Find Kth Bit In Nth Binary String

solved by	Senan
Platform	LeetCode
difficulty	Medium
# Serial	1545
tags	Bit Manipulation
language	C++
solved on	@19/10/2024
link	https://leetcode.com/problems/find-kth-bit-in-nth-binary-string/description/
Completion	☑

Intuition

The sequence `S_n` follows a recursive pattern, and instead of constructing the string explicitly, we can use bit manipulation to directly determine the K-th bit. By analyzing the position and whether it comes from the inverted or non-inverted part of the sequence, we can compute the result in constant time.

Approach

The approach leverages bitwise operations to identify whether the K-th bit is part of the inverted segment of the sequence. We calculate the lowest set bit in `k` and use it to decide if the bit is inverted, and whether the bit should be `0` or `1` can be derived based on whether `k` is even or odd. This eliminates the need to build the entire sequence.

Complexity

Time Complexity:

The time complexity is **O(1)**, as all operations (bitwise manipulation and arithmetic) are performed in constant time, regardless of the values of `n` and `k`.

Space Complexity:

The space complexity is **O(1)** since we only use a few variables and no extra data structures.

Code

```
char findKthBit(int n, int k) {
    int pos = k & -k;
    bool inverted = ((k / pos) >> 1 & 1) == 1;
    bool isOne = (k & 1) == 0;

    if (inverted) {
        return isOne ? '0' : '1';
    } else {
        return isOne ? '1' : '0';
```

```
        }
    }
```