Module Number	Title:
2a	**Foundations Medical Physics**

Module type: compulsory elective	**Language:** English		**Group Size:** 18 students
Study semester: 1	**Availability:** winter semester		**Duration:** 1 semester
Workload: 180 hrs	**Credits:** 6 CP	**Contact time:** 30 hrs	**Independent Study:** 150 hrs

1	**Courses** a) Lecture: 1 PPW b) Practical Course: 2 PPW
2	**Intended Learning Outcomes** Upon completion of this course, students should be able to describe physics concepts with relevance in medicine and apply these concepts in diagnostics and therapy. After the attendance of this course, students are capable to operate essential medical physics equipment, understand their physics and document and analyse the scientific experiments.
3	**Content** **Lecture:** i. *Physics of x-Ray tomography*. x-ray production, x-ray absorption and scattering, x-ray detection. Image formation. ii. *Magnetic resonance*. Magnetic spins, Larmor frequency, spin resonance, spin interaction, contrast, electromagnetic induction. iii. *Magnetic resonance imaging.* Spin manipulation, spin relaxation, spin-echo and gradient echo imaging techniques. iv. *Ultrasound imaging.* Production and propagation of ultrasounds, imaging, absorption and reflection of ultrasounds, image resolution. v. *Blood flow.* Laminar and turbulent flow, Doppler effect, blood velocity and application to stenosis. **Practical Course:** *i. x-Ray tomography*. 3D imaging and artefacts, absorption and scattering, image formation. ii. *Magnetic resonance.* Measuring of the Larmor frequency, free induction decay, measuring of the relaxation times, effect of contrast substance. iii. *Magnetic resonance imaging.* Spin-echo and gradient echo techniques. Effect of work parameters on the image quality. iv. *Ultrasonic imaging.* Measuring of sizes and distances, 3D-imaging and artefacts. Measuring of the heart rate and cardiac output in a heart model. Ultrasonic control of the eye, using an eye model. v. *Blood flow.* Measuring the blood velocity in an arm-model. Measuring of laminar turbulent flow in continuous and pulsed mode. Stenosis detection and characterisation.
4	**Teaching methods** Lecture on the mathematics and concepts of medical physics and their experimental implementation (block of 15 lessons in one week); carrying out experiments in the laboratory, taking, analysis and interpretation of experimental data in the fields of the content (5 blocks of 5 hrs each).
5	**Prerequisites** **Formal:** Proficiency in English level B2 of Common European Framework of Reference for Languages (CEFR) **With regards to content:** Basic knowledge of and interest in mathematics and physics
6	**Examination types** Written report The report should be about 10 pages per experiment, document the familiarity with the experimental work and contain the data taken as well as their analysis.

7	**Requirements for award of credit points** Active participation on practical exercise; passing the oral examination prior to each experiment and submission of a report which gets graded with 4.0 or better four weeks after ending of practical exercise.
8	**Module applicability (in other study courses)** None
9	**Assessment** The mark given will contribute to the final grade in proper relation to its credits.
10	**Module convenor and main lecturers** Prof. Dr. Thomas Heinzel, PD Dr. Mihai Cerchez
11	**Further information** Pre-reading material will be handed out 2 weeks in advance of the laboratory course. The lecture is scheduled for the week preceding the laboratory course. The content of both the pre-reading material and the lecture is prerequisite for the admission to the experimental equipment. For safety reasons and for the conservation of high-value technical resources prior to each experiment the students will be examined orally regarding the operational principles of the experiment. Successful examination grants permission to start the experiment.