1.

**Step 1: Convert 12 to Binary**

12 in decimal = **1100** in binary (4 bits).

**Step 2: Determine Redundant Bits (Parity Bits)**

Hamming Code follows the formula:

Where:

• = number of data bits (**4** in this case: 1100)

• = number of redundant (parity) bits

Solving for :

So, we need **3 parity bits**.

**Step 3: Position the Bits in Hamming Code Format**

The positions of bits follow this rule:

• Parity bits go at positions **1, 2, and 4** (powers of 2).

• Data bits are placed in the remaining positions.

**Position** **1** **2** **3** **4** **5** **6** **7**

Bit P1 P2 1 P4 1 0 0

Where:

• **P1, P2, P4** are parity bits to be calculated.

• **1100** is the data (placed in non-parity positions).

**Step 4: Calculate Parity Bits**

Parity bits are calculated using **even parity** (sum of 1s in selected positions must be even).

**P1 (covers positions 1, 3, 5, 7)**

Bits: **1, 1, 0, 0** → Sum = 2 (even)

**P1 = 0**

**P2 (covers positions 2, 3, 6, 7)**

Bits: **1, 0, 0, 0** → Sum = 1 (odd)

**P2 = 1** (to make sum even)

**P4 (covers positions 4, 5, 6, 7)**

Bits: **1, 1, 0, 0** → Sum = 2 (even)

**P4 = 0**

**Step 5: Final Hamming Code**

**Position** **1** **2** **3** **4** **5** **6** **7**

Bit **0** **1** 1 **0** 1 0 0

**Final Hamming Code for 12 (1100) → 0110100**

**2.**

**Step 1: Identify Data Bits**

**The given binary number is 1011 (4 bits).**

**Step 2: Determine the Number of Parity Bits**

**Using the formula:**

**Where:**

**• (data bits: 1011)**

**• = number of parity bits**

**Solving for :**

**So, 3 parity bits (P1, P2, P4) are required.**

**Step 3: Position the Bits in Hamming Code Format**

**Parity bits are placed at positions 1, 2, and 4 (powers of 2).**

**Data bits are placed in the remaining positions.**

**Position 1 2 3 4 5 6 7**

**Bit P1 P2 1 P4 0 1 1**

**Step 4: Calculate Parity Bits**

**Parity bits are calculated using even parity (sum of 1s in selected positions must be even).**

**P1 (covers positions 1, 3, 5, 7)**

**Bits: 1, 0, 1, 1 → Sum = 3 (odd)**

**P1 = 1 (to make sum even)**

**P2 (covers positions 2, 3, 6, 7)**

**Bits: 1, 1, 1, 1 → Sum = 4 (even)**

**P2 = 0**

**P4 (covers positions 4, 5, 6, 7)**

**Bits: 0, 0, 1, 1 → Sum = 2 (even)**

**P4 = 0**

**Step 5: Final Hamming Code**

**Position 1 2 3 4 5 6 7**

**Bit 1 0 1 0 0 1 1**

**Final Hamming Code for 1011 → 1010011**