**Topic: Addition of binary numbers**

Reading Time: 20 mins

**·        Note\* Highlight important/core points while reading**

·        Read the content and write the answers given in the document in your words, to get the solid grip on topic.

**Addition of Binary Numbers & Overflow**

**Binary Addition**

Binary addition follows the same principles as decimal addition but uses only **0s and 1s**. The basic rules for adding two binary digits are:

|  |  |  |
| --- | --- | --- |
| **Binary Sum** | **Result** | **Carry** |
| 0 + 0 | 0 | 0 |
| 0 + 1 | 1 | 0 |
| 1 + 0 | 1 | 0 |
| 1 + 1 | 0 | 1 (carry 1 to the next column) |
| 1 + 1 + 1 | 1 | 1 (carry 1 to the next column) |

**Example 1: Adding Two Binary Numbers**

Let's add **1011₂ (11 in decimal) + 1101₂ (13 in decimal)**.

   1011   (11 in decimal)

+  1101   (13 in decimal)

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  11000   (24 in decimal)

**Step-by-step explanation:**

1. **1 + 1 = 10** → Write **0**, carry **1**.
2. **1 + 0 + 1 = 10** → Write **0**, carry **1**.
3. **0 + 1 + 1 = 10** → Write **0**, carry **1**.
4. **1 + 1 = 10** → Write **0**, carry **1**.
5. The carry **1** moves to the next column, giving the result **11000₂**.

**Binary Addition with Overflow**

**What is Overflow?**

Overflow occurs in binary addition when the sum exceeds the available number of bits. This happens when a **carry is generated beyond the leftmost bit** in a fixed-size system (e.g., an **8-bit register**).

**Example 2: Overflow in 4-bit Addition**

Adding **1010₂ (10 in decimal) + 1100₂ (12 in decimal)** in a **4-bit system**:

   1010  (10 in decimal)

+  1100  (12 in decimal)

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  10110  (Overflow error in a 4-bit system)

**Explanation:**

* The answer **10110₂ (22 in decimal)** requires **5 bits**, but in a **4-bit system**, we can only store **4 bits**.
* The extra **1** in the leftmost column **cannot be stored**, causing an **overflow error**.

**Example in Real Use:**

* If a computer's **8-bit system** tries to store a result greater than **255₁₀ (11111111₂)**, an overflow will occur.

**A-Rated Questions/Answers By Examiner**

**Q1: What are the four basic rules of binary addition?**

**Answer:**

1. **0 + 0 = 0**
2. **0 + 1 = 1**
3. **1 + 0 = 1**
4. **1 + 1 = 10 (carry 1)**

**Q2: Add 1101₂ and 1011₂ and give the result in binary.**

**Answer:**

    1101  (13 in decimal)

+  1011  (11 in decimal)

   ------------

  11000  (24 in decimal)

So, **1101₂ + 1011₂ = 11000₂**.

**Q3: What is overflow in binary addition?**

**Answer:** Overflow occurs when the result of binary addition exceeds the available number of bits in a system, causing the leftmost bit (carry) to be lost.

**Q4: Give an example of an overflow in a 4-bit system.**

**Answer:** Adding **1011₂ (11) + 1101₂ (13)** in a **4-bit system**:

    1011

+  1101

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  11000  (Overflow error in 4-bit system)

Since **11000₂** requires **5 bits**, overflow occurs.

**Q5: Convert 10110₂ to decimal.**

**Answer:**

* 10110₂ = (1×16) + (0×8) + (1×4) + (1×2) + (0×1)
* = 16 + 0 + 4 + 2 + 0 = 22₁₀

### Write your Answers on your Notebook and Verify it on Next Screen

**Q6: Add 1010₂ and 0111₂ and give the result in binary.**

**Q7: What happens if an overflow occurs in an 8-bit system?**

**Q8: What is the sum of 1001₂ and 0110₂ in binary?**

**Q9: Explain how binary addition is used in computer processors.**

**Q10: What happens when an overflow occurs in a signed (two’s complement) binary system?**

**6. Answer:**

    1010   (10 in decimal)  
+  0111   (7 in decimal)  
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  10001   (17 in decimal)

**7. Answer:**

* If the result of an addition exceeds **8 bits (11111111₂ or 255₁₀)**, the **extra bit is lost**, causing incorrect results.
* **Example:**

11111111₂ (255)

**8. Answer:**

    1001   (9 in decimal)  
+  0110   (6 in decimal)  
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  1111   (15 in decimal)

**9. Answer:**

* Computer processors use **binary addition** in **arithmetic logic units (ALUs)** to perform calculations.
* Operations like **addition, subtraction, multiplication, and division** are based on binary arithmetic.
* Processors also handle **carry bits and overflow detection** to avoid errors in calculations.

**10. Answer:**

* In **two’s complement representation**, overflow occurs **when adding two numbers with the same sign results in a sign change**.
* Example: