CS & IT ENGINEERING

COMPUTER NETWORKS

Error Control

Lecture No-8

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TOPICS TO BE COVERED

- Hamming code

Problem Solving on Hamming Code

Q.1 If a 7 bit hamming code word received by receiver is 1011011. assume even parity state whether the received code word is correct or not ?if it is incorrect then locate the bit having error.

P_1	P_2	3	P_4	5	6	7
1	0	1	1	0	1	1

P_1

1 3 5 7

1 1 0 1 → odd ($P_1 = 1$)

P_2

2 3 6 7

0 1 1 1 → odd ($P_2 = 1$)

P_4

4 5 6 7

1 0 1 1 → odd ($P_4 = 1$)

P_4	P_2	P_1
1	1	1

1 1 1 → Non zero means error

↓ d.val

7th bit got corrupted

Q.2 Assume that a 12-bit Hamming codeword consisting of 8-bit data and 4 check bits is $d_8d_7d_6d_5c_8d_4d_3d_2c_4d_1c_2c_1$, where the data bits and check bits are given in

GATE-2021 (2m)

Data bits							
d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1
1	1	0	x	0	1	0	1

Check bits			
c_8	c_4	c_2	c_1
y	0	1	0

Which one of the following choices gives the correct values of x and y?

A. x is 1 and y is 0

B. x is 1 and y is 1

C. x is 0 and y is 0

D. x is 0 and y is 1

c_1	c_2	3	c_4	5	6	7	c_8	9	10	11	12
0	1	1	0	0	1	0	y	x	0	1	1

c_1

1	3	5	7	9	11
0	1	0	0	x	1

$x = 0$ (For even parity)

c_2

2	3	6	7	10	11
1	1	1	0	0	1 → even

(even Parity)

c_4

4	5	6	7	12
0	0	1	0	1 → even

c_8

8	9	10	11	12
y	x	0	1	1
y	0	0	1	1

$y = 0$ (For even parity)

Q.3 Consider hamming code (Signal bit error detection and correction technique), the minimum parity bits needed for 60 data bits is 7.

$m = 60$

$$\boxed{m + r + 1 \le 2^r}$$

$r = 6 \Rightarrow 60 + 6 + 1 \le 2^6$, $67 \le 64$ (No)

$r = 7 \Rightarrow 60 + 7 + 1 \le 2^7$, $68 \le 128$ (yes)

$$\boxed{r = 7}$$

Q.4 For single bit error correcting hamming code ,the code length for 12 data bit is 17

$m = 12$, code length $(n) = m + r = 12 + 5 = 17$

$$\boxed{m + r + 1 \le 2^r}$$

$r = 4 \rightarrow 12 + 4 + 1 \le 2^4$, $17 \le 16$ (No)

$r = 5 \rightarrow 12 + 5 + 1 \le 2^5$, $18 \le 32$ (yes)

$r = 5$

Q.5 After encoding using Hamming method, the pattern for 1010111 is ~~(consider Even Parity)~~

1 2 3 4 5 6 7 8 9 10 11

A. 10110101111

B. 1011$\boxed{1}$101111

C. 11110101111

D. 10011101111

message (m) = 1010111, m = 7 bit

$$\boxed{m+r+1 \le 2^r}$$

$r=3 \rightarrow 7+3+1 \le 2^3$, $11 \le 8$ (No)

$r=4 \rightarrow 7+4+1 \le 2^4$, $12 \le 16$ (yes)

$$\boxed{r=4}$$

Transmitted data (n) = m + r = 7 + 4 = 11 bit

P_1	P_2	3	P_4	5	6	7	P_8	9	10	11
1	0	1	1	0	1	0	1	1	1	1

Transmitted data = 10110101111

P_1

1	3	5	7	9	11
$\boxed{1}$	1	0	0	1	1

P_4

4	5	6	7
$\boxed{1}$	0	1	0

P_2

2	3	6	7	10	11
$\boxed{0}$	1	1	0	1	1

P_8

8	9	10	11
$\boxed{1}$	1	1	1

Note

"odd Parity is preferable over even Parity"

Q.6 Identify valid 7 bit hamming code.(by using odd parity)

A. 0110011

B. 1011011

C. Both A & B

D. None of these

(a)

P_1	P_2	3	P_4	5	6	7
0	1	1	0	0	1	1

$\underline{P_1}$

1 3 5 7

0 1 0 1 → even

$\underline{P_2}$

2 3 6 7

1 1 1 1 → even

$\underline{P_4}$

4 5 6 7

0 0 1 1 → even

(b)

P_1	P_2	3	P_4	5	6	7
1	0	1	1	0	1	1

$\underline{P_1}$

1 3 5 7

1 1 0 1 → odd

$\underline{P_2}$

2 3 6 7

0 1 1 1 → odd

$\underline{P_4}$

4 5 6 7

1 0 1 1 → odd

Checksum

Checksum = (4 bit, 8 bit, 16 bit, 32 bit)

$\downarrow$

(TCP|IP)

Let us assume checksum = 4 bit

data = 0111 | 1011 | 1100 | 0000 | 0110 |

0111	1011	1100	0000	0110
7	11	12	0	6

checksum = 7 + 11 + 12 + 0 + 6 = 36

checksum = 4 bit

(1) Transmitted data = | 01111011110000000110 | 36 |

checksum = 4 bit

(2) Transmitted data = | 01111011110000000110 | -36 |

$\cancel{36} - \cancel{36} = 0$ (No error)

$\text{checksum} = 4\text{ bit} \xrightarrow{\text{max. No}} 1111 \rightarrow 15$

$\text{checksum} = 36 = \boxed{10}0100$

$\quad\quad\quad\quad\quad\quad\quad\quad + 10$

$\quad\quad\quad\quad\quad\quad\quad 0110 \rightarrow 6$

$(9) \leftarrow 1001$ 1's complement

checksum = 4 bit

Transmitted data = 01111011110000000110 | 1001

If Receiver Received uncorrupted data

Received data = | 0111 | 1011 | 1100 | 0000 | 0110 | 1001 |

7	11	12	0	6	9

$7+11+12+0+6+9 = 45 = \boxed{10}1101$

$$\begin{array}{r} 1101 \\ +\ 10 \\ \hline 1111 \\ \hline 0000 \\ \hline \end{array}$$

1's complement

zero means No error

Q

Suppose that a message 1001 1100 1010 0011 is transmitted using internet checksum (4-bit word). What is the value of the checksum in binary?

H.W

Ans: 1011

9PM