Paper 7, TDC Part-3
Chapter– 3, Number Systems and Codes
Electronics
Lecture - 11

By:

Mayank Mausam

Assistant Professor (Guest Faculty)

Department of Electronics

L.S. College, BRA Bihar University,

Muzaffarpur, Bihar

Example (3) Construct Hamming code for BCD 1001. Use odd parity.

Solution :->

Again $m = 4$ so $k = 3$

i.e.

	p_1	p_2	m_1	p_3	m_2	m_3	m_4
	1	2	3	4	5	6	7
BCD Code			1		0	0	1

$p_1 =$ '1' will make odd parity at position 1, 3, 5, 7

$p_2 =$ '1' " " " " " " 2, 3, 6, 7

$p_3 =$ '0' " " " " " " 4, 5, 6, 7

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Required Hamming Code for BCD Code 1001 ~~for~~ with odd parity,

"1110001"

Example(4) If the Hamming Code sequence "1100110" is transmitted and due to error in one position, is recieved as "1110110". Locate the position of the error bit using parity checks and give the method for obtaining the correct sequence

Soln:-

The received message code is

p_1	p_2	m_1	p_3	m_2	m_3	m_4
1	2	3	4	5	6	7
1	1	1	0	1	1	0

parity check for (4, 5, 6, 7) position gives $C_1 = 0$ (even parity)

IIIly " " " (2, 3, 6, 7) " " $C_2 = 1$ (odd parity)

IIIly " " " (1, 3, 5, 7) " " $C_3 = 1$ (odd parity).

Therefore, the position number formed is $c_1 c_2 c_3 = 011$, which means that the location of the error is in position 3. To correct the error the bit received in location 3, is complemented and the correct message 1100110 is received.

xample(3.)10) Find the distance between the BCD digits 0110 and 0111.

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(b) Determine Hamming codes for 0110 and 0111 and find the distance between them. Use even parity.

Soln (a) Distance between BCD digits "0110" & "0111" is — '1'.

(b) Hamming codes for these are as :-
For even parity.

BCD Code	Hamming Code						
	p_1	p_2	m_1	p_3	m_2	m_3	m_4
	1	2	3	4	5	6	7
0 1 1 0	1	1	0	0	1	1	0
0 1 1 1	0	0	0	1	1	1	1

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The Hamming codes differ in position (1, 2, 4 and 7) so the distance between these 2 codewords is '4'.

Example (6) Some 8-4-2-1 code words are transmitted in Hamming code with even parity checking. The following words are received.

(a) 0 1 0 1 0 0 0 (b) 0 0 1 1 1 0 1
(c) 1 1 0 0 1 0 0 (d) 1 1 0 0 1 1 0
(e) 1 1 1 0 0 1 1 (f) 1 1 1 1 0 0 1
(g) 1 1 0 1 0 0 1 (h) 1 0 0 0 0 1 0

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The Hamming codes differ in position (1, 2, 4 and 7) so the distance between these 2 codewords is '4'.

Example (6) Some 8-4-2-1 code words are transmitted in Hamming code with even parity checking. The following words are received.

(a) 0101000 (b) 0011101
(c) 1100100 (d) 1100110
(e) 1110011 (f) 1111001
(g) 1101001 (h) 1000010

parity checks in positions 2, 3, 6, 7 for C_2

" " " " 1, 3, 5, 7 " C_3

for.

(a) 0 1 0 1 0 0 0.

~~The error position $C_1 C_2 C_3$ =~~

$C_1 = 1$ (odd parity) $C_2 = 1$ (odd parity)

$C_3 = 0$ (even ")

Error position $C_1 C_2 C_3 = 1\,1\,0 = (6)$

wrong bit

0 1 0 1 0 0 0 → wrong message, its correct message is "0 1 0 1 0 1 0", so correct code is "0 0 1 0" $= (2)_{10}$

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$= (2)_{10}$

(b) 0 0 1 1 1 0 1

$C_1 = 1$ (Odd) $C_2 = 0$ (even) $C_3 = 1$ (Odd)

Error position $C_1 C_2 C_3 : 101 = (5)_{10}$

So correct message is "0011001"

" " code is "1001" $= (9)_{10}$

(c) 1 1 0 0 1 0 0

$C_1 = 1$ (Odd) $C_2 = 1$ (Odd) $C_3 = 0$ (even)

Error position is $C_1 C_2 C_3 : 110 = (6)_{10}$

So correct message is "1100110" hence

" code is "0110" $= (6)_{10}$

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(d) 1 1 0 0 1 1 0

$C_1 = 0$ (Even) $C_2 = 0$ (Even) $C_3 = 0$ (Even)

Error position is $C_1 C_2 C_3 = 000 = (0)_{10}$

No error code received is correct.

The code is $(0110) = (6)_{10}$

(e) 1 1 1 0 0 1 1

$C_1 = 0$ (Even) $C_2 = 0$ (Even) $C_3 = 1$ (Odd)

Error position is $C_1 C_2 C_3 = 001 = (1)_{10}$

That is correct message is "0110011" so code is 1011 but this is not a valid 8-4-2-1 (BCD) code because it is greater than $(9)_{10}$ so there is error in more position, which can not be corrected and determin

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(h) 1 0 0 0 0 1 0

$C_1 = 1$ (odd) $C_2 = 1$ (odd) $C_3 = 1$ (odd)

Error position is $C_1C_2C_3 = (111)_2 = (7)_{10}$

Correct message is "1000011" so correct c
is "0011" $= (3)_{10}$

Example (7) For ASCII code

(a) Determine the number of parity bits which must be appended to the co
to make it an error-correcting cod
Hamming code.

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(b) Determine the location of parity bits.

Soln:- (a) For ASCII code $n = 7$, so require no. of parity bits (k) can be find out using formula

$$2^k \geq k + n + 1 = k + 7 + 1 = k + 8$$

i.e. $2^k \geq k + 8$

for $k = 3$ we have, $2^3 = 8 \leq 3 + 8 = 11$

$$8 < 11$$

So $k = 3$ is not correct,

Now for, $k = 4$ we have,

$$2^4 = 16 > 4 + 8 = 12$$

$$16 > 12$$

So required number of parity bits to

to append the ASCII code is '4'.

b) ~~Parity~~ The position of parity bits to append the ASCII code is $2^0, 2^1, 2^2, 2^3$ i.e 1, 2, 4, 8 i.e. as below.

p_1	p_2	n_1	p_3	n_2	n_3	n_4	p_4	n_5	n_6	n_7
1	2	3	4	5	6	7	8	9	10	11

Error Position	Position Number
	C_1 C_2 C_3 C_4

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Error Position	Position Number			
	C_1	C_2	C_3	C_4
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1

For P_1

For P_2

For P_3

For P_4

P_1 is selected to establish parity in positions 1, 3, 5, 7, 9, 11

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IIly p_2 is selected to establish parity in positions 2, 3, 6, 7, 10, 11

IIly p_3 for position 4, 5, 6, 7
" p_4 " " 8, 9, 10, 11

Error occurs in positions
C_1 for 8, 9, 10, 11
C_2 for 4, 5, 6, 7
C_3 " 2, 3, 6, 7, 10, 11
C_4 " 1, 3, 5, 7, 9, 11

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Refer book- Modern Digital Electronics by RP Jain.

Thank You