

Homework 2
CMSC 643
Quantum Computation
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Please feel free to use Mathematica on this homework assignment.

Problem 1. (25pts) Consider the two qubit state

$$|\psi\rangle = \frac{|0\rangle + |1\rangle + (1+i)\sqrt{2}|2\rangle + 3|3\rangle}{\sqrt{15}}.$$

If $|\psi\rangle$ is measured with respect to the standard basis, then what is the probability p_j that the measured state will be $|j\rangle$ for $j = 0, 1, 2, 3$?

Problem 2. (25pts) The Bell Basis

$$|\beta_{00}\rangle, |\beta_{01}\rangle, |\beta_{10}\rangle, |\beta_{11}\rangle$$

for two qubit spaces is given by

$$|\beta_{ab}\rangle = ((Z^a X^b) \otimes I) |\beta_{00}\rangle,$$

where

$$|\beta_{00}\rangle = \frac{|00\rangle + |11\rangle}{\sqrt{2}}.$$

Reexpress the state $|\psi\rangle$ of **Problem 1** in terms of the Bell Basis.

Problem 3. (25pts) If the state $|\psi\rangle$ of **Problem 1** is measured with respect to the Bell basis, then what is the probability q_{ab} that $|\beta_{ab}\rangle$ will be the result of the measurement for $ab = 00, 01, 10, 11$?

Problem 4. (25pts) Find the 4×4 unitary matrix U represented by the following wiring diagram:

