

Contents

Abstract	page
Acknowledgements	i
Contents	iii
List of Figures	v
List of Tables	vii
List of Symbols	xi
List of Abbreviations	xiii
Chapter 1: Preliminaries and literature survey	1
1.1 Introduction	1
1.2 BASIC CONCEPTS AND TERMINOLOGY	3
1.2.1 Qubits	3
1.2.2 Multiqubit States	4
1.2.3 Quantum Gates	4
1.2.4 Density Operators in quantum information processing	6
1.3 QUANTUM ENTANGLEMENT	7
1.3.1 Measures of entanglement in pure and mixed two-qubit states	9
1.3.2 Measures of entanglement in three-qubit states	12
1.4 NONLOCALITY	15
1.4.1 Bell-type inequalities for three-qubit states	16
1.4.2 Quantum Discord	17
1.5 QUANTUM INFORMATION PROCESSING: APPLICATIONS	19
1.5.1 Quantum Teleportation	19
1.5.2 Quantum dense Coding	21
1.5.3 Entanglement Swapping	22
1.5.4 Quantum Algorithms	23
1.5.5 Quantum Cryptography	24
1.6 SCOPE OF THE THESIS	24
Chapter 2: Correlations, nonlocality, and usefulness of an efficient class of two-qubit mixed entangled states	27
2.1 INTRODUCTION	27
2.2 NONLOCALITY, NOISE AND WEAK MEASUREMENTS	28
2.2.1 Amplitude-Damping Channel	29
2.2.2 Alternate method to estimate violation of the Bell-CHSH inequality	33
2.2.3 Phase-Damping Channel	35
2.2.4 Depolarizing Channel	38
2.3 A NEW CLASS OF MIXED ENTANGLED TWO-QUBIT STATES	39
2.4 USEFULNESS OF THE PROPOSED TWO-QUBIT MIXED STATES IN INFORMATION PROCESSING TASKS	42
2.4.1 Quantum Teleportation	42
2.4.2 Fully-Entangled Fraction	45
2.4.3 Dense coding	47
2.5 SUMMARY	49
Chapter 3: Analysing Nonlocality in Multiqubit Entangled States under Noisy Conditions and Weak Measurements	51
3.1 INTRODUCTION	51
3.2 THREE-QUBIT GHZ AND W STATES	53
3.3 NONLOCALITY IN GHZ CLASS STATES UNDER REAL CONDITIONS	54
3.3.1 Amplitude-Damping Channel	54
3.3.2 Phase-Damping Channel	60
3.3.3 Depolarizing Channel	64
3.4 ESTIMATION OF NONLOCALITY IN THE GENERALIZED GHZ CLASS STATES	70
3.5 ANALYSIS OF NONLOCAL CORRELATIONS IN THE W CLASS AND W_n -TYPE STATES	73
3.6 NONLOCALITY IN THE FOUR-QUBIT GHZ STATES	76
3.7 SUMMARY	84
Chapter 4: Nonlocal Quantum Correlations and Cumulant operators	85

4.1	INTRODUCTION	85
4.2	BELL-CUMULANT INEQUALITY	86
4.3	BELL-CUMULANT OPERATOR FOR AN ARBITRARY MIXED SPIN $-\frac{1}{2}$ STATE	89
4.4	RELATIONSHIP BETWEEN THE BELL-CUMULANT INEQUALITY AND DISCORD	92
4.5	MODIFIED SVETLICHNY INEQUALITY FOR THREE-QUBIT STATES	97
4.6	SUMMARY	101
Chapter 5: Bell's Inequality With Biased Experimental Settings		103
5.1	INTRODUCTION	103
5.2	CLASSICAL BOUND FOR THE CHSH OPERATOR WITH BIASED EXPERIMENTAL SET-UP	104
5.3	QUANTUM BOUND FOR THE CHSH OPERATOR WITH BIASED EXPERIMENTAL SET-UP	105
5.4	FINE-GRAINED UNCERTAINTY RELATIONS	107
5.5	ARBITRARY SPIN $-\frac{1}{2}$ STATE AND THE CHSH INEQUALITY WITH BIASED EXPERIMENTAL SET-UP	110
5.6	SUMMARY	114
Chapter 6: Usefulness of Multiqubit W-Type States in Quantum Information Processing		115
6.1	INTRODUCTION	115
6.2	TELEPORTATION USING FOUR-QUBIT W-TYPE STATES	116
6.3	TELEPORTATION USING N-QUBIT W-TYPE STATES	117
6.4	ANALYSIS OF THE EFFICIENCY OF W-TYPE STATES IN TELEPORTATION PROCESS	118
6.5	SUPERDENSE CODING USING N-QUBIT W-TYPE STATES	123
6.6	EXPERIMENTAL GENERATION OF W_k -TYPE STATES	125
6.7	SUMMARY	127
Chapter 7: Conclusion and future scope		129
References		133