2.2 Methods of error detection

Name: _____ Class: _____ Date: _____ **Total: 27 marks**

KEY WORDS parity check • echo check • checksum • parity bit • check digit

Objective

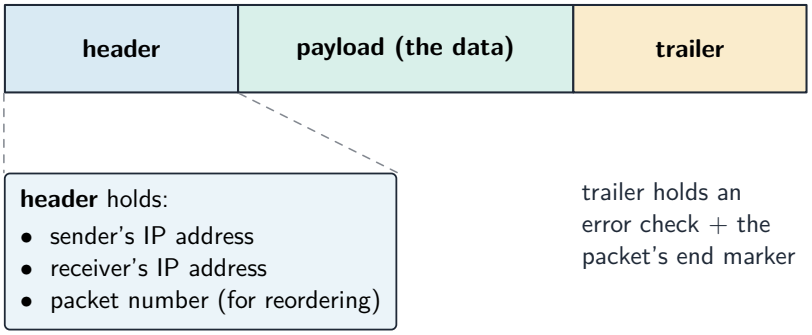
Build the skills to answer exam questions on **error detection** – **parity check**, **checksum**, **ARQ**, and **check digit**.

You must be able to:

- work out a parity bit and detect a parity error
- describe checksum, echo check and ARQ
- describe a check digit and the errors it catches

1 Key knowledge and worked examples

Parity and ARQ



The trailer carries an error check; the receiver checks the data arrived correctly

- **even parity:** total number of 1s must be even; add a parity bit to make it so.
- **ARQ:** receiver sends an acknowledgement; no positive one before the timeout → resend.

■ **Networks: name it, then say what it does**

LAN or WAN? A **local area network (LAN)** covers a small area such as one building and its cabling belongs to the owner. A **wide area network (WAN)** covers a large geographical area and uses third-party communication links; the internet is the largest WAN.

The hardware, and what each does:

Device	What it does
network interface card (NIC)	gives the device its MAC address and lets it connect
switch	joins devices on one LAN and sends a frame only to the port of the device it is addressed to, using a look-up table of MAC addresses
router	joins different networks, reads IP addresses and forwards packets towards the right network
wireless access point	lets Wi-Fi devices join the wired network
modem	converts between the computer's digital signal and the analogue signal a telephone line carries

MAC address or IP address? The **MAC address** is fixed in the hardware and identifies the device itself on the local network; it is written as six pairs of hexadecimal digits, such as `00-1C-B3-4F-25-FE`. The **IP address** identifies the device's position on a network and can change when the device moves to another network. A switch works with MAC addresses; a router works with IP addresses.

Wired or wireless? Wired is faster, more reliable and more secure, because the signal cannot be picked up outside the building; wireless allows movement, needs no cabling and is cheaper to install, but is slower, can be blocked by walls and must be encrypted with a network key.

Worked example. A school connects 30 computers in one room and links them to the internet. Which devices does it need, and why? A NIC in each computer to connect it; a switch to join the computers in the room, because it sends each frame only to the addressed device and so wastes no bandwidth; a router to connect the room's network to the internet, because it forwards packets between different networks using IP addresses; and a wireless access point if tablets must also join.

2 Practice

2.1 State what a parity bit is used for. [1]

2.2 State one error a check digit can detect. [1]

2.3 Give two differences between a LAN and a WAN. [2]

2.4 Identify the device that uses MAC addresses to send data only to the correct port, and the device that connects two different networks. [2]

2.5 Give two advantages of a wired connection over a wireless one. [2]

3 Exam-style questions

3.1 Using **even** parity, the parity bit for the data `1101001` is: [1]

- ☐ **A** 0
- **B** 1
- **C** either
- **D** none

3.2 Data is checked using a checksum.

(a) Describe how a checksum detects an error. [2]

(b) Explain why a parity check might fail to detect an error. [2]

3.3 Describe how Automatic Repeat reQuest (ARQ) ensures data arrives correctly. [2]

3.4 A small office has eight computers, a printer and an internet connection.

(a) Identify the type of network the eight computers form, and justify your answer. [2]

(b) Complete the table by naming the device that performs each task. [3]

Task	**Device**
gives each computer a MAC address and connects it to the network	
sends data only to the port of the computer it is addressed to	
connects the office network to the internet	

(c) Explain the difference between a MAC address and an IP address. [3]

(d) The office adds Wi-Fi for visitors' laptops. Give one benefit and one drawback compared with wired connections. [2]

(e) Explain why the Wi-Fi should use a network key. [2]

Solutions

Each answer shows the steps, then the **result**.

2.1

- extra bit added to a byte so the receiver can check it
- used **to detect an error after transmission**

2.2

- a check digit is calculated from the other digits
- any **one** of: an **incorrect digit** / a **transposition** / a **missing or extra digit**

2.3

- any **two** of: LAN is one building / WAN is a large area; LAN cabling belongs to the owner / WAN uses third-party links; a LAN is usually faster

2.4

- sends data only to the correct port: **switch**
- connects two different networks: **router**

2.5

- any **two** of: faster / more reliable (fewer dropouts) / more secure (signal cannot be picked up outside)

3.1 A

- `1101001` has four 1s, already even, so the even-parity bit is **0**
- B would make the count odd; C and D are not how even parity works

3.2

(a)

- checksum is calculated before sending and again at the receiver
- if the two values **differ**, an error has occurred

(b)

- if two bits flip, the number of 1s may still be even (or odd) as required
- the parity check **passes despite the error**

3.3

- the receiver sends a positive or negative acknowledgement
- if the sender gets **no positive ACK before a timeout**, it **resends** the packet

3.4

(a)

- eight computers in one building, office owns the cabling

- **LAN**

(b)

- MAC address and join the network: **NIC**
- send data only to the addressed port: **switch**
- connect the office to the internet: **router**

(c)

- **MAC**: fixed in the hardware by the manufacturer; identifies the device
- **IP**: identifies where the device is on a network and can change
- a switch uses MAC addresses inside the LAN; a router uses IP addresses between networks

(d)

- benefit: visitors can **move around** and need no cabling
- drawback: **slower or less secure**, and walls can weaken the signal

(e)

- without a key, anyone in range could join
- the key **encrypts** the traffic and **keeps outsiders out**