**2.1, 2.2 & 2.3 – Data Transmission**
**QUESTIONS**

## 2 - Data transmission

| **2.1 Types and methods of data transmission** | | | | |
|---|---|---|---|---|
| 1 | (a) Understand that data is broken down into packets to be transmitted | | | |
| 1 | (b) Describe the structure of a packet | | | |
| 1 | (c) Describe the process of packet switching | | | |
| 2 | (a) Describe how data is transmitted from one device to another using different methods of data transmission | | | |
| 2 | (b) Explain the suitability of each method of data transmission, for a given scenario | | | |
| 3 | Understand the universal serial bus (USB) interface and explain how it is used to transmit data | | | |

***More Guidance:***

| **2.1 Types and methods of data transmission** | | |
|---|---|---|
| Candidates should be able to: | | Notes and guidance |
| 1 | (a) Understand that data is broken down into packets to be transmitted | |
| | (b) Describe the structure of a packet | • A packet of data in a unit of data contains a<br>– packet header<br>– payload<br>– trailer<br>• The packet header includes the:<br>– destination address<br>– packet number<br>– originator's address |
| | (c) Describe the process of packet switching | • Data is broken down into packets<br>• Each packet could take a different route<br>• A router controls the route a packet takes<br>• Packets may arrive out of order<br>• Once the last packet has arrived, packets are reordered |
| 2 | (a) Describe how data is transmitted from one device to another using different methods of data transmission | • Including:<br>– serial<br>– parallel<br>– simplex<br>– half-duplex<br>– full-duplex |
| | (b) Explain the suitability of each method of data transmission, for a given scenario | • Including the advantages and disadvantages of each method |
| 3 | Understand the universal serial bus (USB) interface and explain how it is used to transmit data | • Including the benefits and drawbacks of the interface |

**2.1, 2.2 & 2.3 – Data Transmission**
**QUESTIONS**

| 2.2 Methods of error detection | | | | |
|---|---|---|---|---|
| 1 | Understand the need to check for errors after data transmission and how these errors can occur | | | |
| 2 | Describe the processes involved in each of the following error detection methods for detecting errors in data after transmission: parity check (odd and even), checksum and echo check | | | |
| 3 | Describe how a check digit is used to detect errors in data entry and identify examples of when a check digit is used, including international standard book numbers (ISBN) and bar codes | | | |
| 4 | Describe how an automatic repeat query (ARQ) can be used to establish that data is received without error | | | |

***More Guidance:***

**2.2 Methods of error detection**

| Candidates should be able to: | Notes and guidance |
|---|---|
| 1 Understand the need to check for errors after data transmission and how these errors can occur | • Errors can occur during data transmission due to interference, e.g. data loss, data gain and data change |
| 2 Describe the processes involved in each of the following error detection methods for detecting errors in data after transmission: parity check (odd and even), checksum and echo check | • Including parity byte and parity block check |
| 3 Describe how a check digit is used to detect errors in data entry and identify examples of when a check digit is used, including international standard book numbers (ISBN) and bar codes | |
| 4 Describe how an automatic repeat query (ARQ) can be used to establish that data is received without error | • Including the use of:<br>– positive/negative acknowledgements<br>– timeout |

| 2.3 Encryption | | | | |
|---|---|---|---|---|
| 1 | Understand the need for and purpose of encryption when transmitting data | | | |
| 2 | Understand how data is encrypted using symmetric and asymmetric encryption | | | |

***More Guidance:***

**2.3 Encryption**

| Candidates should be able to: | Notes and guidance |
|---|---|
| 1 Understand the need for and purpose of encryption when transmitting data | |
| 2 Understand how data is encrypted using symmetric and asymmetric encryption | • Asymmetric encryption includes the use of public and private keys |

**2.1, 2.2 & 2.3 – Data Transmission**
**QUESTIONS**

**4** Data is transmitted between a computer and a printer.

**(a)** The data is transmitted one bit at a time down a single wire. The computer can transmit data to the printer and the printer can transmit data to the computer, using the same connection.

Circle the **two** data transmission methods that will transmit data in this way.

parallel full-duplex  parallel half-duplex  parallel simplex

serial full-duplex  serial half-duplex  serial simplex

[2]

**(b)** An odd parity check is used to detect errors in the data transmission.

Explain how the odd parity check detects errors.

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..... [4]

**(c)** Another error detection method sends the data from the computer to the printer, then a copy of the data received is sent back from the printer to the computer. The two sets of data are compared to see if they match.

State the name of this type of error detection method.

..... [1]

**6** The table contains descriptions about data transmission methods.

Complete the table by identifying which data transmission methods are described.

| Data transmission method | Description |
|---|---|
| ..... | Data is transmitted down a single wire, one bit at a time, in one direction only. |
| ..... | Data is transmitted down multiple wires, multiple bits at a time, in both directions, but only one direction at a time. |
| ..... | Data is transmitted down a single wire, one bit at a time, in both directions at the same time. |
| ..... | Data is transmitted down multiple wires, multiple bits at a time, in one direction only. |

[4]

**5** Errors can occur when data is transmitted.

**(a)** Give **one** reason an error may occur when data is transmitted.

.....

..... [1]

**(b)** Some error detection methods use a calculated value to check for errors.

Tick (✓) **one** box to show which error detection method does **not** use a calculated value to check for errors.

**A** Check digit ☐

**B** Checksum ☐

**C** Echo check ☐

**D** Parity check ☐

[1]

**(c)** An automatic repeat request (ARQ) can be used to make sure that data is received free of errors. It can use a positive or negative acknowledgement method to do this.

Explain how an ARQ operates using a positive acknowledgement method.

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..... [5]

**4)**

**(b)** The photographs are also transmitted across a network to cloud storage. A device on the network forwards the data towards its correct destination.

**(i)** State the name of this device.

..... [1]

**(ii)** Describe what is meant by cloud storage.

.....

.....

.....

..... [2]

**(iii)** Give **one** disadvantage of storing the photographs in cloud storage instead of storing them locally.

.....

..... [1]

**5** A website allows users to purchase items.

Computer A sends a request for the homepage to the website's server.

**(a)** The request is sent using packet switching.

The structure of a packet of data has three elements. One element is the packet header.

**(i)** Identify **two** items of data contained in a packet header.

1 .....

2 .....

[2]

**(ii)** Identify the **two** other elements of a packet.

1 .....

2 .....

[2]

**(b)** Computer A needs to be directly connected to a router that is located in a different room.

**(i)** Tick (✓) **one** box to identify whether serial data transmission or parallel data transmission is more suitable for this connection.

Explain the reasons for your choice.

Serial data transmission ☐

Parallel data transmission ☐

Reasons for your choice .....

.....

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.....

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..... [3]

**(ii)** The connection will also use full-duplex data transmission.

Define full-duplex data transmission.

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..... [2]

**(c)** The data transmission will use parity checks.

**(i)** The bytes need to be sent using an even parity byte check.

Complete the parity bit for each byte.

| | Parity bit | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Byte A | | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| Byte B | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[2]

**(ii)** A parity block check can be used instead of a parity byte check.

Explain how a parity block check might detect an error in transmission that would **not** be detected by a parity byte check.

.....

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..... [2]

**(iii)** The data was sent using an even parity block check. One of the bits has been transmitted incorrectly.

| | Parity bit | Bit 1 | Bit 2 | Bit 3 | Bit 4 | Bit 5 | Bit 6 | Bit 7 |
|---|---|---|---|---|---|---|---|---|
| **Byte 0** | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| **Byte 1** | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| **Byte 2** | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| **Byte 3** | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| **Byte 4** | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| **Byte 5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Byte 6** | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| **Parity byte** | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |

Identify the bit number and the byte number of the incorrect bit.

Bit number .....

Byte number .....

[2]

**5** 8 bytes of data are transmitted from one computer to another. Each byte of data has a parity bit.

The data is also sent with a parity byte. Each bit in the parity byte allows a check to be performed on each column of bits.

A parity check is performed on the data and an error is found in one bit. The table shows the data that was received.

| | Parity bit | Bit 2 | Bit 3 | Bit 4 | Bit 5 | Bit 6 | Bit 7 | Bit 8 |
|---|---|---|---|---|---|---|---|---|
| **Byte 1** | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| **Byte 2** | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| **Byte 3** | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| **Byte 4** | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| **Byte 5** | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| **Byte 6** | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 |
| **Byte 7** | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| **Byte 8** | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| **Parity byte** | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |

Identify which bit has an error by giving the Byte number and Bit number.

Explain how you found the error.

Byte number .....

Bit number .....

Explanation .....

.....

.....

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.....

[4]

**9** A system uses parity checks and Automatic Repeat reQuests (ARQ) to detect and correct errors in the transmission of data.

Describe how parity checks and ARQ operate together to detect and correct errors.

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..... [6]

**2.1, 2.2 & 2.3 – Data Transmission**
**QUESTIONS**

7 Umar is a manager in an office. The data that he uses on a daily basis is stored on a file server close to his computer.

Data is sent from his computer to the file server using parallel simplex data transmission.

**(a)** Describe how the data is sent using parallel simplex data transmission.

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.....

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..... [3]

**(b)** The file server is moved to another building that is 1 km away.

Explain why the parallel simplex data transmission method that Umar uses is no longer suitable.

.....

.....

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..... [2]

**(c)** Checksum and Automatic Repeat reQuest (ARQ) are both used when transmitting the data from a computer to the file server.

Explain why checksum and ARQ are both used.

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.....

..... [3]

3 **Five** statements are given about the error-checking methods checksum, check digit and parity check.

**(a)** Tick (✓) to show whether each statement applies to checksum, check digit or parity check. Some statements may apply to more than **one** error-checking method.

| Statement | Checksum (✓) | Check digit (✓) | Parity check (✓) |
|---|---|---|---|
| uses an additional bit to create an odd or even number of 1s | | | |
| checks for errors on data entry | | | |
| compares **two** calculated values to see if an error has occurred | | | |
| will **not** detect transposition errors | | | |
| sends additional values when data is transmitted from a computer to another | | | |

[5]

**(b)** Identify **one** other error-checking method.

..... [1]

3 **(a)** **Six** statements are given about methods of data transmission.

Tick (✓) to show if each statement applies to serial simplex, parallel simplex, parallel half-duplex or serial duplex data transmission. Some statements may apply to more than **one** data transmission method.

| Statement | Serial simplex (✓) | Parallel simplex (✓) | Parallel half-duplex (✓) | Serial duplex (✓) |
|---|---|---|---|---|
| bits are transmitted along a single wire | | | | |
| data is transmitted in both directions | | | | |
| it is only suitable for distances less than 5 metres | | | | |
| bits from the same byte are transmitted one after the other | | | | |
| data may **not** arrive in the correct sequence | | | | |
| data is transmitted in both directions, but only **one** direction at a time | | | | |

[6]

**(b)** A Universal Serial Bus (USB) connection can be used to transmit data from a mobile device to a computer.

Give **three** benefits of using a USB connection for this purpose.

Benefit 1 .....

.....

Benefit 2 .....

.....

Benefit 3 .....

.....

[3]

**3** **Five** statements are given about error-checking methods.

**(a)** Tick (✓) to show whether each statement applies to Automatic Repeat reQuest (ARQ), check digit or checksum. Some statements may apply to more than **one** error-checking method.

| Statement | ARQ (✔) | Check digit (✔) | Checksum (✔) |
|---|---|---|---|
| checks for errors on data entry | | | |
| uses a process of acknowledgement and timeout | | | |
| compares **two** calculated values to see if an error has occurred | | | |
| may resend data until it is confirmed as received | | | |
| checks for errors in data after transmission from a computer to another | | | |

[5]

**(b)** Identify **one** other error-checking method.

..... [1]

**9** A parity check is used to check for errors after transmission on the **four** given binary values.

All **four** values are transmitted and received correctly.

Identify whether each 8-bit binary value has been sent using odd or even parity by writing odd or even in the type of parity column.

| Binary value | Type of parity |
|---|---|
| 10011001 | |
| 01111110 | |
| 11100000 | |
| 00111001 | |

[4]

**3)**

Julia uses a USB connection to transfer data onto her USB flash memory drive.

**(i)** One benefit of using a USB connection is that it is a universal connection.

State **two** other benefits of using a USB connection.

Benefit 1 .....

.....

Benefit 2 .....

.....

[2]

**(ii)** Identify the type of data transmission used in a USB connection.

..... [1]

**8** Four 7-bit binary values are transmitted from one computer to another. A parity bit is added to each binary value creating 8-bit binary values. All the binary values are transmitted and received correctly.

**(a)** Identify whether each 8-bit binary value has been sent using odd or even parity by writing odd or even in the type of parity column.

| 8-bit binary value | Type of parity |
|---|---|
| 01100100 | |
| 10010001 | |
| 00000011 | |
| 10110010 | |

[4]

**(b)** An error may **not** be detected when using a parity check.

Identify why an error may **not** be detected.

.....

..... [1]

**(c)** The data is sent using parallel half-duplex data transmission.

**(i)** Describe how data is sent using parallel half-duplex data transmission.

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..... [4]

**(ii)** State **two** drawbacks of using parallel data transmission.

Drawback 1 .....

.....

Drawback 2 .....

.....

[2]

**6** Four 7-bit binary values are transmitted from one computer to another. A parity bit is added to each binary value creating 8-bit binary values. All the binary values are transmitted and received correctly.

**(a)** Identify whether each 8-bit binary value has been sent using odd or even parity by writing odd or even in the type of parity column.

| 8-bit binary value | Type of parity |
|---|---|
| 01111100 | |
| 10010000 | |
| 10011001 | |
| 00101001 | |

[4]

**(b)** The 8-bit binary value 10110001 is transmitted and received as 10110010

A parity check does **not** identify any errors in the binary value received.

State why the parity check does **not** identify any errors.

.....

..... [1]

**2)**

**(c)** The student sends the sound file to a friend. The file is transmitted across a network that uses packet switching.

**(i)** Identify **two** pieces of data that would be included in the header of each packet.

1 .....

2 .....
[2]

**(ii)** Explain how the file is transmitted using packet switching.

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..... [5]

4 A simple symmetric encryption system is used to encrypt messages. Each letter of the alphabet is substituted by another letter.

**Plain text**

| a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Cypher text**

| v | p | n | a | q | b | r | u | z | s | c | o | y | k | w | f | x | i | e | m | d | j | t | l | h | g |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**(a)** Convert the following plain text to cypher text.

Plain text: **d a t a s e c u r i t y**

Cypher text: .....[2]

**(b)** A new cypher text is created by shifting each letter of the alphabet **five** places to the right.

Show the new cypher text below.

**Plain text**

| a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**New cypher text**

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

[2]

**(c)** State, giving a reason, which cypher text would be more secure.

.....

.....

.....

.....[2]

**2.1, 2.2 & 2.3 – Data Transmission**
**QUESTIONS**

**6** **(a)** State what is meant by encryption.

.....

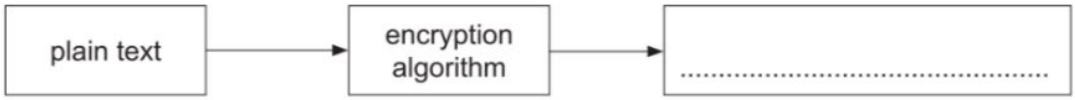
..... [1]

**(b)** State what is meant by symmetric encryption.

.....

..... [1]

**(c)** Complete the diagram:




[1]

**10** Choose **five** correct terms from the following list to complete the spaces in the sentences below:

- cypher text
- encryption algorithm
- encryption key
- firewall
- plain text
- proxy server
- symmetric encryption

..... is a security system.

It uses the same ..... to encrypt and decrypt a message.

Before encryption, the message is called ..... .

The ..... processes the original message.

The output is known as ..... . [5]

**2.1, 2.2 & 2.3 – Data Transmission**
**QUESTIONS**

2 **(a)** State what is meant by the term USB.

.....

.....

[1]

**(b)** Describe **two** benefits of using USB connections between a computer and a device.

1 .....

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.....

2 .....

.....

.....

[2]

**2.1, 2.2 & 2.3 – Data Transmission**
**QUESTIONS**

6 **(a)** **Three** descriptions of data transmission are given below.

Tick (✓) the appropriate box in each table to show the:

- type of transmission
- method of transmission

**Description 1:**

Data is transmitted several bits at a time down several wires in both directions simultaneously.

| Type | Tick (✓) |
|---|---|
| simplex | |
| half-duplex | |
| full-duplex | |

| Method | Tick (✓) |
|---|---|
| serial | |
| parallel | |

**Description 2:**

Data is transmitted in one direction only, one bit at a time, down a single wire.

| Type | Tick (✓) |
|---|---|
| simplex | |
| half-duplex | |
| full-duplex | |

| Method | Tick (✓) |
|---|---|
| serial | |
| parallel | |

**Description 3:**

Data is transmitted one bit at a time down a single wire; the data is transmitted in both directions but not at the same time.

| Type | Tick (✓) |
|---|---|
| simplex | |
| half-duplex | |
| full-duplex | |

| Method | Tick (✓) |
|---|---|
| serial | |
| parallel | |

[6]

**(b)** Give **two** reasons why serial transmission, rather than parallel transmission, is used to connect devices to a computer.

1 .....

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2 .....

.....

[2]

**4** There are various methods used to detect errors that can occur during data transmission and storage.

Describe each of the following error detection methods.

Parity check .....

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.....

.....

Check digit .....

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.....

.....

Checksum .....

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.....

Automatic Repeat request (ARQ) .....

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.....

.....

[8]

**7** Computer A is communicating with computer B.

**(a)** Draw an arrow or arrows to show simplex, duplex and half-duplex data transmission. The **direction** of the data transmission must be fully **labelled**.

**Simplex data transmission**


**Duplex data transmission**


**Half-duplex data transmission**


[6]

**2.1, 2.2 & 2.3 – Data Transmission**
**QUESTIONS**

3 **Five** computer terms and **seven** descriptions are shown below.

Draw a line to connect each computer term to its correct description.

| Computer term | Description |
| --- | --- |
| Serial, simplex data transmission | Several bits of data sent down several wires, in both directions, but not at the same time |
| | Several bits of data sent down several wires, in both directions, at the same time |
| Parallel, half-duplex data transmission | An even or odd number of bits set to 1 in a byte, used to check if the byte has been transmitted correctly |
| Parity check | One bit sent at a time, over a single wire in one direction only |
| | An additional digit placed at the end of a number to check if the number has been entered correctly |
| Automatic repeat request (ARQ) | A value transmitted at the end of a block of data; it is calculated using the other elements in the data stream and is used to check for transmission errors |
| Checksum | An error detection method that uses response and time out when transmitting data; if a response is not sent back to the sender in an agreed amount of time, then the data is re-sent |

[5]

**7** Complete the statements about data packets and packet switching.

Use the terms from the list.

Some of the terms in the list will **not** be used. You should only use a term once.

destination address  first  footer  header

last  main data  packets  payload

routers  servers  trailer

Data is broken down into packets. A data packet has a packet ..... that contains the packet number and the ..... .

Each packet could take a different path from the sender to the receiver; this is controlled by ..... .

Packets may arrive out of order. Once the ..... packet has arrived, the packets are reordered.

[4]