New SPA UG Modules 2017/18

Foundation Year: Introduction to Modern Physics (exercise class times unconfirmed) - Dr Teppei Katori

The purpose of this module is to provide a broad overview of modern physics and its development. The approach will be more descriptive than quantitative with the goal to describe physical phenomena and concepts rather than provide proofs and derivations.

The module will not require mathematics beyond basic algebra and complex numbers.

The topics include: theory of relativity, quantum mechanics, statistical mechanics, nuclear and particle physics, and cosmology.

First Year: Classical Physics - Prof David Dunstan

This module reviews the classical understanding of space, time and motion: the fundamental physical principles that underpin modern physics. We begin with an overview of classical mechanics, where we will study kinematics and dynamics; rotational motion; dynamics of a rigid body and the gyroscope; and gravity and planetary orbits. In the second part of the module, we focus on oscillatory phenomena and wave motion, which occur throughout nature in fields from biology to quantum mechanics. Topics will include the 1D wave equation; free, damped, forced and coupled oscillations; resonance and driven simple harmonic motion; calculations of normal modes for coupled oscillators; waves in linear media including gases and solids; dispersion, phase and group velocity; interference, beats and standing waves; simple diffraction phenomena; and the Doppler effect in sound and light.

Academic Content:

- Newton's laws and the laws of conservation of energy, momentum, and angular momentum, taking into account translational and rotational symmetry where appropriate
- Newtonian gravitation, including Kepler's laws, predicting the trajectory and performing simple calculations on circular and elliptical planetary orbits
- Non-intertial reference frames, in particular relating the Coriolis force with aspects of world weather and comprehending the motion of a gyroscope
- Free, damped, forced and coupled oscillations, including resonance and normal modes
- Waves in linear media, including waves on strings and sound waves, and including the concepts of phase and group velocities and the Doppler effect

First year: Professional Skills for Scientists (PC Lab) - Dr Jon Hays

This module develops professional and computational skills that are fundamental to the discipline, enable student engagement with employers, and expand student networks. Students develop introductory computational skills including using and writing computer programs to model physical systems, analyse quantitative data, and solve problems. These computational skills are applicable to any role that requires quantitative analysis and evidence-based decision making. Students will become proficient in preparing professional quality documents including scientific project reports, presentations and job application materials.

Academic Content:

- Methods of effective professional communication (i.e., cover letters, CV organisation and presentation, oral presentations)
- Introductory concepts of computer programming
- Computational methods for analysing data and solving problems in physics

Third Year: Computational Condensed Matter Physics (PC Lab) - Dr Kostya Trachenko

Computational Condensed Matter Physics has become a third distinct line of inquiry in addition to experiments and theory and had been playing a crucial role not only in physics but also in chemistry, biology, materials science and engineering. This course will cover fundamental theoretical ideas behind the computational methods such as molecular dynamics simulations with empirical potentials, electronic structure methods and Monte Carlo simulations. The theoretical ideas will be complemented with a hands-on computational laboratory using state-of-the-art programs with the aim of providing our students with a basic understanding of the technical implementations and strengths and shortcomings of these methods. The students will acquire and develop coding and analysis skills.

Academic Content:

- Develop an understanding of the theory behind modern computational methods such as molecular dynamics simulations, electronic structure methods and Monte Carlo simulations.
- Demonstrate the knowledge of main algorithms involved in molecular dynamics, ab initio and Monte Carlo methods and identify numerical and computational issues involved (integration algorithms, thermostats, basis sets, convergence criteria, computational requirements)
- Demonstrate the knowledge of how forces, minimization techniques and different ensembles are implemented in these methods.
- Identify what physical properties can be calculated on the basis of the three main techniques above and how.