**Theoretical Computer Science (Bridging Course)**

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# Exercise Sheet 6
### Due: 11th December 2014

**Exercise 6.1** (Turing Machines)

(a) Design a Turing Machine that decides the language $L := \{0^n 1^n \mid n \geq 1\}$. Explain your choice.

(b) Give the sequence of configurations for the input string 0011.

(c) Give the sequence of configurations for the input string 0010.

**Exercise 6.2** (Turing Machines)
Describe a TM that decides the language

$$L = \{w \in \{0,1\}^* \mid |w|_0 = |w|_1\}.$$

where $|w|_0$ and $|w|_1$ are respectively the number of 0's and 1's in $w$.

**Exercise 6.3** (Pushdown Automata, Turing Machines)
How would one simulate a PDA on a Turing machine? Please do not write the Turing machine itself, but rather write the key idea in plain English.

**Exercise 6.4** (Non Deterministic Turing Machines)
We call a natural number *composite* if it is not prime[1], formally, the set of natural composite numbers is

$$\{hk \mid h, k \in \mathbb{N}, \ h, k \geq 2\}$$

Give a nondeterministic Turing machine of the alphabet of vertical bars $\Sigma = \{|\}$ that recognizes the language of composite numbers encoded as unary numbers (i.e. a natural number $n$ is encoded in the form $|^n$). You should not give a formal construction, but describe the idea behind it as precise as possible.

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[1]Remember that 1 and $-1$ are <u>not</u> prime numbers! By definition, prime numbers must not be invertible in $\mathbb{Z}$.