T-79.192 Special Course in Theoretical Computer Science, 2001
Home assignment 7

return date: Thu Nov 15

1. Design, using only XOR gates, a quantum circuit, which takes two input qubits, and performs on them the operation

$$\begin{aligned} 00 &\rightarrow 00 \\ 01 &\rightarrow 10 \\ 10 &\rightarrow 01 \\ 11 &\rightarrow 11 \end{aligned}$$

   that is, the circuit swaps the values of the input bits if they differ but does nothing is the input qubits are the same.
   You will most probably need some auxiliary qubits. Their input values must be constant, either $|0\rangle$ or $|1\rangle$ (choose yourself). Output values of any auxiliary qubits don't matter.
   Return you solution as a drawing, preferably using the same symbols as the book. All correctly working solutions are accepted, but the person(s) doing the design with the least number of XOR gates may next time take a bigger piece of ice cream cake than the others.

2. Let's take a look at Bob's part of the teleportation circuit, Figure 9.9 on page 204. Alice has measured her two qubits and sent Bob two classical bits, 1 and 0. Bob puts these into his circuit, $|1\rangle$ to the upper line and $|0\rangle$ to the middle.
   Which rotation (of those in Table 9.1 page 199) Bob's circuit now performs? Explain in detail what is the role of each part (S's, T's and XOR's) of Bob's circuit in choosing which rotation to do and to doing it.