Course content for MT3260/4260, Quantum Theory I

Prerequisites:

Aims:
To provide a complete introduction to the major methods and concepts of quantum theory at a level suitable for third year students. The course will stress applications and will cover many of the classic problems of quantum theory. The probabilistic theory of measurement is explained and its philosophical implications are touched upon.

Learning outcomes:
On completion of the course students should be able to:

- show whether a given operator is linear and hermitian
- to understand the probabilistic interpretation of quantum theory
- write down the Schrödinger equation for an arbitrary dynamical system
- obtain the expectation value of a hermitian operator for a given wave function
- to solve the Schrödinger equation and obtain the eigen-energies and energy eigenfunctions for a constant potential, the harmonic oscillator and the hydrogen atom
- to write down the uncertainty relationship between two conjugate hermitian operators.

Course content:
Historical origins of quantum theory and formal background: Linear Hermitian operators; Dirac delta functions. Closure, orthogonality; postulates of quantum mechanics.
Applications: Schrödinger equation: free particle, particle in an infinite well, particle in a box, potential barriers, quantum tunnelling. Particle in a finite well, quantum parity. Simple harmonic oscillator. Angular momentum. The hydrogen atom. The momentum representation.
More basic principles: Heisenberg uncertainty principle. Connections with classical physics, Ehrenfest's theorem. Measurement theory.