CSE610, Fall 2021 **Problem Set 1** **Due Thu. Sep. 23**

(1) Suppose A and B are both unitary and Hermitian, the latter meaning $A^* = A$ and $B^* = B$. Show that $A \otimes B$ is also unitary and Hermitian. (Some of this is done in lecture notes; alternatively, it might help you to use the concatenation-based indexing convention that $A[u, v]B[w, x] = (A \otimes B)[uw, vx]$. 12 pts. total)

(2) Find a 2×2 unitary matrix A such that $A^2 = iY$. (The scalar multiple i doesn't matter in quantum computing and allows A to have real entries. 12 pts.)

(3) Lipton-Regan text, exercises 4.11 and 4.12, OK to skip the "argue generally" part of the latter. (Note the references to problem 4.8, and 4.10; 18 pts. total)

(4) Lipton-Regan text, exercise 4.13 on page 39. As always expected, show the calculation to justify your answer. (6 pts.)

(5) Consider two-qubit circuits in which line 1 has the H-T-H sequence discussed in lecture in connection with *Bell's Theorem*. There are four places to insert a CNOT gate whose control is on line 1. Do all four preserve the property that on input 00, the probability of measuring 0 on line 1 is irrational? (18 pts. total)

(6) Lipton-Regan text, exercise 14.1 (24 pts. total, for 90 on the set)