Midterm Exam

PHY 414: Introduction to Quantum Computing

Note: Submission time is Monday 7 PM. Each problem is worth 10 points.

Problem 1: Answer the following short questions: (You will have to type answers in LMS.)

1. What do you think is the major source of power of quantum computers?

2. Why Bernstein–Vazirani algorithm is important in showing power of quantum computers more so that the DJ algorithm?

3. What is one main application of teleportation on a quantum computer?

Problem 2: (Only submit Jupyter Notebook)

Construct a **(3+1) or (3+2)-qubit** phase oracle that transforms 3-qubit input $|x\rangle$ to $(-1)^{f(x)}|x\rangle$ where $f(x) = 1$ when the 3-qubit $|x\rangle$ is binary representation of a prime number (1, 2, 3, 5, or 7) and $f(x) = 0$ when $|x\rangle$ is binary representation of **0, 4, or 6.** Iimplement this oracle in qiskit and evolve each of the eight input states and plot the output on Bloch sphere and Qsphere for all qubits (including the ancillary qubits).

Problem 3: (Only submit the scanned copy of paper solution. No Notebook is required)

If the input of the Grover search algorithm is initialized to state $|111...1\rangle$ and the Diffuser is defined as $V = H^{\otimes n}(I - 2|1111...1\rangle\langle 111...1|)H^{\otimes n}$, will the algorithm still be able to search the solution the same way as it worked for the case when Grover algorithm was initialized to $|00..0\rangle$ state? Prove or disprove by working out the derivation of algorithm. You don't have to do the complete derivation and you can use the results that are already derived in the class. Only that much is required which will prove or disprove the use of new scheme.