Dan Koskiranta

G00397054

Group B

Internet Technology 2

Lab 8 – Hamming coding and decoding

30 March 2023

Q. 1)

Hamming Coding

2^P >= k + P + 1

P = parity bits, k = number of information bits

In Hamming codes, the position of the parity bits is set by applying the 2^P expression.

2^0 = P1

2^1 = P2

2^2 = P4

2^3 = P8

Q. 2)

11100101011: how many data & parity bits are there?

Bit location	11	10	9	8	7	6	5	4	3	2	1
Bit designation	D11	D10	D9	P8	D7	D6	D5	P4	D3	P2	P1

k = 11

2^4 >= 11 + 4 + 1

16 >= 16

Number of parity bits is 4 and data bits is 7.

Q. 3)

The data bits for the example in Q. 2:

D11	**D10**	**D9**	**D7**	**D6**	**D5**	**D3**
1	1	1	0	1	0	0

Q. 4)

The parity bits for the example in Q2:

P8	P4	P2	P1
0	1	1	1

Q. 5)

How is each parity bit calculated? For **11100101011**

P1 = D3, D5, D7, D9, D11. You take into account every other bit and you check how many ones does this stream of bits contain. If the number of ones is even, then the parity bit value = 0. If the number of ones is odd, the parity bit value is 1.

P2 = D3, D6, D7, D10, D11. Starting from P2, you take two bits and then you skip two bits, and you continue this to the end of the block of bits. You check how many ones this stream of bits contain. Again, if the number of ones is even, the parity bit value is 0. If it's odd, the value is 1.

P4 = D5, D6, D7. Start at P4. You take four, you skip four.

P8 = D9, D10, D11. Start at P8. You take eight, you skip eight.

Q. 6) Calculate the parity bits.

Bit location	9	8	7	6	5	4	3	2	1
Bit designation	D5	**P4**	D4	D3	D2	**P3**	D1	**P2**	**P1**
Information bits	1		1	0	0		1		
Parity bits		1				1		0	1

Q. 7) Determine if there is an error in the transmission.

Bit location	9	8	7	6	5	4	3	2	1
Bit designation	D5	**P4**	D4	D3	D2	**P3**	D1	**P2**	**P1**
Received code	1	1	0	0	0	1	1	0	1

P1 = 1, 0, 0, 1. Number of ones is even, so P1 = 0. There is an error.

P2 = 1, 0, 0. Number of ones is odd, P2 = 1. There is an error.

P3 = 0, 0, 0. Number of ones 0, P3 = 0. Error

P4 = 1. Correct

Q. 8) Generate the Hamming coded data for the following 14- bit data.

01 1101 1010 0111

2^5 >= 14 + 5 + 1

32 >= 20

Bit location	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Bit designation	0	1	1	**P16**	1	0	1	1	0	1	0	**P8**	0	1	1	**P4**	1	**P2**	**P1**

P1	D3	D5	D7	D9	D11	D13	D15	D17	D19
P1	1	1	0	0	0	1	1	1	0
P2	D3	D6	D7	D10	D11	D14	D15	D18	D19
P2	1	1	0	1	0	0	1	1	0
P4	D5	D6	D7	D12	D13	D14	D15		
P4	1	1	0	1	1	0	1		
P8	D9	D10	D11	D12	D13	D14	D15		
P8	0	1	0	1	1	0	1		
P16	D17	D18	D19						
P16	1	1	0						

Number of ones for P1 is odd, so P1 = 1

P2 is odd, P2 = 1

P4 is odd, P4 = 1

P8 is 4, P8 = 0

P16 is 2, P16 = 0

Hamming coded data

19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	1	1	**0**	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1

Q. 9) If bit 7 is incorrect, recalculate the corrected Hamming code sequence

01 1101 1010 0111

19	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
0	1	1	**P16**	1	0	1	1	0	1	0	**P8**	1	1	1	**P4**	1	**P2**	**P1**

P1	D3	D5	D7	D9	D11	D13	D15	D17	D19
P1	1	1	1	0	0	1	1	0	0
P2	D3	D6	D7	D10	D11	D14	D15	D18	D19
P2	1	1	1	1	0	0	1	1	0
P4	D5	D6	D7	D12	D13	D14	D15		
P4	1	1	1	1	1	0	1		
P8	D9	D10	D11	D12	D13	D14	D15		
P8	0	1	0	1	1	0	1		
P16	D17	D18	D19						
P16	1	1	0						

P1 is odd, P1 = 1

P2 is even, P2 = 0

P4 is even, P4 = 0

P8 is even, P4 = 0

P16 is even, P16 = 0

19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	1	0	0	1	0	1	1	0	1	0	0	1	1	1	0	1	0	1

Q. 10) List advantages of Hamming encoding and decoding

Hamming encoding and decoding is a great way for detecting errors of the data received and to correct the data.

Q. 11) List disadvantages of Hamming encoding and decoding

You can’t correct multiple error bits. The requirement of transmission bandwidth is high.