Exeter College Oxford Summer Programme
Quantum Computer Science: an introduction

The course comprises 12 lectures, 6 seminars, and 4 tutorials. It requires the students to read in advance to gain an understanding of the contents to be discussed.

Lecture Schedule and required reading

Lecture 1. Introduction; classical bits and classical information

Andrew Steane, Quantum computing, Rep. Prog. Phys. **61** (1998) 117–173, sections 1 and 2. Mermin 1.1—1.4

Lecture 2. Classical computer science

Steane section 3.

Lecture 3. The basic quantum observation; superposition, entanglement, measurement

Feynman R, Leighton R B and Sands M L 1965 *The Feynman Lectures on Physics*, volume III, chapter 1.

Lecture 4. Mathematical background: linear algebra

Mermin Appendix A

Lecture 5. Quantum bits, quantum states, gates and measurement

Mermin 1.5 – 1.12

Lecture 6. No-cloning, Bell states, dense coding and quantum teleportation

Steane section 5.1—5.5, Mermin 6.1, 6.3—6.6

Lecture 7. Experimental methods

Steane section 8

Lecture 8. Quantum cryptography

Steane section 5.7, Mermin 6.2

Lecture 9. Quantum algorithms: Deutsch-Jozsa, Grover, Simon

Mermin chapter 2

Lecture 10. Period-finding, factoring and cryptography

Mermin chapter 3

Lecture 11. Communication in the presence of noise: classical error correction

Andrew M. Steane, *A Tutorial on Quantum Error Correction*, sections 1—5 [Proceedings of the International School of Physics "Enrico Fermi", course CLXII, "Quantum Computers, Algorithms and Chaos", G. Casati, D. L. Shepelyansky and P. Zoller, eds., pp. 1–32 (IOS Press, Amsterdam 2006).]

Lecture 12. Quantum error correction; Conclusion

Mermin chapter 5, Steane sections 5—8

GENERAL READING

There are various textbooks on quantum computing available in bookstores, and plentiful lecture notes on the web. The trick is to find material at the right level. Preskill's notes are too advanced for a reader with little mathematics, but will suit those ready for mathematical detail. Mermin's book is a good way in. The Wikipedia article gives a brief survey of ideas, perhaps worth a look before you plunge into a book. The book by Nielsen and Chuang is a good reference text. There is, finally, a very nice on-line book by Thomas G. Wong which is expressly designed to help people learn and has many examples.