

Assessment 0 for 41076: Methods in Quantum Computing

This is an optional problem set for students who want to refresh their knowledge of elementary quantum computing and linear algebra.

1. Do the following expressions correspond to normalized quantum states?

(a) $\frac{1}{2}|0\rangle + \frac{\sqrt{3}}{2}$

(b) $\frac{1}{2}|0\rangle + \frac{-1}{2}|1\rangle + \frac{i}{2}|2\rangle + \frac{-i}{2}|3\rangle$

(c) $\begin{pmatrix} 0.3 \\ 0.7 \end{pmatrix}$

2. Suppose that we perform a measurement in the computational basis on the state $\frac{1}{2}|0\rangle + \frac{\sqrt{3}}{2}|1\rangle$. What states can we measure and what would be the probabilities for each measurement?

3. Consider the matrix $X = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$. Which of the following statements are true?

(a) X is an identity.

(b) X is symmetric.

(c) X is diagonal.

(d) X is positive semi-definite.

(e) X is unitary.

(f) X is hermitian.

4. Write the operator $X \otimes I$ as a 4×4 matrix in the computational basis.

5. Let $A = \begin{pmatrix} 1 & 1 \\ 1 & 0 \end{pmatrix}$.

(a) Compute A^2

(b) What are A's eigenvalues?