School of Mathematics **Spring 2018**

QUANTUM COMPUTATION

Exercise sheet 6

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1. **Shor's 9 qubit code.** Imagine we encode the state $|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$ using Shor's 9 qubit code, and then an X error occurs on the 8th qubit of the encoded state $|E(\psi)\rangle$.

   (a) Write down the state following the error.

   (b) We now decode the encoded state, starting by applying the bit-flip code decoding algorithm. What are the syndromes returned by the measurements in the algorithm?

   (c) Now imagine that $|E(\psi)\rangle$ is affected by two X errors, on the 7th and 8th qubits. What are the syndromes returned this time? What state does the decoding algorithm output?

   (d) Which patterns of X errors are corrected by Shor's 9 qubit code?