Data Transmission

2.2 Methods of error detection

1 Parity checks are often used to check for errors that may occur during data transmission.

(a) A system uses **even parity**.

Tick (✓) to show whether the following three bytes have been transmitted correctly or incorrectly.

Received byte	Byte transmitted correctly	Byte transmitted incorrectly
1 1 0 0 1 0 0 0		
0 1 1 1 1 1 0 0		
0 1 1 0 1 0 0 1		

[3]

(b) A parity byte is used to identify which bit has been transmitted incorrectly in a block of data.

The word "F L O W C H A R T" was transmitted using nine bytes of data (one byte per character). A tenth byte, the parity byte, was also transmitted.

The following block of data shows all ten bytes received after transmission. The system uses **even parity** and column 1 is the parity bit.

	letter	column 1	column 2	column 3	column 4	column 5	column 6	column 7	column 8
byte 1	F	1	0	1	0	0	1	1	0
byte 2	L	1	0	1	0	1	1	0	0
byte 3	O	1	0	1	0	1	1	1	1
byte 4	W	1	0	1	1	0	1	1	1
byte 5	C	1	0	1	0	0	0	1	1
byte 6	H	0	0	1	0	1	0	0	0
byte 7	A	0	0	1	0	0	1	0	1
byte 8	R	1	0	1	1	0	0	1	0
byte 9	T	1	0	1	1	0	1	0	0
parity byte		1	0	1	1	1	1	1	0

(i) **One** of the bits has been transmitted incorrectly.

Write the byte number and column number of this bit:

Byte number .....

Column number .....

[2]

(ii) Explain how you arrived at your answer for **part (b)(i)**.

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.....[2]

(c) Give the denary (base 10) value of the byte: **1 0 1 1 1 1 1 0**

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.....[1]

(d) A parity check may not identify that a bit has been transmitted incorrectly.

Describe **one** situation in which this could occur.

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.....[1]

2 Parity checks are used to check for errors during data transmission. A system uses **odd** parity.

(a) Complete the following two bytes of data so that they both have **odd** parity:

	1	1	1	1	0	0	0
	0	0	0	0	1	1	1

[2]

(b) Name and describe another method which can be used to check whether data has been correctly transmitted.

Name of method .....

Description .....

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[2]

3 **(a)** Check digits are used to ensure the accuracy of input data.

A 7-digit code number has an extra digit on the right, called the check digit.

Digit position	1	2	3	4	5	6	7	8
Digit	–	–	–	–	–	–	–	–

The check digit is calculated as follows:

- each digit in the number is multiplied by its digit position
- the seven results are then added together
- this total is divided by 11
- the remainder gives the check digit (if the remainder = 10, the check digit is X)

(i) Calculate the check digit for the following code number. Show all your working.

4 2 4 1 5 0 8 …

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Check digit .....

[2]

(ii) An operator has just keyed in the following code number:

3 2 4 0 0 4 5 X

Has the operator correctly keyed in the code number?

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Give a reason for your answer.

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(b) When data are transmitted from one device to another, a parity check is often carried out on each byte of data. The parity bit is often the leftmost bit in the byte.

(i) If a system uses even parity, give the parity bit for each of the following bytes:

parity bit

	1	**1**	**0**	**0**	**1**	**1**	**0**

parity bit

	0	**0**	**0**	**0**	**0**	**0**	**1**

[2]

(ii) A parity check can often detect corruption of a byte.

Describe a situation in which it **cannot** detect corruption of a byte.

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.....[1]

4 Check digits are used to ensure the accuracy of entered data.

A 7-digit number has an extra digit on the right, called the check digit.

digit position:	1	2	3	4	5	6	7	8
digit:	–	–	–	–	–	–	–	–

check digit

The check digit is calculated as follows:

- each digit in the number is multiplied by its digit position
- the seven results are then added together
- this total is divided by 11
- the remainder gives the check digit (if the remainder = 10, the check digit is X)

(a) Calculate the check digit for the following number. Show all your working.

4 2 4 1 5 0 8 ...

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Check digit .....

[2]

(b) An operator has just keyed in the following number:

3 2 4 0 0 4 5 X

Circle below **correct** if the check digit is correct **OR incorrect** if the check digit is incorrect.

correct **incorrect**

Explain your answer.

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[3]

5 **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

6 When eight bytes of data have been collected, they are transmitted to a computer 100 km away. Parity checks are carried out to identify if the data has been transmitted correctly. The system uses **even parity** and column 1 is the parity bit.

The eight bytes of data are sent together with a ninth parity byte:

	parity bit	**column 2**	**column 3**	**column 4**	**column 5**	**column 6**	**column 7**	**column 8**
byte 1	1	0	0	0	0	1	0	0
byte 2	1	1	1	1	0	0	1	1
byte 3	0	1	0	0	1	0	0	0
byte 4	0	1	1	1	0	0	0	1
byte 5	1	0	0	0	1	1	1	1
byte 6	0	0	0	0	0	0	0	0
byte 7	1	1	1	0	1	0	0	0
byte 8	1	0	0	0	1	1	1	0
parity byte	1	0	1	1	0	1	1	1

(i) Identify which of the eight bytes contains an error.

byte .....[1]

(ii) Identify which column contains an error.

column .....[1]

(iii) The incorrect bit is indicated where the byte number and column cross.

Give the corrected byte.

[1]

(iv) Calculate the denary value of the corrected byte.

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(v) Considering the fault condition given in **part (c)**, explain why it is very important that the incorrect bit is located and corrected.

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.....[2]

7 Nine bytes of data are transmitted from one computer to another. Even parity is used. An additional parity byte is also sent.

The ten bytes arrive at the destination computer as follows:

	parity bit	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7	bit 8
byte 1	1	1	1	0	1	1	1	0
byte 2	0	0	0	0	0	1	0	1
byte 3	0	1	1	1	1	0	0	0
byte 4	1	1	0	0	0	0	0	0
byte 5	1	0	1	1	1	1	1	0
byte 6	0	1	0	1	1	0	0	1
byte 7	0	1	1	1	0	0	1	1
byte 8	0	0	1	1	0	1	1	0
byte 9	1	1	0	0	0	0	1	1
parity byte	0	0	1	0	0	0	1	0

One of the bits was corrupted during the data transmission.

(a) **Circle** the corrupt bit in the corrupt byte in the table above. [1]

(b) Explain how the corrupted bit was found.

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.....[2]

8 (a) Parity checks are often used to detect errors that may occur during data transmission.

The received bytes in the table below were transmitted using **odd parity**.

Tick (✓) to show whether each byte has been **corrupted during transmission** or **not corrupted during transmission**.

Received byte	corrupted during transmission (✓)	not corrupted during transmission (✓)
10110100		
01101101		
10000001		

[3]

(b) Another method of error detection is Automatic Repeat reQuest (ARQ).

Explain how ARQ is used in error detection.

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..... [4]

9 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]

10 The three binary numbers in the registers A, B and C have been transmitted from one computer to another.

	Parity bit							
Register A	1	0	0	1	1	0	0	0
Register B	0	1	1	0	0	1	1	1
Register C	1	0	0	1	1	0	0	1

One binary number has been transmitted incorrectly. This is identified through the use of a parity bit.

Identify which register contains the binary number that has been transmitted **incorrectly**. Explain the reason for your choice.

The binary number that has been transmitted incorrectly is in **Register** .....

Explanation .....

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[4]

11 The three binary numbers in the registers X, Y and Z have been transmitted from one computer to another.

								Parity bit
Register X	1	0	0	1	0	0	1	0
Register Y	1	1	1	0	0	1	1	1
Register Z	1	1	1	0	1	0	0	1

Only **one** binary number has been transmitted correctly. This is identified through the use of a parity bit.

Identify which register contains the binary number that has been transmitted **correctly**. Explain the reason for your choice.

The binary number that has been transmitted correctly is in **Register** .....

Explanation .....

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[4]

12 Data can sometimes be corrupted when it is transmitted from one computer to another, causing errors to be present in the data.

Identify and describe **three** methods of error detection that could be used to see if an error has occurred.

Error detection method 1 .....

Description .....

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Error detection method 2 .....

Description .....

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Error detection method 3 .....

Description.....

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[9]

13 Parity checks and Automatic Repeat reQuests (ARQ) can be used to check for errors during data transmission and storage.

(a) A system uses **even parity**. Write the appropriate parity bit for each byte.

Parity Bit							
	1	0	1	0	0	1	1
	1	0	1	1	1	1	1
	1	0	1	0	0	0	1

[2]

(b) Explain how Automatic Repeat reQuests (ARQ) are used in data transmission and storage.

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.....[2]

(c) State **one** other method that could be used to check for transmission errors.

.....[1]

14 The contents of three binary registers have been transmitted from one computer to another. **Even parity** has been used as an error detection method.

The outcome after transmission is:

Register A and **Register C** have been transmitted **correctly**.

Register B has been transmitted **incorrectly**.

Complete the **Parity bit** for each register to show the given outcome.

	Parity bit							
Register A		0	1	0	0	1	0	1
Register B		1	0	0	0	0	0	1
Register C		1	0	0	0	0	1	1

[3]

15 The three binary numbers in the registers given have been transmitted from one computer to another.

One binary number has been transmitted incorrectly. This can be identified by the use of a **Parity bit**.

Identify the binary number that has been transmitted **incorrectly**. Explain how you identified the incorrect binary number.

	Parity bit							
Register A	1	0	1	1	1	0	0	1
Register B	1	1	1	0	0	1	1	1
Register C	1	0	0	1	1	0	1	1

The binary number that has been transmitted incorrectly is in **Register** .....

Explanation .....

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..... [4]

16 Data is valuable to a company.

(a) Companies use error detection methods to make sure that data is accurate.

One error detection method is the use of a check digit.

Explain what is meant by a check digit and how it is used to detect errors.

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..... [4]

(b) Companies can use a range of security methods to keep their data secure.

Identify **two** security methods that a company can use to keep their data secure **and** explain how each method can keep the data secure.

Security method 1 .....

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Security method 2 .....

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[6]

17 The contents of three binary registers have been transmitted from one computer to another. **Odd parity** has been used as an error detection method.

The outcome after transmission is:

- **Register A** and **Register B** have been transmitted **correctly**.
- **Register C** has been transmitted **incorrectly**.

Write the appropriate **Parity bit** for each register to show the given outcome.

	Parity bit							
Register A		0	1	0	0	0	1	1
Register B		0	0	0	0	1	1	1
Register C		0	0	0	0	0	1	1

[3]

18 Two error detection methods that Allison's computer uses are check digit and checksum.

(a) Give **two** similarities between the check digit and checksum methods.

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2 .....

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[2]

(b) Identify **one other** error detection method that Allison's computer could use.

Describe how the method checks for errors.

Method .....

Description .....

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[4]

19 Victoria is entering data into a computer system. The data will be transmitted to cloud storage.

(a) An even parity check is used to check for errors in the binary values after transmission.

For each of the **7-bit binary values**, write the **Parity bit** that makes sure **even** parity is met.

7-bit binary value	Parity bit
1100010	.....
1001011	.....
0100010	.....
0010111	.....

[4]

(b) Identify **two** other error checking methods that could be used to check the binary values are correct after transmission.

Method 1 .....

Method 2 .....

[2]

(c) A check digit is used to check whether data is correct when entered into the system.

Describe how a check digit can be used to make sure the data entered is correct.

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..... [4]

20 **Four** 7-bit binary values are transmitted from one computer to another. A parity bit was added to each binary value creating 8-bit binary values. All the binary values have been transmitted correctly.

(a) Tick (✓) to show whether an **Even** or an **Odd** parity check has been used for each binary value.

8-bit binary value	Even (✓)	Odd (✓)
11111111		
01100110		
01111011		
10000000		

[4]

(b) The data will also be checked using a checksum.

Describe how a checksum can be used to check that the data has been transmitted correctly.

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..... [5]

21 **Four** 7-bit binary values are transmitted from one computer to another. A parity bit was added to each binary value creating 8-bit binary values. All the binary values have been transmitted correctly.

(a) Tick (✓) to show whether an **Even** or an **Odd** parity check has been used for each binary value.

8-bit binary value	Even (✓)	Odd (✓)
10000001		
10000010		
00101001		
00101000		

[4]

(b) A parity check may not always detect errors that have occurred in data transmission.

State why a parity check may not detect data transmission errors.

..... [1]

(c) Give **one** other error checking method that could be used to check for errors in data transmission.

..... [1]

22 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.

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..... [1]

23 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.

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..... [1]

24 **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]

25 **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]

26 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]

27 **(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]

28 Errors can occur when data is transmitted.

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

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..... [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]

29 A company owner has installed a new network. Data is correct before it is transmitted across the network.

The company owner is concerned that data might have errors after transmission.

(a) Explain how the data might have errors after transmission.

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..... [3]

(b) The company owner decides to introduce an error detection system to check the data for errors after transmission.

The error detection system uses an odd parity check and a positive automatic repeat query (ARQ).

(i) Describe how the error detection system operates to check for errors.

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[8]

(ii) Give **two** other error detection methods that could be used.

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[2]

30 The table contains statements about error detection methods.

Complete the table by giving the correct error detection method for each statement.

error detection method	statement
.....	An odd or even process can be used.
.....	A value is calculated from the data, using an algorithm. This happens before and after the data is transmitted.
.....	A copy of the data is sent back to the sender by the receiver.
.....	Acknowledgement and timeout are used.
.....	A value is appended to data that has been calculated using the data. This value is checked on data entry.

[5]