1. **Reversible Simulation** Show that there is a reversible TM U that takes as input the description of a TM M and an input x to M and a number T. If M is reversible, then the output of U is the configuration of M on input x after T steps. If M is not reversible, U is allowed to output anything (but its simulation must be reversible).

2. **Fourier transform** Suppose you are given quantum circuits for Fourier transforms over Z_{p_j} for $1 \leq j \leq k$, where the p_j are relatively prime. Give a quantum circuit for carrying out the Fourier transform over Z_q where $q = \Pi_j p_j$. Bound the size of the resulting circuit in terms of q and the sizes of the given circuits.

3. **Generalization of Simon's algorithm** Let p be a prime. Let $H \subseteq Z_p^k$. Given a function $f : Z_p^k \to Z$ that is constant on the cosets of H, give a quantum algorithm to determine H.