CS 1511 Homework 22

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43.

44 a. Alice can perform rotations that are multiples of $\pi/4$. Take the value of x and y combined and use those to determine how many degrees to rotate the qubit by. Say x=0, y=0, then rotate the qubit by 0 degrees. x=0, y=1, then rotate by $\pi/4$ degrees. If x =1 y=0, rotate by $2\pi/4$. If x = 1, y = 1, rotate by $3\pi/4$ degrees.

44 b. The state of b will be unchanged, because Alice performed rotations only on the first qubit. The state of a will now be dependent on the value of x and y.

44 c.

If a = 0^n, Simon's algorithm still works. This is because if the function is one-to-one, and $a = 0^n$, after we compute $\mid xz\rangle - > \mid x(y \oplus f(x))\rangle$ we can measure $\mid (x \oplus a)$ and see that it's equivalent to x. This will let us know that $a = 0^n$. We will therefore have correctly computed a. Or, if we continue Simon's algorithm, we will eventually be finding k linear equations for $y \odot a = 0$ with a uniform string for y that makes this true. In this case, every single one of these y's will work. Solving the linear equations will give us that all values of a are 0, which is true.

44 a. To get the Bell state $1/\sqrt{2} \mid 0\rangle + 1/\sqrt{2} \mid 1\rangle$, Alice can perform a rotation of $\pi/4$ to her qubit. This could be when x = 0 and y = 0.

To get the Bell state $1/\sqrt{2} \mid 0\rangle - 1/\sqrt{2} \mid 1\rangle$, Alice can perform a rotation of $-\pi/4$ to her qubit. This could be when x = 0 and y = 1.

To get the Bell state $-1/\sqrt{2} \mid 0\rangle + 1/\sqrt{2} \mid 1\rangle$, Alice can perform a rotation of $3\pi/4$ to her qubit. This could be when x = 1 and y = 0.

To get the Bell state $-1/\sqrt{2} \mid 0\rangle - 1/\sqrt{2} \mid 1\rangle$, Alice can perform a rotation of $-3\pi/4$ to her qubit. This could be when x = 1 and y = 1.
So basically, Alice will want to rotate by $\pi/4$ when x = 0 and rotate by $3\pi/4$ when x = 1. If y = 1 then this rotation is negative, otherwise it's positive.

44 b.

The state of a and b will be as described above, depending on the values of x and y.

44 c.

If we apply a hadamard operation to the state of a and b, we can find x from examining the vector that is created after the operation. We can find y by taking the negation of x.