

CS 4390/5353
Quantum Computing, Test 2
Tuesday, November 24, 2009

Name:

5 pages of notes allowed.

1. Show, step-by-step, that Grover's algorithm works on an example when among 4 elements of an array, only one element $a[1] = a[01_2]$ satisfies the desired property.
2. Prove, in detail, that Grover algorithm requires $\sim \sqrt{N}$ steps to find a desired element in an unsorted array of size N . For simplicity, assume that in this array, there is only one element with the desired property.
3. Show, in detail, how we can use Fast Fourier transform to compute the product of two polynomials:

$$A(x) = 1 - 2x + 4x^2 \text{ and } B(x) = 1 + 2x.$$

4. Explain what exactly Shor's algorithm does, and why it is important.
5. Describe, step by step, how computing without computing works.

(Turn over, please)

6. Describe, step by step, how one can teleport a state $\frac{3}{5} \cdot |0\rangle + \frac{4 \cdot i}{5} \cdot |1\rangle$. Assume that when Alice measures the values of the first two bits, she gets the result 11.

7. Explain why tensor methods are needed when we multiply two large matrices. Show, in detail, how the tensor method works, on the example of multiplying the following two 4×4 matrices:

$$A = \begin{pmatrix} 1 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 \\ 1 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 \end{pmatrix}, \quad B = \begin{pmatrix} 0 & 1 & 0 & -1 \\ 1 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 \\ 1 & 0 & -1 & 0 \end{pmatrix}$$