.25%.

Discuss the uses of this technology and any ethical issues surrounding its use in a commercial setting.

You may wish to consider what the technology would be used for, privacy concerns, who holds the information and the impact of wearable technology. [12]

Total marks = /29

4.8. Consequences of Uses of Computing – Test 2

1. a) Peer-to-peer networks are frequently used to share files on the Internet.

i. Explain what a peer-to-peer network is. [1]

ii. Give two reasons why peer-to-peer networks are more popular than traditional client-server networks for distributing pirated videos. [2]

b) Explain what digital rights management (DRM) is. [1]

c) Give four ways DRM might restrict the way a video file can be used. [4]

2. Robots have long been used in manufacturing facilities; however, until recently they had not made a significant impact in other industries.

a) Explain why it is easier to make a robot that works on an assembly line in a factory than it is to make a robot that cleans someone’s house. [2]

b) Robots are now commonly used in distribution warehouses, picking and packing orders for customers. Describe two advantages and two disadvantages of using robots for this purpose. [4]

c) Self-driving cars have huge potential to change the way people travel; however, they present legislators with a number of challenges. Describe two challenges that legislators will need to overcome before self-driving cars can become commonplace. [2]

3. In January 2015 the British Prime Minister David Cameron announced new legislation designed to limit the use of strong forms of encryption. He said:

*‘Are we going to allow a means of communication which it simply isn't possible to read? My answer to that question is no, we must not.’*

Discuss the advantages and disadvantages of having strong forms of encryption readily available to members of the public. Provide examples of the sorts of communication that people might want to encrypt for positive or negative reasons. [6]

4. ‘According to a well-written and thorough article in the*Virginia Journal of Law & Technology*, what we've been saying for over three years has been determined to be true: WarDriving is not a crime.’

In September 2004, this statement was written by Marius Milner. Marius was the engineer who developed NetStumbler, which is a tool used to map Wi-Fi networks using a Wi-Fi card and GPS. This process is known as ‘WarDriving’.

Marius Milner also worked for Google and his code for gathering this information was implemented on the street-view cars which were used to gather data on mapping networks and to directly ‘snoop’ data from open networks as street-view information was being gathered.

Discuss the ethics and legality of WarDriving. You may wish to consider how easy it is nowadays to do WarDriving yourself, what information could be gathered, what the end goal may be of gathering such information, what happens to the information later, and where it is stored. [12]

Total marks = /34

4.9. Communication and Networking – Test 1

1. a) Define the following types of communication link:

i. Serial [1]

ii. Parallel [1]

b) A company wishes to connect sites which are a considerable distance apart with their WAN. Which sort of cabling would you advise them to use, serial or parallel, and why? [2]

2. A printer is connected to a computer via a USB (universal serial bus) link.

a) USB uses asynchronous transmission.

i. What is asynchronous transmission? [1]

ii. Asynchronous transmissions often use special bits to control the flow of data. What are these bits called and exactly what is it they do? [2]

b) The alternative to asynchronous transmission is synchronous transmission.

Describe how synchronous transmission differs from asynchronous transmission and give an advantage of using synchronous transmission. [3]

3. Describe what is meant by the following terms:

a) Client-server networking [2]

b) Peer-to-peer networking [2]

c) Internetworking [1]

4. A home user is trying to set up a local area network which is connected to the Internet. They have drafted you in to help them set it up.

a) What is a gateway and why will they need one to connect to the Internet in this example? [2]

b) They have bought a router. The router has an internal IP address of 192.168.1.1. The external IP address is provided by their Internet Service Provider.

i. Explain what a router is and why it is necessary. [2]

ii. The router they have bought has a built-in wireless access point. Explain why it is better for the access point to use the Wi-Fi standard rather than other alternatives and what the security implications of a wireless network are. [2]

c) They have a printer with a network port. Suggest an appropriate static IP address for the printer, assuming a subnet mask of 255.255.255.0. [1]

d) Laptop computers connect to the network using Wi-Fi. They use carrier sense multiple access with collision avoidance (CSMA/CA) to determine when to transmit data.

Describe how the CSMA/CA method is used. [6]

Total marks = / 28

4.9. Communication and Networking – Test 2

1. You are assessing an experimental high-speed communications link for use by your company.

a) If the link has a bit rate of 200Gbps and a baud rate of 100Gbps, how many bits must be sent per signal change? [1]

b) The link uses even parity bits to check for errors. There is one parity bit for every seven data bits.

i. Explain what an even parity bit is and how it is used to check for errors. [2]

ii. Does the byte 10110111 contain an error? [1]

iii. What is the limitation of using only parity bits for error checking? [1]

c) The link has been described to you as low latency. What does this mean? [1]

2. Increasingly, applications are being delivered to users’ computers via networks, both over local business networks and over the Internet.

a) What is a thin client? [1]

b) Give an advantage and disadvantage of having a server take on more ‘work’ than its clients? [2]

c) What is a web service? Give a benefit of a web service. [2]

3. The Internet is a very useful thing. However, connecting a computer to it exposes it to a number of threats.

a) What is a firewall and how does it protect a computer? [2]

b) Two capabilities of a firewall system can be packet filtering and a proxy server. Describe what each of these capabilities are and what they try to achieve. [4]

c) Define the term ‘virus’ and explain briefly how viruses work. [3]

d) Define the term ‘worm’ and describe how it differs from a virus. [2]

e) Define the term ‘Trojan horse’ and describe how it differs from a virus. [2]

4. Online shopping is made possible by a variety of encryption and security measures.

a) Name and briefly describe the three main security procedures which should be followed to prevent or subsequently detect unauthorised access to a server. [6]

b) Explain the concept of public/private key encryption and give a brief description of digital certificates and signatures. [6]

5. Networks can be formed in a number of topologies. Describe how bus and star network topologies   
work and compare the advantages and disadvantages of each. [6]

Total marks = /42

4.10. Databases – Test 1

1. Consider the following entity-relationship diagram:

Students

Teachers

Each student has only one teacher, and there are usually about 30 students per class. Each class has only one teacher. Each student and teacher also belongs to a single college.

a) What is the relationship between colleges and teachers? [1]

b) Extend the entity-relationship diagram to include collegesand update all the relationships. [2]

2) Define each of the following terms:

a) Primary key [1]

b) Foreign key [1]

c) Composite key [1]

3. SQL is a language commonly used to create, maintain and query databases.

a) Consider this data definition language (DDL) statement:

CREATE TABLE db.users

(

UserName VARCHAR(20),

FirstName VARCHAR(20),

LastName VARCHAR(20),

Password VARCHAR(20),

PRIMARY KEY (UserName),

UNIQUE INDEX (UserName)

);

i. What is the purpose of this statement? [3]

ii. Why can’t the primary key be *LastName*? [1]

b) Explain what each of the following SQL statements would do when applied to the database *db*:

i. SELECT \* FROM users [1]

ii. SELECT UserName, Password FROM users ORDER BY UserName DESC [2]

iii. SELECT FirstName, LastName FROM users WHERE UserName = ‘Bilbo33’ [2]

4. Consider the following table, ‘Players’, from an online fantasy role-playing game:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PID** | **GivenName** | **Surname** | **Character** | **Level** | **Race** | **Items** |
| 001 | Alan | Smith | Alzabeck | 32 | Orc | Potion, Armour, Axe |
| 002 | Yvette | Jones | Thornzon | 2 | Dwarf | Armour, Sword |
| 003 | Ibrahīm | Hassan | Teylar | 12 | Dwarf | Staff, Potion |
| 004 | Lili | Yu | Axethorn | 6 | Human | Axe, Horse |
| 001 | Alan | Smith | Tamto | 24 | Elf | Potion, Horse |

a) Create an entity definition for the above table. [2]

b) What is the purpose of database normalisation? [2]

c) Place this table into third normal form (3NF). You may assume that all character names are unique, and that race and items only need to be stored as attributes, and do not need tables of their own. Each PID is unique to a real person. [5]

Total marks = /24

4.10. Databases – Test 2

1. Consider the following entity description for a flat-file shop orders database.

Order(OrderNum, CustNum,Title, FirstName, Surname, Address, PostCode, StockNum, StockName, Price, Manufacturer, OrderDate, OrderTime, Dispatched)

a) Normalise the above database into 3NF by writing the entity descriptions for the new tables.   
You may assume at this stage that you only need to order one item at a time. [4]

b) i. Identify the primary keys. [1]

ii. State the purpose of a primary key. [1]

iii. Identify the foreign keys and their location. [1]

iv. State the purpose of a foreign key. [1]

c) Draw an entity-relationship diagram for your database. [3]

d) Complete a data dictionary for your database, using the column headings below for each table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Field | Data Type | Format | Validation Rule / Input Mask / Default Value | Key Field |

Note that not all fields will have an entry for every column. You should aim to suggest at least one sensible validation rule or input mask or default value in each table. Under the Key Field column you can enter ‘Primary’, ‘Foreign’ or leave it blank as appropriate. [12]

e) Answer the following SQL questions based on the structure you have used in part d).

i. Write an SQL statement to return all information on every item of stock. [1]

ii. Write an SQL statement to return the title, first name, surname and postcode of all customers in alphabetical order of surname. [2]

iii. Write an SQL statement to return a list of order numbers, dates and times of orders of every item that has not been dispatched. The list should be in ascending order of date ordered. [3]

f) i. Assuming a three-table structure has been used to represent the flat-file database described in this question, what restriction does this place on the database that would be an issue in the day-to-day running of a shop? [2]

ii. Describe a possible solution to this problem. [2]

iii. Draw an entity-relationship diagram for your new structure. [4]

Total marks = /37

4.11. Big Data – Test 1

1. It has been calculated that 90% of the world’s data has been gathered and created in the last two years.

This explosion in the amount of data we gather and need to store has led to new possibilities and problems in the modern world. This phenomenon is known as Big Data.

a) The ‘big’ in Big Data represents the scale of the data in terms of the demands it puts on our systems. Other than the large volume of data (and the necessary storage capacity required to host it), describe two other demands Big Data may have. [4]

b) The main challenges that Big Data brings are due to its lack of structure. Why does this lack of structure pose a problem? [2]

c) The huge size of data being stored often means it cannot be stored on one server. Why is this a problem and what method can be used to help use data that is distributed across multiple servers? [2]

d) Describe three developments in technology in recent years that have led to the creation of the Big Data phenomenon. [6]

e) George Lee (CIO at Goldman Sachs) referenced the fact that for years society has used ‘experiential wisdom’ (learning from and gaining wisdom from one’s experiences) to make decisions in many areas of our lives. How does Big Data contribute to this way of thinking? Explain how Big Data can potentially be used in Medicine, Agriculture and Manufacturing (you may choose any area of manufacturing to talk about). [14]

Total marks = /28

4.11. Big Data – Test 2

1. Functional programming languages are widely used to process Big Data.

a) Map is a common function in Big Data applications. Map is an example of a higher-order function. What is meant by a higher-order function? [1]

b) Big Data frameworks such as Apache Spark can distribute higher-order functions across multiple physical servers. Explain why it is possible for this to be done safely when a purely functional programming language is used. [2]

2. Stock exchanges update their prices every few microseconds. The following table gives some example data that might be produced by a stock exchange.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Timestamp** | **Stock Name** | **Min Price** | **Average Price** | **Max Price** |
| 612090 | MGX | 102 | 105 | 108 |
| 612094 | MGX | 102 | 104 | 108 |
| 612097 | APP | 80 | 83 | 85 |
| 612099 | MGX | 100 | 102 | 108 |
| 612102 | GTP | 3 | 3 | 3 |
| 612108 | APP | 80 | 84 | 86 |

a) Explain what a fact-based model is. [2]

b) Give an example of a fact from the table above. [1]

c) Describe the elements that make up a graph schema. [3]

d) Draw a graph that represents the stock exchange data above. [3]

e) Stocks may be listed on more than one stock exchange at a time. Describe how you would need to modify your graph schema to represent the relationships that stocks have with the multiple stock exchanges. [3]

3. Smartphones, networked sensors and video surveillance are three modern sources of Big Data. Describe what kind of data these devices generate and describe why this data can be so difficult to store. [5]

4. Search-engine companies such as Google, Bing and Yahoo! generate a huge amount of data. Google alone responded to 1.2 trillion search requests in 2012. Discuss the types of data a search engine might collect and how the search engine could use this information to improve its accuracy or the effectiveness of its advertising. [12]

Total marks = /32

4.12. Functional Programming

1. A recursively defined function named map and a function named double are defined as follows:

map f [] = []

map f (x:xs) = f x : map f xs

double x = 2 \* x

The function map has two parameters, a function f , and a list that is either empty, indicated as [], or non-empty, in which case it is expressed as (x:xs), in which x is the head and xs is the tail; which is itself a list.

a) Write the values at the head and tail of the list [2, 4, 6, 8, 10]. [2]

b) Calculate the result of the following function call map triple [2, 4, 6, 8, 10] [2]

c) Explain how you arrived at your answer to part b) and the recursive steps that you followed. [3]

2. In functional programming, the higher-order function filter is defined as:

filter :: (a -> Bool) -> [a] -> [a]

filter \_ [] = []

filter p (x:xs) | p x = x : filter p xs

| otherwise = filter p xs

a) Describe what this function does. [3]

b) Calculate the answer of making the function call filter even [1..10]. [2]

c) Calculate the answer of making the function call filter (not . even) [1..10]. [1]

3. Assume you have two functions, f and g, that both perform a given mathematical calculation on a given integer argument.

f: A 🡪 B

g: B 🡪 C

a) What does g ○ f mean? [2]

b) For the function g ○ f, state the domain and codomain. [2]

c) If the function f(x) = (x – 5) and g(y) = y2, calculate what the resultant function g ○ f would be. [2]

4. A commonly used higher-order function in functional programming is the fold function (otherwise known as reduce).

a) Explain what the fold function does. [4]

b) Explain how the following function (which uses the fold function to calculate the factorial of a   
number n) works. [3]

factorial n, where n <= 0 := 1

factorial n := fold \* 1 take n [1..]

Total marks = /26