10752-713(8) Solid State Physics (1½l, 1½p)

2017

Course summary:

Diffraction by crystals and the reciprocal lattice. Periodic crystal potentials, the tight-binding model, semi-conductors. Magnetism: para-, dia-, ferro- and antiferromagnetism. Superconductivity.

Module relevance in programme:

Monte Carlo algorithms are used extensively for numerical integration, whether this is a multi-dimensional integral, or a very complicated system consisting of many interacting particles. A Monte Carlo method is not only a numerical solution tool, but a means of performing numerical experiments from which much physics of many-particle systems can be learned (such as about phase transitions). Here we introduce the necessary computational and statistical tools and concepts to write such codes and to analyse the data they produce. The simulation of a two-dimensional ferromagnet will be of benefit to students following honours statistical physics (Physics 721), complementing the analytical approaches there. The third-year module, Physics 314, introduces some of the ideas relevant to this module, but also exposes students to the nature of the physical systems that we would want to study using computer simulations. The modules in computational physics (Physics 214, 244) provide a suitable precursor.

Outcomes of course:

The course is intended as introduction to various aspects of solid state physics. Students who complete the course will be familiar with the basic physical principles underlying a variety of fundamental phenomena in the solid state. The course aims to introduce fundamental concepts and techniques for describing matter in its solid state. The student will be exposed to the standard approximations, models and methods concerning this discipline. Important applications in current-day technology, industry, and research will be introduced as well.Learning Goals: Specific heat problem in a crystal; Free electron gas; Vibration in solids and phonons;

Lecturer:

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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 the Honours programme and its modules is Prof KK Müller-Nedebock kkmn@physics.sun.ac.za.

Course content:

Specific heat problem: Boltzmann, Einstein and Debye model. Electrons in metals: Drude and Sommerfeld theory. Vibration in solids and phonons. Tight binding model: an introduction. Geometry of crystals. Neutron and X-ray diffraction. Electron in solids and bands theory. Application to the bands theory: physics of semiconductors. Magnetism: para-, dia- ,ferro- and antiferromagnetism.

Practical (Tutorials):

Weekly tutorials (as per honours course schedule)

Study material:

Prescribed textbook: S.H.Simon "The Oxford Solid State Basic", Oxford University Press (2013).

Assessment:

Methods of Assessments
Assessment shall occur by means of continuous assessment, comprising the following: One final written exam which includes both theoretical questions and exercises; three homework assignments; one or more oral examinations (theory and/or exercises).

Venue and time of assessment opportunities
See timetable

Availability of marks:
Immediately following assessment or assignment.

Calculation of final mark for the module:
Final examination 40/100, homework assignments 54/100, one in-class oral examination 6/100.