# Error checking

Bits can change during transmission owing to interference. Computers use a variety of systems to verify that the data they receive is actually the same as the data that was sent.

You will need to know how the following methods work

* Parity Bits
* Majority voting
* Checksums
* Cyclic redundancy check

## Parity bits

|  |  |  |
| --- | --- | --- |
| **Word bank** | | |
| represented | ASCII | Parity bit |
| Check | odd | even |
| transmitted | bit | Most significant bit |

A parity bit is an additional ............ that is used to ............ that the other bits ............ are likely to be correct. Using 7-bit ............ with an 8-bit system meant that there was an extra bit available. This was used as a .............

Computers use either ............ or ............ parity and the parity bit is used to ensure that the total number of 1s in each byte, including the parity bit, equals an odd or even number, for example an **R** is ............ by 1010010 in 7-bit ASCII:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | 1 | 0 | 1 | 0 | 0 | 1 | 0 |

Using odd parity, the parity bit above is the ............ and becomes 0 to make the total number of 1s an odd number – in this case 3. Using even parity, the parity bit would have been set to 1.

### Question

What would be the parity bit value for the following using odd parity?

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 0 | 1 | 0 | 1 | 1 | 0 |

## Majority voting

|  |  |  |
| --- | --- | --- |
| **Word bank** | | |
| bit | recipient | majority |
| three | flipped | changed |

Majority voting is a system that required each bit to be sent ............ times. If a ............ value is ............ during transmission over a noisy line, the ............ computer would use the ............ rule and assume that the two bits that have not ............ were therefore correct.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | | | 0 | | | 1 | | | 0 | | | 0 | | | 1 | | | 1 | | | 0 | | |
| 0 | 0 | **1** | 0 | 0 | 0 | 1 | 1 | **0** | 0 | 0 | 0 | **1** | 0 | 0 | 1 | 1 | 1 | 1 | **0** | 1 | 0 | 0 | 0 |

### Question

Assuming 010 011 110 010 000 110 111 100 is received, what value would be accepted?

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |

## Checksums

|  |  |  |
| --- | --- | --- |
| **Word bank** | | |
| packet | applied | match |
| transmitted | algorithm | again |

A checksum is a mathematical ............ that is applied to a “unit” or ............ of data, for example a block of 256 bytes. The data in the block is used to create a checksum value which is ............ with the block. The same algorithm is ............ to the block after transmission and if the two checksums ............, the transmission is deemed to have been successful. If they do not match, an error must have occurred during transmission and the block should be transmitted .............

A simple example of a checksum algorithm is to add together all of the numerical values of each byte in the block. If any bits change, it is likely but not guaranteed to change the checksum and the block should be resent. In this short block of 3 bytes, the checksum would be 114 i.e. 51 + 43 + 20.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 51 | | | | | | | | 43 | | | | | | | | 20 | | | | | | | |
| 114 | | | | | | | | | | | | | | | | | | | | | | | |

## Cyclic redundancy check (CRC)

|  |  |  |
| --- | --- | --- |
| **Word bank** | | |
| polynomials | remainder | codewords |
| division | calculates | sending |

CRC is a different approach to detect if the received frame contains valid data. This technique involves binary ............ of the data bits being sent. The divisor is generated using ............. The sender performs a division operation on the bits being sent and ............ the ............. Before ............ the actual bits, the sender adds the remainder at the end of the actual bits. Actual data bits plus the remainder is called a codeword. The sender transmits data bits as .............

### Question

* A “majority voting” system of error checking is used to transmit data, with each bit being sent three times. What will be the final bit pattern received by the user if the following bit pattern is transmitted

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |

* Name one disadvantage of the majority voting system for transmitting data
* Explain, with the aid of an example, how an even parity system of error checking works when transmitting data