School of Mathematics

Course 471 — Quantum Computing 2000-01
(JS & SS Mathematics)

Lecturer: Professor T. C. Dorlas

Requirements/prerequisites: Linear Algebra and some computing experience.

Duration: 21 weeks

Number of lectures per week: 3

Assessment: End of year examination.

End-of-year Examination: 3-hour end of year exam?

Description:

1. Introduction to the basics of classical computing

   Binary and heaxadecimal numbers. Elements of assemply language for DOS.

   Boolean logic. Definition of a Boolean ring. Various circuits: The full adder, binary decoders, multiplexers. flip-flops.

2. Introduction to quantum mechanics.

   The two-slit experiment. Plane waves. Probabilities and amplitudes. Dirac notation.

   Spin and Stern-Gerlach experiment.

   Hilbert space. Matrics and operators. Measurement and eigenvalues. Time evolution and the Schroedinger equation. Precession of spin. Pauli matrices and the magnetic Hamiltonian. Nuclear magnetic resonance.

3. Quantum computing.

   Definition of tensor product and qubits. Entanglement and the EPR experiment.

   Quantum gates and quantum circuits. The controlled-NOT gate, the Toffoli gate and the Hadamard gate.

   Universality and a proof of Deutch's theorem.

   Quantum parallelism and quantum algorithms. Deutch's theorem and the Deutch-Jozsa promise problem; quantum algorithm and classical random algroithm. Simon's XOR problem.

   Grover's search algorithm.

   Introduction to factorisation of numbers and Schor's algorithm.