The purpose of this monograph is to provide the mathematically literate reader with an accessible introduction to the theory of quantum computing algorithms, one component of a fascinating and rapidly developing area which involves topics from physics, mathematics, and computer science. The author briefly describes the historical context of quantum computing and provides the motivation, notation, and assumptions appropriate for quantum statics, a non-dynamical, finite dimensional model of quantum mechanics. This model is then used to define and illustrate quantum logic gates and representative subroutines required for quantum algorithms. A discussion of the basic algorithms of Simon and of Deutsch and Jozsa sets the stage for the presentation of Grover's search algorithm and Shor's factoring algorithm, key algorithms which crystallized interest in the practicality of quantum computers. A group theoretic abstraction of Shor's algorithms completes the discussion of algorithms. The last third of the book briefly elaborates the need for error-correction capabilities and then traces the theory of quantum error-correcting codes from the earliest examples to an abstract formulation in Hilbert space. This text is a good self-contained introductory resource for newcomers to the field of quantum computing algorithms, as well as a useful self-study guide for the more specialized scientist, mathematician, graduate student, or engineer. Readers interested in following the ongoing developments of quantum algorithms will benefit particularly from this presentation of the notation and basic theory. Series: Progress in Computer Science and Applied Logic, Volume 19 Contents Preface Acknowledgements 1. Quantum Statics 1.1 Context 1.2 Experimental motivation for quantum mechanics 1.3 The basic model 1.4 The basic example: spin-1/2 particles 1.5 Dirac notation 1.6 Unitary transformations 2. Basics of Quantum Computation 2.1 Qubits and tensor products 2.2 The basic strategy of quantum algorithms 2.3 Quantum gates 2.4 Quantum subroutines: addition on a quantum computer 2.5 Quantum subroutines: a teleportation circuit 3. Quantum Algorithms 3.1 Deutsch-Josza algorithm 3.2 Simon's algorithm 3.3 Grover's algorithm 3.4 Shor's algorithm: factoring N=15 3.5 Shor's algorithm: factoring N=pg 3.6 The finite Fourier transform 3.7 Eigenvalues in guantum algorithms 3.8 Group theory and quantum algorithms 4. Quantum Error-Correcting Codes 4.1 Quantum dynamics and decoherence 4.2 Error correction 4.3 Shor's nine gubit error-correcting code 4.4 A seven gubit error-correcting code 4.5 A five gubit error-correction code 4.6 Stabilizers and the five qubit code 4.7 Theoretical aspects of stabilizer codes 4.8 CSS codes 4.9 Abstract quantum error correction 4.10 Further aspects of quantum error-correcting codes Afterword References Index

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