

**Q. Find the Hamming code for 1011.**

sol.

let the 1st, 2nd, 3rd and a 4th bit from the left side of data be  $m_1, m_2, m_3,$  and  $m_4$ .

Total number of data bits  $m = 4$

Total number of redundant bits 'r' will be:

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

**For  $r = 1$ :**

$$2^1 \geq 4 + 1 + 1$$

$$\Rightarrow 2 \geq 6 \quad (\text{not true})$$

**For  $r = 2$ :**

$$2^2 \geq 4 + 2 + 1$$

$$\Rightarrow 4 \geq 7 \quad (\text{not true})$$

**For  $r = 3$ :**

$$2^3 \geq 4 + 3 + 1$$

$$\Rightarrow 8 \geq 8 \quad (\text{true})$$

So, the total number of redundant bits will be 3. Therefore, total length of Hamming code will be  $4 + 3 = 7$  bits

Let the redundant bits be name as  $r_0, r_1$  and  $r_2$

So, position of  $r_0 = 2^0 = 1$

position of  $r_1 = 2^1 = 2$

position of  $r_2 = 2^2 = 4$

The Hamming code will look like this:

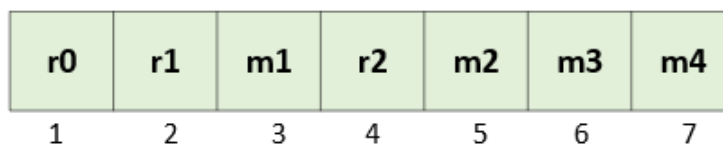


Fig. 1.1 model of hamming code for hamming (4,7)

After putting the values of  $m_1, m_2, m_3$  and  $m_4$  from data bits:

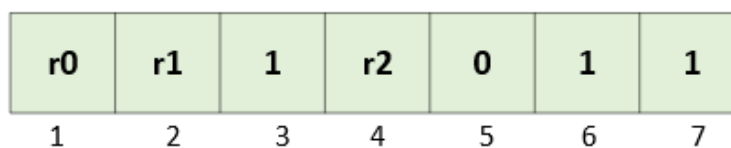


Fig. 1.2 model of hamming code for Hamming (4,7) with data bits

Now, we need to find the values of  $r_0$ ,  $r_1$  and  $r_2$ . For that lets make a table decimal to binary conversion table from 1 to 7.

1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

**Note: We are taking Even parity.**

**For  $r_0$ :**

Check for the numbers in the above table, which has '1' at the most significant bit i.e. the last bit form left.

we can see that 1,3,5 and 7 has '1' at most significant bit.

Copy the values at the positions 1,3,5 and 7 from fig 1.2.

Therefore, we have:  **$r_0$  1 0 1**

Since, for even parity, number of 1's should be even and we have even number of 1's.

Therefore,  **$r_0 = 0$**

**For  $r_1$ :**

Check for the numbers in the above table, which has '1' at the 2<sup>nd</sup> bit form left.

we can see that 2,3,6 and 7 has '1' at 2<sup>nd</sup> bit position.

Copy the values at the positions 2,3,6 and 7 from fig 1.2.

Therefore, we have:  **$r_1$  1 1 1 1**

Since, for even parity, number of 1's should be even and we have odd number of 1's.

Therefore,  **$r_1 = 1$**

**For  $r_2$ :**

Check for the numbers in the above table, which has '1' at the first bit form left.

we can see that 4,5,6 and 7 has '1' at first bit position.

Copy the values at the positions 4,5,6 and 7 from fig 1.2.

Therefore, we have:  **$r_2$  0 1 1**

Since, for even parity, number of 1's should be even and we have even number of 1's.

Therefore,  **$r_2 = 0$**

Therefore, The Hamming code is:

0	1	1	0	0	1	1
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Or, The Hamming code for 1011 is 0110011