Course Package

Applied Physics – 2B

Name module	Applied Physics - 2B
Educational programme	MSc Applied Physics
Period	Second block of the second semester (block 2B)
Study load	15 ECTS

Applied Physics			
block 1A	**block 1B**	**block 2A**	**block 2B**
			Electives: choose 15 EC
			Capillarity Phenomena – 193565000 (5 EC)
			Cryogenic Science and Techn. - 201100146 (5 EC)
			Biomedical Optics – 193500000 (5 EC)
			Modern Topics in Condensed Matter Physics – 201500167 (5 EC)
			Fluids and Elasticity - 201400195 (5 EC)
			Medical Acoustics – 193542070 (5 EC)

Required preliminary knowledge: Completed Bachelor's (Applied) Physics; Basic course Fluid dynamics; Bachelor TN or equivalent; Thermodynamics; Geometrical and Physical Optics; Basic mathematical skills; including working with complex numbers; Simple Differential Equations and Fourier Transforms; Basic skills in MATLAB or Python for data processing; Heat and Mass Transfer; Thermodynamics.

Electives: choose 15 EC

193565000 - **Capillarity Phenomena**

Many physical and technological processes are affected by Capillarity and Wetting (C&W) phenomena. C&W phenomena dominate many processes in fluid dynamics on small scales. Compared to other fluid physics courses within the APH curriculum this course focuses on the effect of interfaces and the related interfacial energies that control fluid flows indirectly by imposing well-defined boundary conditions. The course focuses on fundamental concepts described within the context of fluid dynamics and discusses a variety of classical phenomena of microscopic fluid flows.

The course covers the following topics:

- Molecular interaction force and interfacial tensions
- Derivation of the fundamental equations of Young and Laplace
- Wetting in external fields
- Wetting and molecular forces (disjoining pressure)
- Thin film flows and lubrication approximation
- Linear stability analysis and classical instabilities (Rayleigh Plateau, Rayleigh Taylor)

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.*

- Contact line dynamics
- Dewetting
- Surface tension-driven flows (Marangoni)
- Electrowetting

201100146 - **Cryogenic Science and Technology**

Learning objectives
1. Is aware of the historical developments in producing cold and cryogenics.
2. Recognize and understand the material and fluid properties at low temperatures. Is able to plot the phase diagrams of typical cryogenic substances.
3. Is able to apply design principles in the construction of a cryostat and other cryogenic equipment. Is aware of the safety standards related to handling cryogenic equipment.
4. Recognize the working principles of cryogenic coolers and liquefiers. Is able to apply fundamental thermodynamic laws to analyze the system performance. Interpret thermodynamic property diagrams.
5. Analyse and model heat transfer at low temperature.
6. Describe and explain cryogenic instrumentation methods and principles.
7. Synthesize and propose applications of cryogenics
8. Analyze low temperature transport phenomena and identify dominant physical principles.

193500000 - Biomedical Optics

Skin and other biological tissues scatter light, making it impossible to look directly inside the body. Still, there are many optical methods that can image structures deep under the skin e. g. by cleverly using interactions between light and tissue, by exploiting the properties of light propagation in scattering materials, or by combining light with ultrasound. In this course, you will get to know the basic theoretical models for light propagation in biological tissue, and you will learn the working principle of a large range of optical imaging methods, ranging from highly experimental approaches to devices widely used in the clinic on a daily basis. Topics include: light scattering on small particles, light diffusion and radiative transport, optical coherence tomography, photoacoustic tomography, speckle-based blood flow monitoring, optical wavefront shaping, and more. In addition to the lectures, you will perform a series of light-scattering experiments.

Written examination (weight factor 0.5). Reports on experiments (weight factor 0.5).

Threshold: a minimum grade of 5.5 is required for both parts (the written examination and the experiment report). If this threhold is not reached, the lowest of the two grades is counted.

201500167 - Modern Topics in Condensed Matter Physics

Modern topics in condensed matter physics will be introduced and studied form recent literature. After an introductory lecture on the topic, students should deliver an oral report on recent literature articles.

The topics are:

- Advanced Spectroscopy
- 2D Materials
- Tuneable interactions
- Reactions @ surfaces
- 1D systems

201400195 - Fluids and Elasticity

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Many fluid flows exhibit interactions with deformable, elastic boundaries. Examples range from flexing of airplane wings to wetting of soft contact lenses by a tear film. The objective of this course is to provide an introduction to the basics principles of elasticity theory, viewed from a fluid mechanical perspective. We first derive the Navier equations and various solution strategies to classical problems in elasticity, such as Hertz contacts, cracks and surface waves. We then develop a variational formalism to discuss beam mechanics and buckling, and discuss several elastic instabilities. After these basics, we address a selected set of contemporary problems bordering fluid physics and elasticity.

193542070 - Medical Acoustics

This course will focus in-depth into various diagnostic methods used in medical ultrasound for cardiac and radiology applications. These include color flow Doppler, intravascular ultrasound, high-frequency ultrasound and contrast imaging. Several experts in the field of medical ultrasound will provide interesting cases. There is ample room for hands-on demonstrations in the practical sessions.

There will be a weekly lecture on Thursday mornings followed by a tutorial session. In the practical sessions on Friday mornings knowledge obtained in the lectures will be put into practice. The goal is to design a simple medical ultrasound scanner.

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