Mid-term examination on Logic Circuit Design (Group 2)

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1 Balanced Ternary

Definitions. An integer N is said to be represented in *balanced ternary* if there are $t_i \in \{-1, 0, 1\}$, called *trits*, such that $N = t_{n-1}3^{n-1} + \cdots + t_1 3^1 + t_0$. It is convenient to write $\overline{1}$ instead of 1, so, for example, we have $\overline{1}01\overline{1}_{3b} = (-1)3^3 + (0)3^2 + (1)3^1 + (-1)3^0 = -27 + 3 - 1 = -25$. One can also consider a complement operator such that $\overline{0} = 0$ and $\overline{\overline{1}} = 1$. By extension, $\overline{N} = \overline{t_{n-1}3^{n-1} + \cdots + t_1 3^1 + t_0} = \overline{t_{n-1}}3^{n-1} + \cdots + \overline{t_1}3^1 + \overline{t_0}$.

Question 1. Give the lower and upper bounds of a number represented in balanced ternary with n trits.

Question 2. Prove that if the leftmost nonzero trit is 1, then the number is positive, otherwise it is negative or zero.

Question 3. Write an **efficient** `C` function which converts a decimal number into its balanced ternary representation as a string, where the trit $\overline{1}$ is represented by the character `'I'`. Prototype: `char* from10to3b(int dec)`.