Exercise 4
CMSC 691Q
Quantum Computation
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1 Entantaglement swapping problems

Let

$$\left\{ \left|\psi_{b_1 b_0}\right\rangle = \frac{1}{\sqrt{2}} \left[(-1)^{b_1} \left|b_1 b_0\right\rangle + \left|\overline{b}_1 \overline{b}_0\right\rangle \right] : b_1, b_0 \in \{0,1\} \right\}$$

and

$$\left\{ \left|\psi_{b_2 b_1 b_0}\right\rangle = \frac{1}{\sqrt{2}} \left[(-1)^{b_2} \left|b_2 b_1 b_0\right\rangle + \left|\overline{b}_2 \overline{b}_1 \overline{b}_0\right\rangle \right] : b_2, b_1, b_0 \in \{0,1\} \right\}$$

denote respectively the Bell bases for 2 qubit and 3 qubit Hilbert space, where $\overline{b}_j$ denotes the complement of b_j.

Let all qubits be labeled from right to left with 0, 1, 2, ... Then what is the resulting state if a Bell measurement is made on:

1. Qubits 1,2 of
$$\left|\psi_{000}\right\rangle$$
2. Qubits 2, 5 of
$$\left|\psi_{000}\right\rangle \bigotimes \left|\psi_{000}\right\rangle$$
3. Qubits 2,5,8 of
$$\left|\psi_{000}\right\rangle \bigotimes \left|\psi_{000}\right\rangle \bigotimes \left|\psi_{000}\right\rangle$$
4. Qubits 1,2 of
$$\rho_{00} \bigotimes \rho_{00}$$
where
$$\rho_{00} = \frac{1}{2} \left|\psi_{00}\right\rangle \left\langle\psi_{00}\right| + \frac{1}{2} \left|\psi_{11}\right\rangle \left\langle\psi_{11}\right|$$