Course Package

Materials Physics – Q2

Name module	Materials Physics - Q2
Educational programme	MSc Applied Physics
Period	First semester (Quartile 2)
Study load	15 ECTS

Materials Physics			
Quartile 1	**Quartile 2**	**Quartile 3**	**Quartile 4**
	Electives: choose 15 EC		
	Theoretical Solid State Physics **193510040** (5 EC)		
	Intro. to High Energy Physics **193530040** (5 EC)		
	Nano-Electronics **193400141** (5 EC)		
	Applications of Superconductivity **201100214** (5 EC)		

Suitable for: 3rd year student (or completed) the Bachelor of (Applied) Physics.

Required preliminary knowledge on bachelor level: Quantum Mechanics; Introduction to Solid State Physics; Nanoscience or Nanophysics (for Nano Electronics); Introduction to Superconductivity (for Applications of Superconductivity).

Electives: choose 15 EC

193510040 - **Theoretical Solid State Physics**

This course builds on Introduction to Solid State Physics, treating the material in more detail and extending the scope to cover a number of additional topics:

- Tight-binding method
- Semiclassical Transport Theory
- Magnetism

The emphasis of the course is on operationalizing the theoretical material treated in the lectures by doing homework. This is corrected and the mark contributes to the final mark.The course is based upon the following chapters of "Solid State Physics" by Ashcroft & Mermin, supplemented with lecture notes:

§1 The Drude Theory of Metals

§2 The Sommerfeld Theory of Metals

§3 Failures of the Free Electron Model

§10 The Tight-Binding Method

§12 The Semiclassical Model of Electron Dynamics

§13 The Semiclassical Theory of Conduction in Metals

§14 Measuring the Fermi Surface

§15 Band Structure of Selected Metals

§16 Beyond the Relaxation-Time Approximation

§17 Beyond the Independent Electron Approximation

§31 Diamagnetism and Paramagnetism

§32 Electron Interactions and Magnetic Structure

§33 Magnetic Ordering

193530040 - **Introduction to High Energy Physics**

- Big bang and elementary particles: 'macroscopy' versus 'fermiscopy',
- Theory of special relativity and relativistic kinematics,
- Particles, waves and fields,
- The atomic nucleus and particle decay,
- Rutherford scattering and the theory of scattering,
- Electromagnetic, strong and weak interactions,
- Matter – antimatter asymmetry
- Baryons en mesons: the quark model,
- Particle accelerators,
- W± en Z0 : carriers of the weak force; experiments,
- The Standard Model and the discovery of the top quark and Higgs boson
- Structure of the proton: the quark-parton model; experiments,
- Electron-positron annihilation; precision measurements,
- Particles and matter: detection principles,
- Detectors in high energy particle and astro-particle physics.

193400141 - Nano-Electronics

Nanoelectronics comprises the study of the electronic and magnetic properties of systems with critical dimensions in the nanoregime. Quantum electronics, spin electronics, organic electronics and neuromorphic electronics form important subfields of nanoelectronics and are being discussed in this course. Quantum electronics and neuromorphic electronics will be treated in-depth. For those who want to get a thorough introduction into the new exciting directions that will contribute to future electronics, this course is indispensable. Recommended for MSc students Nanotechnology. Applied Physics and Electrical Engineering. The course consists of lectures, assessments and a project. In the project, a small research proposal is written on a theme related to the course. The proposal is presented in written and oral form and graded by the lecturers.

201100214 - Applications of Superconductivity

Superconducting materials: Metallic (NbTi, Nb3Sn, MgB2), ceramic (ReBCO, BSCCO) and pnictide (BaFe2As2) materials; Superconductor shape and processing (composite wires and tapes); Structure and function of superconducting cables.

Physical and technological issues: Transport properties and characteristic critical currents and current densities; Thermal-electro-magnetic stability criteria; Magnetization and Alternating Current losses; and the dependence all of these issues on temperature, magnetic field and mechanical strain.

Practical applications: High-field magnets for e.g. High Field Magnet facilities, NMR and MRI medical diagnostics; Magnets for particle accelerators (like the LHC and FCC at CERN) and for medical accelerators for proton therapy; Particle detector magnets; Magnets for Plasma Fusion reactors (ITER, W7X, DEMO); Electrical power applications (motors, generators and cables for current transport).

Please note: these packages are not fixed. They serve as an example of what you are able to select. It may be possible for you to make changes if you would like to do so.

The modules are tentative and subject to change. Please check the website *regularly.*