King Fahd University of Petroleum and Minerals

College of Computer Science and Engineering
Computer Engineering Department
COE 466: Quantum Architecture and Algorithms

Problem Set 3

Due date: Wednesday 4-11-2020 (11:59 PM)

Problem Sets

1. Let $|\psi >= [c_0, c_1, ..., c_{n-1}]$. Check that multiplying $|\psi >$ by any complex number c will not alter the calculation of probabilities. (Hint: Factor out c in the ratio.)

2. Write the matrix that corresponds to a NOR gate. Then, find the output of

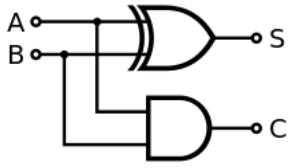
$$NOR * \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \end{bmatrix}$$

3. Figure 1 shows the circuit for a one-bit half-adder. A one-bit half-adder adds the bits x, y and outputs the bits s (sum) and c (carry). There are two inputs and two outputs, so the matrix will be of dimension 2^2-by-2^2.

   (a) Write the truth table of one-bit half-adder

   (b) Write the matrix that would corrosponds to a one-bit hald-adder (Hint: Mark the columns as 00, 01, 10, .., 11, where column, say, 01 corresponds to x = 0, y = 1 and so on)

Figure 1: One-bit Half-Adder Circuit



4. Show a circuit that represents NAND gate using one Toffoli gate.

5. Prove the following using the gates' matrix representation

   (a) $X = HZH$

   (b) $Z = HXH$

   (c) $-1Y = HYH$

6. Show that Toffoli gate can be constructed using ${}^{c}U$, where $U = {}^{c}\text{NOT}$