

# Mid-term examination on Logic Circuit Design (Group 1)

Christian Rinderknecht

20 October 2008

## 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  $N = t_{n-1}3^{n-1} + \dots + t_13^1 + t_0$ . It is convenient to write  $\bar{1}$  instead of  $-1$ , so, for example, we have  $\bar{1}01\bar{1}_{3b} = (-1)3^3 + (0)3^2 + (1)3^1 + (-1)3^0 = -27 + 3 - 1 = -25$ . One can also consider a complement operator such that  $\bar{0} = 0$  and  $\bar{\bar{1}} = 1$ . By extension,  $\overline{N} = \overline{t_{n-1}3^{n-1} + \dots + t_13^1 + t_0} = \overline{t_{n-1}}3^{n-1} + \dots + \overline{t_1}3^1 + \overline{t_0}$ .

**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 negates a number given in balanced ternary. Prototype: `char* negate(const char bter[])`. The trit  $\bar{1}$  is represented by the character 'I'.