

14 Quantum Computing (sjh227)

- (a) In the superdense coding protocol, Alice and Bob each have one qubit from the entangled pair  $\frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$ , which enables Alice to send two bits of classical information to Bob, using a single qubit. Explain the superdense coding protocol in detail, and show that it does indeed enable the transmission of two bits using a single qubit. [10 marks]
- (b) This question concerns entangled states.
- (i) Suppose Alice transmits the two-bit string ‘00’ using the superdense coding protocol and an eavesdropper, Eve, intercepts the qubit transmitted by Alice, measures it in the computational basis and then re-transmits to Bob. Find the probability that Bob correctly receives ‘00’. [5 marks]
- (ii) Suppose further that prior to Eve’s interception there is a 50% probability that the qubit experiences a bit-flip. What is the probability that Bob correctly receives 00? (Note that after Eve’s retransmission no errors occur) [5 marks]