12998 - 334 (16) Quantum Mechanics A (3L, 3P)

2022

Course summary:

Schrödinger equation; spherically symmetric potentials, orbital angular momentum: Eigenvalues and spherical harmonic functions. The hydrogen atom. Time-independent perturbation theory, spin and application to the atom

Method of assessment: Flexible assessment

Prerequisite pass module: Physics 224
Prerequisite modules:

- *Physics 254*
- *Mathematics 214, 244 or Applied Mathematics 214, 244*

Language policy:

English only for a module:
Where all the students in the class group have been invited to vote by means of a secret ballot and those students who have voted, agree unanimously to the lectures being presented in English only.

As far as the COVIT-19 protocol permits, lectures and tutorials will be face-to-face

Module relevance in programme:

Following the mathematical preparation on waves (Physics 224) and the introduction to quantum mechanical ideas in the wave mechanics part of Physics 254, this module forms a foundation module for quantum mechanics, one of the pillars of the physics, and core to most modern physics. A systematic approach is followed, and one highlight is the explanation for the spectrum of hydrogen, which is treated in careful detail. The module leads directly to the Honours module in quantum physics, and is also the basis for all modules in atomic and nuclear physics (for example, Physics 354), solid state physics and a variety of laser and spectral physics applications. The concurrently offered statistical physics module (Physics 314) uses concepts of quantum mechanics, and of identical particles in a profound way.

Outcomes of course:

The student is skilled in the practical application of quantum mechanical principles in three dimensional microscopic systems like nuclei, atoms and crystals.

Lecturer:

Prof H Weigel
Telephone number: (021) 808-3378
E-mail address: weigel@sun.ac.za
Office: Room number 1025 in the Merensky Physics Building.

Mentor:

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for third year programme and its modules is **Mr GL Andrews (glandrews@sun.ac.za)**

Course content:

Revision

- Uncertainty principle
- Statistical interpretation
- Schroedinger equation
- Stationary states

Quantum mechanics in three dimensions
- Schroedinger equation in spherical coordinates

- Angular momentum and spherical harmonic functions
- Hydrogen atom
- Spin

Identical particles
- Two and more particle systems
- Bosons and fermions—Pauli's exclusion principle
- Periodic table of elements

Time-independent perturbation theory
- Non-degenerate perturbation theory
- Degenerate perturbation theory
- Applications
  - Fine structure of Hydrogen
  - Zeeman effect
  - Hyperfine splitting

Variational principle
- Theory
- Applications
  - Ground state of Helium atom

Practical (Tutorials):

One tutorial per week for 13 weeks

Tutorials and lectures are face-to-face (which may change according to regulations). Please observe all protocols and rules when attending lectures or tutorials.

Study material:

DJ Griffiths: ***Introduction to Quantum Mechanics***
Important note: There are many other, maybe even better, textbooks in the library!
Groffiths' textbook is recommended but not prescribed.

Assessment:

Methods of Assessments
Continuous assessment with the following components:

(approx. weekly) homework assignments:	25%
short oral exams (2):	25%
1st test (April 25th):	25%
2nd test (June 4th):	25%

Subject to changce wrt COVIT protocols .

Venue and time of assesment opportunities: See ***timetable*** on Physics home page

Availability of marks:
As soon as possible.