**N = 7**

**1. 10110011010101011111**

1+0+1+1+0+0+1+1+0+1+0+1+0+1+0+1+1+1+1+1 = 1, значит ошибка произошла.

**2. Код Хемминга 100001111101**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **2** | 3 | **4** | 5 | 6 | 7 | **8** | 9 | 10 | 11 | 12 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |

1-й: 1+0+0+1+1+0 = 1 – ошибка

2-й: 0+0+1+1+1+0 = 1 – ошибка

4-й: 0+0+1+1+1 = 1 – ошибка

8-й: 1+1+1+0+1 = 0 – ошибки нет

Ошибка в 1+2+4 = 7 бите. Следовательно верный код Хемминга:

100001011101

**3. Исходное сообщение: 111110100000100011**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **2** | 3 | **4** | 5 | 6 | 7 | **8** | 9 | 10 | 11 | 12 | 13 | 14 | 15 | **16** | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |

1-й: 1+1+1+1+1+0+0+0+0+0+1 = 0

2-й: 1+1+1+0+1+0+0+1+0+1+1 = 1

4-й: 1+1+1+0+0+0+0+0+0+1+1 = 1

8-й: 1+0+1+0+0+0+0 = 0

16-й: 0+1+0+0+0+1+1 = 1

Таким образом, код Хемминга для исходного сообщения: 01111110101000010100011

**4. Код x1 = 0001, x2 = 0111, x3 = 0110, x4 = 1001, x5 = 0101, x6 = 1011, x7 = 1110, x8 = 0000.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **0001** | **0111** | **0110** | **1001** | **0101** | **1011** | **1110** | **0000** |
| **0001** | - | 2 | 3 | 1 | 1 | 2 | 4 | 1 |
| **0111** | 2 | - | 1 | 3 | 1 | 2 | 2 | 3 |
| **0110** | 3 | 1 | - | 4 | 2 | 3 | 1 | 2 |
| **1001** | 1 | 3 | 4 | - | 2 | 1 | 3 | 2 |
| **0101** | 1 | 1 | 2 | 2 | - | 3 | 3 | 2 |
| **1011** | 2 | 2 | 3 | 1 | 3 | - | 2 | 3 |
| **1110** | 4 | 2 | 1 | 3 | 3 | 2 | - | 3 |
| **0000** | 1 | 3 | 2 | 2 | 2 | 3 | 3 | - |

Кратчайшее расстояние – 1