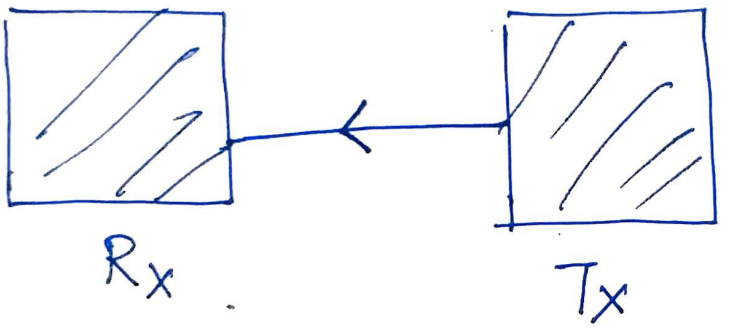
Parity

↳ It is a concept to detect errors

↳ A single bit error is detected by it.

↳ For more than one bit parity is not used



↳ Let the signal be 4 bit, which is transmitted, so it will have error or noise

↳ So parity is an extra bit send with the signal

↳ This extra bit tells as the total no. of 1s

0100 → no. of 1s is 1

Tx signal

↳

Parity

odd parity

even parity

Ex:-

0100 1

original signal — Parity bit

0100 1 → even parity

The overall signal should be even no. of 1's are even.

1100 0 (Even Parity)

Signal

In this whole signal is even.

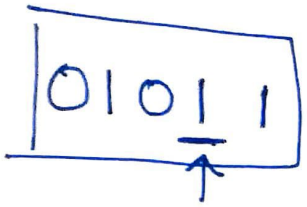
* Odd Parity

0100 0 → overall signal is odd

odd parity

1100 1 overall signal is odd

If signal 0 1 0 0 1 (P), has a noise added



CRx but the parity bit is even but Rx signal is odd parity so there is an error.

Hamming Code

H.W

Assign the proper even parity bit to the following

a) 1010 b) 111000 c) 101101

d) 1000111001001 e) 101101011111

Q

even all the above questions can be solved for odd parity.

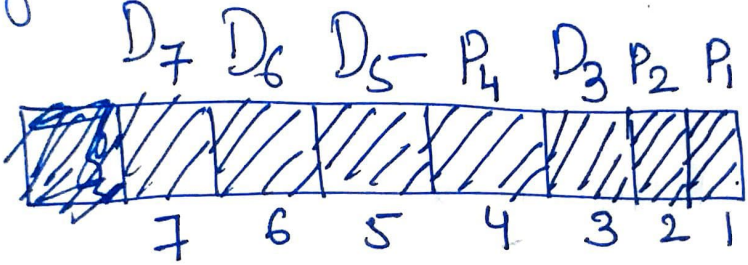
Hamming Code | Error Detection

↳ Given by R.W. Hamming

↳ Easy to implement

↳ 7-bit Hamming Code is used commonly

↳ Tx & Rx data when transmitted through a channel detects noise or gets noise effect the signal.



Rules

1) Data bits :- data bits. (4) bits

2) Parity bits (Extra bit sent along with data bit to detect error)

(3) bits

For 7 bits — 4 (data bits)

— 3 (parity bit)

$2^P \geq m + P + 1$

m → Data bit

P = parity bit

2^n {where $n = 0, 1, \cdots n$} position of parity bits

$2^0 = 1$ $n = 0$

$2^1 = 2$ $n = 1$

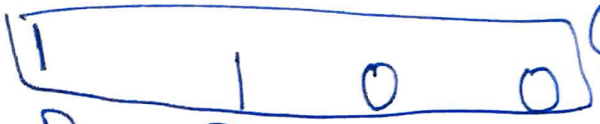
$2^2 = 4$ $n = 2$

$n = 3 = 2^3 = 8$ (bits are more than 7)

Rest bits are data bits

$P_1 \rightarrow D_3\ D_5\ D_7$

For Ex:- Even Parity

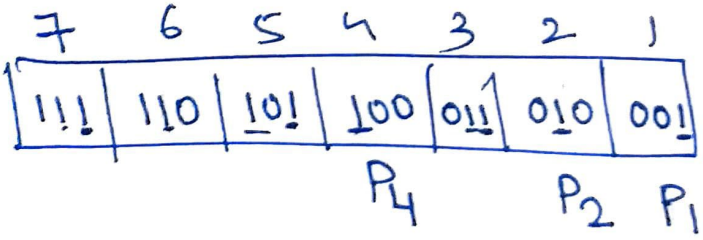


→ even

$P_1 \rightarrow D_3\ D_5\ D_7$

$P_2 \rightarrow D_3\ D_6\ D_7$

$P_3 \rightarrow D_5\ D_6\ D_7$

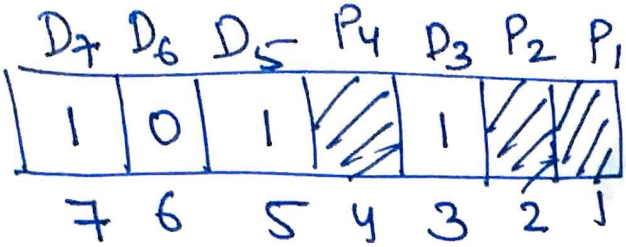


$P_1 \rightarrow 1 \oplus 3 \oplus 5 \oplus 7 \longrightarrow 3, 5, 7$

$P_2 \rightarrow 2 \oplus 3 \oplus 6 \oplus 7 \rightarrow 3, 6, 7$

$P_4 \rightarrow 4 \oplus 5 \oplus 6 \oplus 7 \rightarrow 5, 6, 7$

Ex:- 1011, Transfer with even parity



$P_1 \rightarrow$ 3 5 7

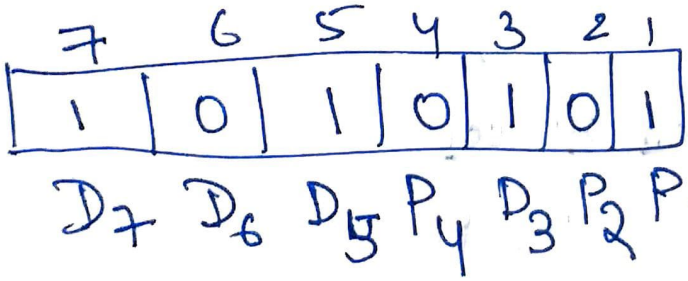
1 1 1 1

$P_2 \rightarrow$ 3 6 7

0 1 0 1

$P_3 \rightarrow$ 5 6 7

0 1 0 1



→ Data send

If noise is added.

D7 P6 P5 D3

1 1 1 0 1 0 1 (Rx signal)

P4 P2 P1

$P_1 \rightarrow$ 3 5 7

1 1 1 1 ✓

$P_2 =$ 3 6 7

0 1 1 1 x

$P_4 \rightarrow$ 5 6 7

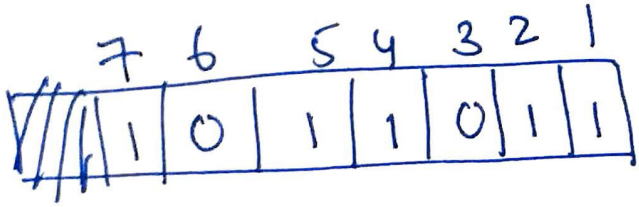
0 1 1 1 ✗

So error is recognized

Hamming Code - Error Correction

Ex:- If the 7 bit Hamming Code word received by the receiver is 1011011 Assuming the even parity state, whether the received code word is correct, wrong If wrong locate the bit having error.

Soln:-



P_1

P_1 3 5 7

1 0 1 1

↓

odd parity which is wrong

$P_1 = 1$

P_2

P_2 = 3 6 7

1 0 0 1

even parity

$P_2 = 0$

$P_4 = 1$

5 6, 7

1 0 1

P_4 = 5 6 7

1 1 0 1 → odd parity

P_4 has error

So make $P_4 = 1$

P_4 P_2 P_1

$(1\ 0\ 1)_2 = 5$ (So 5th bit is having error)

7 6 5 4 3 2 1

1 0 0 1 0 1 1. Correct code send by sender

H.W

a) A 7 bit hamming code is 0101101. Having ~~even~~ odd parity, check whether the code is correct or not and detect the error

b)