

Problem B: Shortlex

The set of all binary strings of finite length, denoted $\{0, 1\}^*$, plays an important role in computer science, and it is often useful to impose an ordering on the elements of this set. One option is standard *lexicographic order* (dictionary order with the convention that 0 comes before 1), but this has a serious drawback: every string that starts with 0 appears before every string that starts with 1, and since there are infinitely many strings that start with 0, it is impossible to assign a finite index to any string that starts with 1. A better option is *length-lexicographic order*, also known as *shortlex order*, which is based on two simple rules. For $x, y \in \{0, 1\}^*$:

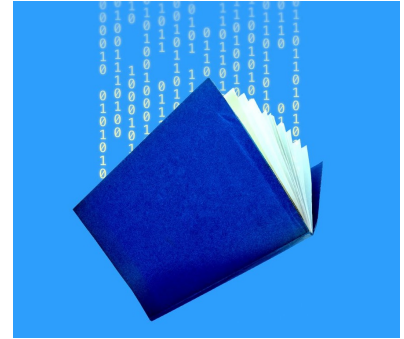


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1. if the length of x is less than the length of y , then x precedes y
2. if x and y have the same length, then they are ordered lexicographically relative to each other

Following the convention that the empty string (denoted ε) is assigned index 0, Figure 1 gives the first 8 elements and their associated indices in the shortlex order of $\{0, 1\}^*$.

Your challenge: For $i \geq 1$, determine the binary string with index i in the shortlex order of $\{0, 1\}^*$.

Index	Element of $\{0, 1\}^*$
0	ε
1	0
2	1
3	00
4	01
5	10
6	11
7	000

Figure 1: First 8 elements in the shortlex order of $\{0, 1\}^*$

Input

The first line of input contains an integer T ($1 \leq T \leq 100$), the number of test cases. This is followed by T lines, one per test case. Each test case consists of a single integer i ($1 \leq i \leq 10^{18}$).

(continued on the next page)

Output

For each test case i , output a single line containing the binary string with index i in the shortlex order of $\{0,1\}^*$.

<i>Sample Input</i>	<i>Sample Output</i>	<i>Sample Output, with visualized whitespace</i>
4	10	10 \n
5	011	011 \n
10	00111	00111 \n
38	100100	100100 \n
99		

Note: is a space, and \n is a newline character.