Course Package

Physiological Signals and Systems - 2B

Name module	Physiological Signals and Systems - 2B
Educational programme	MSc Biomedical Engineering
Period	Second block of the second semester (block 2B)
Study load	15 ECTS
Coordinator	J. Huttenhuis

Physiological Signals and Systems			
block 1A	**block 1B**	**block 2A**	**block 2B**
			Dynamic Behaviour of Neuronal Networks 193810100 (5 EC)
			Identification of Human Physiological Systems 201700071 (5 EC)
			Electives: choose 5 EC
			Bioelectromagnetics - 201400282 (5 EC)
			Topics in Human Anatomy & Sports Physiology- 202200365 (5 EC)

Required preliminary knowledge: BSc in Biomedical Engineering; Technical Medicine or another relevant technical BSc. Matlab basic programming skills; Basic Knowledge of Anatomy and Physiology; Signal Analysis (incl. Sampling; Fourier Transform; Filtering; Windowing); Applied Physics; Biomedical Engineering; Applied Mathematics; Electrical Engineering; Advanced Technology; the courses 'Biological control systems' or 'Mathematical Methods are recommended; Neural Systems; Neurophysiology; Electric circuit analysis; Vector Analysis; Advanced Techniques for Signal Analysis.

193810100 - Dynamic Behaviour of Neuronal Networks

Complex networks of interacting neurons define the physiological properties of various brain functions, including motor control, language, perception, autonomic control, and memory. Intuitive reasoning about these networks is often sufficient for a first global understanding or guiding a particular treatment or experiment. However, a more profound understanding will provide tools to contribute to new developments and insights relevant for improved diagnostics and innovative therapeutic approaches.

The second-year TG bachelor module "Neurale systeem en onderzoek" touches upon various issues related to membrane and network dynamics. The emphasis, however, was rather conceptual, and the treatise was mainly at an introductory level. This course will present a much more in-depth treatment of the physiology and dynamic behaviour of neurons and neural networks. From a clinical perspective, we will integrate this knowledge with various diseases of the central or peripheral nervous system and the EEG.

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

We will discuss basic concepts from nonlinear dynamics, including equilibrium, limit cycles, homoclinic orbits, stability and synchronization. Modelling and simulation will be introduced to understand the individual behaviour of neurons and their interactions better.

Various examples from basic neuroscience to clinical neurology and neurophysiology will be treated, with an emphasis on epilepsy, ischaemia and neuromodulation (e.g. for the treatment of seizures or movement disorders). The course also discusses how modelling and simulation can contribute to a better understanding of normal and pathological EEG rhythms.

201700071 - Identification of Human Physiological Systems

Distorted physiological control systems underlie various impairments in motor control, respiration and cardiovascular function. For instance, a hyperactive control loop to regulate muscle length is the underlying cause for spasticity. Clinicians are perfectly able to see that something is wrong and can use available clinical scales to quantify the severity of the impairment or disability. However, they are much less able to see what is wrong. System identification techniques make it possible to characterize the distorted physiological control systems for various conditions in a standardized way. In this course, we will cover different approaches and techniques to be able to identify a linear system. The addressed topics vary from correlation functions, identification in the frequency and time domain, open and closed loop system identification, perturbation signal design and parameter estimation and optimization. In the course we will focus on distorted human motor control. Yet, the learned methods and techniques can be applied to a wide range of physiological and technical systems.

Electives: choose 5 EC

201400282 - Bioelectromagnetics

In this course, a general introduction to the theory of volume conduction of ionic currents (bioelectric sources), based on Maxwell's equations, is presented. This generalized approach can be applied to the various electrophysiological and biophysical processes underlying the generation of bioelectrical activity (nervous system and muscles) which generate the electrical and magnetic signals that can be measured noninvasively on the body surface, such as the electroencephalogram (EEG)/magnetoencephalogram(MEG), the electrocardiogram (ECG)/ magnetocardiogram(MCG), and the electromyogram (EMG). These signals provide information on the (patho)physiological condition of the corresponding tissues in clinical situations.

With this course, students should be able to:

- analytically describe static electric and magnetic fields of simple setups (e.g. current sources in a homogeneous medium)
- analytically describe simple cases of electromagnetic waves based on Maxwell’s equations
- numerically compute examples of static electric and magnetic fields in more complex volume conductors
- adapt these numeric simulations to problems in biomedicine, e.g. neurology or cardiology
- write a short paper on a specific problem with clinical relevance.

200900040 - Topics in Human Anatomy & Sports Physiology

This course will focus at different topics in the field of human anatomy and physiology with a focus on sport injuries and sport physiology. Lectures and practical courses will be used alternatively. In addition, guest speakers who are experts in the field of sport injuries and rehabilitation will provide one or more lectures. The course will be examined by a written exam and two assignments throughout the course.

Topics that will be addressed are:

- Anatomy
- Anatomy and pathology of the upper extremities with a focus on injuries of the shoulder
- Anatomy and pathology of the lower extremities with a focus on injuries of the knee
- Anatomy in vivo with a focus on the muscular structures involved in sporting activities
- Clinical anatomy and physiology
- Neuro-anatomy and physiology for motor control
- How imaging can help to detect (sports) injuries

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