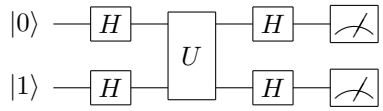
CSEP 590tv In Class Problems, July 13, 2005

Dave Bacon

1. Suppose we are given a two qubit system with the wave function $|\psi\rangle = \frac{1}{\sqrt{2}}|01\rangle + \frac{1}{2}|10\rangle + \frac{1}{2}|11\rangle$. If we measure the second qubit in the computational basis, what are the probabilities of the two outcomes and what is the quantum wave function of the system after this measurement?

2. Suppose that U is the controlled-NOT gate. Find the wave function of the two qubit system after each of the gates in the Deutsch circuit have been applied



3. Three qubits, the first qubit being $|v\rangle = v_0|0\rangle + v_1|1\rangle$ and the second and their qubit being $|\psi\rangle = \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$. Express this three qubit wave function, $|v\rangle \otimes |\psi\rangle$ in the Bell basis for the first qubit and the computational basis for the third qubit. Recall that the Bell basis is

$$\begin{aligned} |\Psi_+\rangle &= \frac{1}{\sqrt{2}}(|01\rangle + |10\rangle), \quad |\Psi_-\rangle = \frac{1}{\sqrt{2}}(|01\rangle - |10\rangle), \\ |\Phi_+\rangle &= \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle), \quad |\Phi_-\rangle = \frac{1}{\sqrt{2}}(|00\rangle - |11\rangle) \end{aligned}$$