

## Problem E

### Circular Codes

Input file: *testdata.in*  
Time limit: 10 seconds

### Problem Description

The Circular Intelligence Agency stores all secret information in the following circular codes. Each encrypted string is an  $N$ -bit binary string  $c = c_0c_1 \cdots c_{N-1}$ . We say that binary string  $a = a_0a_1 \cdots a_{N-1}$  is a *circular rotation* of  $c$  if there exists an index  $k$  with  $0 \leq k \leq N-1$  such that  $c_i = a_{(i+k) \bmod N}$  holds for each  $i = 0, 1, \dots, N-1$ . The message  $d = d_0d_1 \cdots d_{N-1}$  to be decrypted is the bit-wise exclusive-OR of  $a = a_0a_1 \cdots a_{N-1}$  and  $b = b_0b_1 \cdots b_{N-1}$ , where

- $a$  is the circular rotation of  $c$  such that the binary number represented by  $a$  (if treated as a nonnegative integer) is the maximum, and
- $b$  is the circular rotation of  $c$  such that the binary number represented by  $b$  (if treated as a nonnegative integer) is the minimum.

For instance, if  $c = 11001$ , then  $a = 11100$ ,  $b = 00111$ , and  $d = 11011$ .

## Technical Specification

- $1 \leq N \leq 300000$

### Input Format

In the first line of the input file there is an integer  $C$ , indicating the number of distinct test cases to be followed. Each of the next  $C$  lines stands for a test case. For each test case, there is an integer  $N$ , followed by an  $N$ -bit binary string.

### Output Format

Output should be  $C$  lines. The binary string in the  $j$ -th line is the decrypted message for the  $j$ -th test case.

### Sample Input

```
5
5 10101
6 111111
7 0000000
6 110110
25 11010010111100100111010101
```

### Sample Output

```
10001
000000
0000000
101101
11001101101111110001110011
```