CONTENTS

APPROVAL PAGE . . . . . **i**

SELF DECLARATION AGAINST PLAGIARISM . . . . . **ii**

ABSTRACT . . . . . **iii**

ACKNOWLEDGEMENT . . . . . **iv**

PREFACE . . . . . **vi**

CONTENTS . . . . . **vii**

LIST OF FIGURES . . . . . **x**

LIST OF TABLES . . . . . **xii**

LIST OF ABBREVITATIONS . . . . . **xiii**

LIST OF SYMBOLS . . . . . **xiv**

ACHIEVEMENTS . . . . . **xvii**

1 INTRODUCTION **1**

1.1 Background 1

1.2 Problem Identification 5

1.3 Objective 5

1.4 Scope of Work 6

1.5 Research Methodology 7

1.6 Stucture of The Thesis 7

2 BASIC CONCEPTS **9**

2.1 General Communications 9

2.2 Channel Coding 10

2.3 Quasi-cyclic Low-Density Parity-Check Codes . . . 10
2.3.1 Accumulator Codes . . . 12
2.3.2 Low-Density Parity-Check (LDPC) Codes . . . 13
2.3.3 LDPC Codes for Encoding Process . . . 14
2.3.4 Traditional Decoding Process of LDPC Codes . . . 15
2.4 Parity Check Matrices and Generator Matrices Correlation . . . 16
2.5 Binary Phase Shift Keying (BPSK) Modulation . . . 17
2.6 Rayleigh Fading Channels . . . 17
2.7 6th Telecommunication Generation (6G) . . . 17
2.8 Artificial Intelligence (AI) . . . 18
2.9 Component of Machine Learning . . . 19
2.9.1 Data . . . 20
2.9.2 Models . . . 20
2.9.3 Training . . . 20
2.9.3.1 Supervised Learning . . . 21
2.9.3.2 Unsupervised Learning . . . 22
2.9.3.3 Federated Learning . . . 22
2.9.3.4 Reinforcement Learning . . . 22
2.10 Markov Decision Process (MDP) . . . 23
2.11 Backpropagation Algorithm . . . 25
2.12 The principle of Neural Network . . . 27
2.13 Log-likelihood Algebra and Soft Values . . . 30
2.14 Reinforcement Learning Framework for Rateless Coding Scheme . . . 32

3 SYSTEM MODEL . . . 34
3.1 System Model . . . 34
3.1.1 Learning for Channel Coding . . . 35
3.1.2 Learning to Transfer Knowledge . . . 40
3.2 Rate Adaptability Via Q-Learning . . . 42

4 PERFORMANCE EVALUATIONS . . . 45
4.1 The Effect of Bias and Activation Function in ML for LLR Values . . . 45
4.2 Machine Learning for Box-plus Operation . . . 48
4.3 Transfer Learning for QC-LDPC Codes . . . 50
4.4 Rate Adaptability Via Q-Learning . . . 53

4.5 FER Performances of The Proposed Reinforcement Learning-based Rateless Coding Scheme 57
4.6 BER Performances of The Proposed Reinforcement Leaning-based Rateless Coding Scheme 58
4.7 Complexity Analysis 60

5 CONCLUSIONS 63
5.1 Conclusions 63
5.2 Future Works 63

REFERENCES 64