1. Consider a quantum algorithm that starts with an initial state $|\psi_0\rangle$, to which the sequence of unitary gates $U_1, U_2, \ldots, U_T$ is to be applied. Suppose that only approximations V_i to the gates U_i, such that $\| U_i - V_i \|_2 \leq \delta$, are available to us. How far (in ℓ_2-norm) is the final state $|\xi_T\rangle = V_T V_{T-1} \cdots V_1 |\psi_0\rangle$, which we get from the approximate computation, from the ideal state $|\psi_T\rangle = U_T U_{T-1} \cdots U_1 |\psi_0\rangle$? Thus, how accurate do we require our "real" gates to be, for a polynomial time computation?

   Hint: Apply the hybrid argument that we used to show a lower bound for the search problem.

2. Show that a quantum error correcting code that is resilient against both a bit- and a phase-flip on one qubit is also resilient against *any* linear error on one qubit. Verify this for the 9-qubit Shor code.

   What about linear errors on more qubits?

   Hint: Can you express any linear operation on one qubit in terms of the identity (no error), a bit-flip, a phase-flip, and a simultaneous bit and phase flip?

3. Suppose H is a linear subgroup of $\mathbb{Z}_2^n$. Verify that the Hadamard transform (the Fourier transform over $\mathbb{Z}_2^n$) maps a uniform superposition over any coset of H onto a superposition over the perp subgroup $H^\perp = \{g : g \cdot h = 0, \forall h \in H\}$. Here, $x \cdot y$ denotes the scalar product $\sum_{i=1}^n x_i y_i \pmod 2$.