Course Package

Imaging & In Vitro Dagnostics – Q4

Name module	Imaging & In Vitro Dagnostics – Q4
Educational programme	MSc Biomedical Engineering
Period	Second quartile of the second semester – Q4
Study load	15 ECTS
Coordinator	J. Huttenhuis

Imaging & In Vitro Dagnostics			
Quartile 1	**Quartile 2**	**Quartile 3**	**Quartile 4**
			Biomedical Optics 193500000 (5 EC)
			Advanced Computer Vision and Pattern Recognition 201100254 (5 EC)
			Imaging Technology in Radiology 201800114 (5 EC)

Required preliminary knowledge: Basic mathematical skills, including working with complex numbers, simple differential equations, and Fourier transforms; Knowledge of geometrical and physical optics, including interference; Basic skills in MATLAB or Python for data processing; Understanding of how to obtain measurable signals from the human body using CT, PET/SPECT, and MRI.

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 four light-scattering experiments. For these experiments, you need **only four time slots** out of the slots mentioned in the schedule. At the beginning of the course you can schedule these practicum sessions in order to prevent overlap with other courses.

201100254 - Advanced Computer Vision and Pattern Recognition

Advanced Computer Vision and Pattern Recognition (ACVPR) is a compulsory course for the Computer Vision and Biometrics (CVB) Master's Specialisation for EE, but the course can also be followed by students in other specialisations and programmes, like CS, EMSYS, and others. The course uses project-based learning, i.e. you learn subjects by studying and applying them in the context of a specific project. Normally, you will work in groups of 2-4 persons on a subject. The results of the project are to be reported in the form of a short scientific article of about 6 pages.

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

The subjects of the projects are divided into 3 main themes:

Deep Learning in Computer Vision
Video Analysis
Computer Vision for Biometrics/classical computer vision

The ACVPR course uses current literature, i.e. published articles. A useful book on Image processing techniques is "Computer Vision Algorithms and Applications" by Richard Szeliski. The book can be downloaded from Springer for free.

201800114 - Imaging Technology in Radiology

The goal of this course is that students understand and can apply techniques that are currently used in the clinic to generate medical images from signals. Next to that they can optimize the acquisition and reconstruction of these images for specific purposes such as image quality, acquisition time or dose reduction.

It is expected from the students that they already know how to get a measurable signal from a human body using CT, PET/SPECT and MRI. The requirements on hardware to obtain signals should therefore be known. Using this course the students learn how to make optimal use of this equipment.

The lectures on radiography and fluoroscopic imaging give the student an overview of the radiographic and mammographic systems used in the clinic, as well as on fluoroscopy systems used for interventional procedures. The different clinical applications of these systems, their relation to patient dose, and the relation between image quality and the diagnostic accuracy are discussed.

In the lectures on Computed Tomography students will gain insight in the different configurations of CT systems, the techniques of image formation, image reconstruction and the influence of acquisition and reconstruction parameters on image quality. In addition, the students will learn about radiation dose in CT and the significance of dose saving strategies and radiation dose indices provided on the scanner. The translation of the technical parameters on CT and their influence on the diagnosis of patients will be enlightened by different case studies.

The PET/SPECT lectures will introduce the key aspects of nuclear medicine imaging. Radioactivity as a means of detecting functional processes inside the body and radiation protection issues will be considered. The students will also gain insight into technological basics of PET and SPECT scanners as well as into image reconstruction and quantification techniques. Typical artefacts will be presented in selected case studies.

During the MRI part of the course students will become familiar with signal encoding that makes generating images possible and the parameters that influence the resulting image quality and resolution. Next to that, students will learn how this acquisition can be described and optimized in the frequency domain. Finally, by practical sessions on an MRI scanner students will learn how to use a scanner and optimize it for a specific use.