ABSTRACT

This thesis proposed quantum error-correcting codes (QECC) that have a larger amount of quantum information than existing quantum codes. These quantum codes are stabilizer-based, called $[[N,K,d]]$ stabilizer codes with N is the block length, K the number of information, and d the minimum distance, which utilizes the classical parity-check matrix (PCM) as the stabilizer generator.

This thesis uses classical non-binary Hamming codes on the Galois field GF(4), i.e. $(5,3)$ Hamming codes, as the stabilizer generator element of $[[5,1,3]]$ quantum Hamming codes with $K = 1$ to serve as the basis for constructing the proposed quantum codes with information number $K > 1$. This thesis then increases the number of information to $K = 2$ with $[[10,2,3]]$ codes and $K = 4$ with $[[20,4,3]]$ codes, although only with $[[5,1,3]]$ quantum Hamming codes as a base. This thesis performs computer simulations to evaluate the performance of quantum word error rate (QWER) in quantum depolarizing channels.

This thesis successfully constructs quantum codes with $K = 2$ and $K = 4$ that have a symplectic inner product (SIP) equal to zero to guarantee all stabilizers and logical operators respectively commute. All syndromes generated by these proposed codes are unique so that they can be categorized as non-degenerate codes that provide perfect error correction. QWER performance analysis shows that the proposed quantum code works well characterized by the coincidence of simulation and theory QWER curves. The results of this thesis are expected to contribute to the development and research of stabilizer codes, especially quantum codes with larger quantum information.

Keywords: QECC, Hamming codes, stabilizer codes, GF(4).