12998-254(16) Electromagnetism & Introduction to Quantum Physics (3l, 3p)

2015

Course summary:

Electrostatic fields; magnetic fields; electromagnetic induction and alternating currents, Maxwell's equations and electromagnetic waves. Quantum properties and wave-particle duality. Schrödinger equation in one dimension, eigenvalues and eigenfunctions for piecewise constant potentials and the harmonic oscillator. Time dependence, wave packets and tunnelling.

Continuous assessment

PP Mathematics 114,
P Mathematics 144
P Physics 224

Outcomes of course:

This course exposes the student to electromagnetism and quantum mechanics on an introductory level.

The electromagnetism component of the course will enable the student to understand and appreciate the most important equations of electromagnetism, namely the Maxwell equations. It also prepares the student for further applications and generalization of these equations. The main goal is to show that the properties of electromagnetic waves can be derived from the Maxwell equations.

The quantum mechanics component of the course establishes an understanding of the background to physical observations and arguments which lead to the introduction of quantum mechanics as the basic description of the microscopic world. Students will understand the motivation for and status of the Schrödinger equation and will be able to solve this equation for simple one-dimensional systems. The foundation for more general interpretation aspects of the measurement of physical observables is established. Students will also be able to solve and interpret the simplest quantum mechanical scattering processes which serve as an entry to how the bulk of information on the microscopic level is obtained.

Lecturers:

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Course content:

Formal lectures
The course is split into two term components in the second semester: the third term component focuses on electromagnetism and builds on the Physics 144 course. Topics covered includes: *Electrostatic fields*; *magnetic fields*; *electromagnetic induction* and *alternating currents*, *Maxwell's equations*, *electromagnetic waves in vacuum* and the *properties of the waves.*

The fourth term component comprises a first course in quantum mechanics. The course itself is strongly based on the first 11 chapters of French and Taylor, with the exception of chapters 6 and 7. The Bohr atom and evidence for discrete energy levels are discussed as background material, followed by wave

properties of particles with emphasis on the double slit experiment as discussed in the Feynman Lectures. This is followed by further motivation for the Schrödinger equation and applications to one-dimensional systems, including the infinite and finite square wells and the harmonic oscillator. Time-dependent states are discussed with emphasis on the superposition principle and the interpretation of measurements. Scattering from one-dimensional potential barriers is discussed in the time-independent framework.

Laboratory work
A program of practicals and tutorials will be provided.

Practical (Tutorials):

A program of practicals and tutorials will be provided.

Study material:

Prescribed texts:
DJ Griffiths, **Introduction to electrodynamics** (Prentice Hall, 1999 Fourth edition)

Recommended additional reading:
RP Feynman, RB Leighton and M Sands, **The Feynman Lectures on Physics, Vol III** (Addison-Wesley, 1971).

All books are on reserve in the Gericke and Physics libraries for the duration of the course.

Learning opportunities:

Tutorials
Video on Feynman's lecture about the double slit experiment.

Assessment:

Methods of Assessments
Continuous Evaluation.

Venue and time of assessment opportunities
Physics Merensky Building

See *timetable* on Physics home page.

Availability of marks:
Papers are returned as soon as possible.

Calculation of final mark for the module:
Electromagnetism:
Tutorial test 1 - 5%
Tutorial test 2 – 15%
Tasks – 15%
Practical work 30%
Test 1 – 35%

Quantum mechanics:
Class test 2 – 45%
Laboratory work – 25%
Homework problem sets, tutorial tests and class quizzes – 30%

*Note that Introduction to quantum physics covers one half of the Phys 254 module. The marks above refer to this part only.

Final mark: Quantum mechanics 50% Electromagnetism 50%