Final Exam
PHY 414: Introduction to Quantum Computing

Note: Submission time is Thursday, July 8th, 5 PM. Each problem is worth 10 points. All problems should be combined in one Notebook.

1. Prepare a (3+2) Grover oracle that marks 101, 100, and 111 solutions. Now use this oracle in the Quantum Counting algorithm to count the number of solutions.

2. Using a noise model (X, with probability 0.1, I with probability 0.9) on all qubits during measurements, find the error in measured phase θ using quantum phase estimation when the phase in the Unitary operator is set at $\theta = 0.75$.

3. We saw in the class that QFT transforms the state from computational basis to Fourier bases. When viewed on Bloch spheres, the states in up/down configuration go to states rotated in the horizontal plane (xy plane).

For this problem, design and implement a circuit in qiskit that transforms 4-bit states from computational basis to a new basis such that the states are all present in the vertical plane (xz plane) but all rotated. See figure obtained after transforming 1111 state. Your new transformation should do the same as Fourier transform does, but instead of taking all states into xy plane and rotating around z axis, it should take them all to xz plane and rotate them around y axis.