

PREFACE.....	5
Introduction	
QUANTUM SOFTWARE ENGINEERING: SOME FUNDAMENTAL CONCEPTS OF QUANTUM COMPUTATIONAL INTELLIGENCE TOOLKIT AND QUANTUM SUPREMACY.....	30
Quantum Circuits and Algorithmic Quantum Gate-based Computing Platform.....	30
Chapter 1	
INTRODUCTION TO MATHEMATICAL BACKGROUND OF LINEAR OPERATORS (MATRIX REPRESENTATION) IN HILBERT SPACE OF QUANTUM MECHANICS.....	96
1.1. The Pauli matrices.....	96
1.2. Inner and outer products.....	96
1.2.1. Definitions of orthogonal and orthonormal vectors. The Gram—Schmidt procedure.....	97
1.2.2. The inner product on Hilbert space.....	98
1.2.3. The outer product on Hilbert space.....	99
1.2.4. The completeness relation.....	99
1.2.5. Pauli operators and the outer product.....	101
1.3. Eigenvectors and eigenvalues.....	101
1.4. Adjoint and Hermitian operators.....	102
1.4.1. Projector operators and orthogonal complement.....	103
1.5. Spectral decomposition theorem.....	104
1.5.1. Hermitian unitary matrix and operator.....	105
1.6. Tensor products: Introduction.....	106
1.7. Operator functions.....	108
1.7.1. Trace of a matrix.....	109
1.8. The Commutator and anti-commutator.....	110
1.9. The polar and singular value decompositions.....	112
Types of matrix.....	114
Chapter 2	
SOME INTERRELATIONS IN MATRIX THEORY AND LINEAR ALGEBRA FOR QUANTUM COMPUTING AND QUANTUM ALGORITHMS DESIGN.....	118
Introduction.....	118
References to Chapter 2.....	146

Chapter 3	
MATRIX THEORY AND LINEAR ALGEBRA FOR QUANTUM COMPUTING	
AND QUANTUM ALGORITHMS DESIGN.....	147
Introduction.....	147
3.1. Krawtchouk matrices and quantum random walk.....	148
3.2. Entropy and Hadamard matrices.....	153
3.3. General properties of Walsh—Hadamard transformation $W(a, b, q)$ (see Appendix 3 to Chapter 3).....	156
3.4. Relationships among some Walsh transforms.....	157
3.5. Simon's problem and algorithm.....	158
3.5.1. <i>The qualitative description of Simon's problem</i>	158
3.5.2. <i>Mathematical model of Simon's problem: Simon's XOR problem</i>	159
3.6. Walsh transforms and Simon's problem.....	160
3.7. Generalized QA based on using of Walsh transform.....	161
3.8. Algorithm of solution.....	162
3.9. Deutsch—Jozsa QA and Walsh—Hadamard transformation.....	164
References to Chapter 3.....	168
Appendix 1 to Chapter 3. Tensor products.....	169
Appendix 2 to Chapter 3. Symmetric tensor spaces.....	170
Appendix 3 to Chapter 3. General properties of Walsh—Hadamard transformation $W(a, b, q)$	172
Chapter 4	
EXAMPLES OF QUANTUM COMPUTING TOOLKIT: KRONECKER PRODUCT	
AND QUANTUM FOURIER TRANSFORMATIONS IN QUANTUM ALGORITHMS.....	175
Introduction.....	175
4.1. Generalized Kronecker products.....	176
4.2. Properties of the Kronecker product in quantum information theory.....	180
4.2.1. <i>Mathematical aspects of Kronecker product</i>	180
4.3. Similar operators (matrices).....	182
4.4. Physical aspects of Kronecker product and its applications in quantum information theory.....	183
4.5. Applications in quantum theory.....	184
4.6. Kronecker product in quantum information theory to get the spin Hamiltonians.....	185
4.7. Similar matrices in quantum computation.....	187
4.8. CNOT operator gates and CNOT's similar matrices in quantum computing.....	187

4.9.	Physical differences between the CNOT matrices.....	188
4.10.	Physical interpretation of similar matrices.....	189
4.11.	The quantum fourier transform and algorithms based on it: from DFT to QFT.....	191
4.12.	Phase estimation.....	193
4.13.	Order-finding and other applications.....	194
4.14.	Fourier transform on arbitrary groups.....	196
4.15.	The hidden subgroup problem.....	198
4.16.	A coarse outline on QFT-based algorithms.....	200
4.17.	Quantum search algorithms.....	202
4.18.	Grover's algorithm.....	202
4.19.	Quantum counting: combining Grover operator and phase estimation.....	205
4.20.	Applications of Grover's algorithm.....	206
4.21.	Quantum search and NP problems.....	207
4.22.	Hogg's algorithm.....	208
4.23.	Quantum Simulation.....	211
4.24.	Speed-up limits for quantum algorithms.....	213
	References to Chapter 4	214

Appendix 1

	POSTULATES OF QUANTUM MECHANICS AND ITS APPLICATIONS.....	216
--	--	-----

AI .1.	Maximum likelihood principle of incompatible observations in quantum mechanics.....	229
--------	---	-----

Appendix 2

	MATRIX REPRESENTATION FROM SU(2) TO SO(3).....	234
--	---	-----

Appendix 3

	QUANTUM MEASUREMENTS, QUANTUM DISTINGUISHABILITY
--	---

	AND NON-ORTHOGONAL STATES.....	237
--	---------------------------------------	-----

A3.1.	Quantum Measurements.....	238
A3.1.1.	<i>Standard measurements.....</i>	238
A3.1.2.	<i>Generalized measurements.....</i>	239
A3.1.3.	<i>Geometrical representation.....</i>	240

Appendix 4

	GENERAL PROPERTIES OF WALSH-HADAMARD TRANSFORMATION IV(a, b, q).....	241
--	--	-----

Appendix 5	
QUANTUM COMPUTING: UNIFIED APPROACH TO FAST UNITARY TRANSFORMS.....	252
A5.1. The Walsh—Hadamard transform.....	261
A5.2. The Slant transform.....	262
A5.3. The Hartley transform.....	264
A5.4. The Universality of the quantum Fourier transform in forming the basis of quantum computing algorithms.....	266
A5.5. Toffoli and Control-NOT in universal quantum computation.....	279
Appendix 6	
SCHUR COMPLEMENTS.....	289
Appendix 7	
MODELS OF GROVER'S QUANTUM SEARCH ALGORITHMS FOR INFORMATION TECHNOLOGY AND CONTROL ENGINEERING.....	297
A7.1. Introduction.....	297
A7.2. Grover's QuantumSearch Algorithm.....	299
<i>Physical and Mathematical Background of Grover's Quantum Operators and Quantum Searching Processes.....</i>	304
A7.3. Physical Interpretation of Grover's Algorithm as Quantum Computing.....	314
<i>The Framework of Grover's Algorithm as Quantum Computation.....</i>	315
A 7.4. Physical Quantum Computing Model of Grover's Algorithm.....	317
<i>Adiabatic computing.....</i>	319
A7.5. Model Simulation Example of Grover's algorithm.....	324
<i>Simplified model of quantum search algorithm.....</i>	325
<i>Description of Grover's quantum search algorithm.....</i>	325
A7.6. Entanglement of Quantum Oracle in Quantum Search Algorithms.....	337
A7.6.1. <i>Quantum searching algorithms: oracle structures, bounds of complexity and effectiveness.....</i>	340
A7.6.2. <i>Pole of Entanglement in Quantum Algorithms.....</i>	342
A7.6.3. <i>Entanglement and speed-up of Grover's quantum search algorithm.....</i>	343
A7.6.4. <i>Lower bound on quantum searching.....</i>	348
A7.7. Quantum global optimization on Grover's search algorithm.....	353