Course Package

Physiological Signals and Systems – Q3

Name module	Physiological Signals and Systems – Q3
Educational programme	MSc Biomedical Engineering
Period	First quartile of the second semester – Q3
Study load	15 ECTS
Coordinator	J. Huttenhuis

Physiological Signals and Systems			
Quartile 1	**Quartile 2**	**Quartile 3**	**Quartile 4**
		Human Movement Control **191150480** (5 EC)	
		Biomedical Signal Acquisition **191210720** (5 EC)	
		***Advanced Techniques for Signal Analysis** **193810020** (5 EC)	

Required preliminary knowledge: Completed BSc degree in Biomedical Engineering; Electrical Engineering; Physics / Applied physics, or an equivalent of Technical Medicine; knowledge of Dynamics and Control; Basics of Linear System Analysis; Basics of Linear Algebra; Familiarity with Matlab; Signal Analysis (incl. sampling, aliasing, Fourier transform, filtering, windowing); Advanced control engineering; Brain in Balance: Mechanics; Systems Analysis; Biorobotics: Multibody Dynamics & Control; Biomedical Signal Analysis; Dynamical Systems: Dynamics 1; Mechatronic Design: Dynamics 2; System and Control Engineering 1.

*Mandatory knowledge: Matlab basic programming skills

191150480 - Human Movement Control

Different neuromuscular systems are involved in the control of human movement. These systems include the different sensory systems (visual, proprioceptive, vestibular), the central nervous system and the muscles. This course discusses the role of the separate systems and their interactions in motor control with an emphasis on integration of sensory information, postural control and control and adaptation of reaching movements. Obtained knowledge can be applied in the development of treatments and assessment methods for diagnosis in neurology and (neuro)rehabilitation. In this course student will obtain knowledge about the physiological and computational mechanisms involved in movement control through lectures and self study and will learn to make use of engineering skills/tools in assignments and a practical to better understand the importance of the different involved processes.

Regarding the required background skills and knowledge, you should be able to:

- Make a free body diagram of a particular system including all forces and moments working on the system
- derive the equations of motions for a particular system,
- linearize a nonlinear differential equation around an operating point
- transform the different representations of a linear time invariant (LTI) system in each other (differential equation, state space, transfer function),
- know how the Bode Diagram and step response of standard LTI systems (integrator, differentiator, time delay, 1st order system) look like,
- indicate the effect of mass, damping coefficient and spring constant of a mass-spring-damper system on the response of this system in the time and frequency domain,
- know how relative damping, the system gain and eigen frequency can be recognized in a time and/or frequency response,
- determine the stability of a system using the Bode diagram/Nyquist diagram and poles and zeros.

191210720 - Biomedical Signal Acquisition

The electrochemical detection methods form a beautiful comprehensive part of this course: starting from electrochemical processes at an electrode and the subsequent mass transport phenomena result in the three basic operational principles (potentiometry, amperometry and conductometry). When the relation between the variable to be determined (ionic species and/or its concentration) and the measured quantity (voltage, current or conductance) is known, the relevant examples follow: the oxygen electrode (Clark electrode), the carbon dioxide sensor (Severinghaus princinciple) and the pH sensors (glass electrode). Additionally, other chemical biosensors like the glucose sensor, and biosensors based on optical detection principles are treated. The treatment of physical sensor systems is guided by the biomedical application: blood pressure and flow, lung volume and capacity. A bridge to the course Lab-on-a-Chip is formed by some examples of micro Total Analysis Systems, of which the detector is based on one of the mentioned sensor principles. This course is open for TM, MBE, APH, NANO and EE students. General knowledge from your bachelor programs is required. For TM students, this course bridges the gap between biophysiology and biomedical signal processing and -analysis. This course consists of 12 lectures, where you actively participate in discussions to reach the learning objectives.. You will write your critical review paper in teams of two students to train and improve your knowledge and understanding via the original papers you have to review. Moreover, a 4-hr practical project concerning synchronous sensor data retrieval into a computer is one of the instructional modes of this course.

193810020 - Advanced Techniques for Signal Analysis

The signal analysis techniques that were introduced in the bachelor phase of the Technical Medicine program are often not sufficient for the analysis of biomedical signals. These signals often have stochastic characteristics and may change significantly during short periods of time (non-stationarity), e.g., EEG recorded during an epileptic seizure. Signal analysis requires knowledge of the underlying physiology in order to design accurate detection and/or parameter estimation algorithms of the corresponding system. Artefact removal is often required to eliminate or reduce signals generated from the continuous processes within the body (respiration, cardiac activity, eye blinking, etc.). In this course several advanced techniques will be investigated for the analysis of biomedical signals; examples: EEG incl. epileptiform discharges, EEG during sleep, ECG, EMG, MUAPs.Several signal analysis techniques will be explained in the syllabus and during the lectures. Theoretical and clinically oriented exercises will be solved during the course using Matlab.