Faculty common course 2021

English course title: Electrical Measurements for Biomedical Applications

Swedish course title: Elektrisk Mätteknik för Biomedicinska Applikationer

Extent (credits): 4 hp

Language of instruction: English

Recommended prerequisites: Students from different fields of natural sciences and engineering can attend the course but they should have at least basic knowledge of either electrical engineering OR cell culturing. The students will use a data analysis software of their choice, e.g., Matlab or similar, and therefore they should be familiar with at least one such software.

Learning outcomes of the course: This course gives the students an overview of technology and methodology where electrical measurements assess biomedical parameters, a field which is believed to increase in importance as a range of biological models with increased complexity and specificity are developed. The students will be trained in interdisciplinary research where electronics is mixed with biology. The students are also trained in data analysis and learn about state-of-the-art research for one of the presented techniques through project work.

Specify which learning outcomes of the doctoral degree that are address/covered (see appendix 1 of the call or the template of ISP). Describe how:
A1. Demonstrate broad knowledge and systematic understanding of the research field as well as advanced and up-to-date specialized knowledge in a limited area of this field.
•The course systematically goes through the electrical measurement techniques commonly used in biomedical applications.
•The students will make a focused project on research performed by using one of the techniques.
•The course brings together students with different backgrounds, and by this, the students will reflect on and discuss the broader research field than their own.

A2. Demonstrate familiarity with research methodology in general and the methods of the specific field of research in particular.
•The lectures discuss techniques for electrical measurements in biomedical applications in terms of methodology to give an overview and an understanding of the similarities and the differences of the different approaches.
•The students will read up on one method through a focused project and attend the presentations of the other students' projects and thereby increase their knowledge of research methodology. In particular, the students will get practice on how to critically assess the relevance of the commonly used methods by reviewing scientific publications on the subject.

B1. Demonstrate the capacity for scholarly analysis and synthesis as well as to review and assess new and complex phenomena, issues, and situations autonomously and critically.

•By reading and presenting scientific publications, the students will learn how to autonomously and critically assess other people's work. This will also be beneficial for the students when planning and conducting their own research projects.

B5. Demonstrate the ability to identify the need for further knowledge.
•In the course, the students will perform a focused study and review scientific publications on a specific technique. For the students to be able to judge the scientific quality of these papers, they will have to practice their ability in identifying the need for new knowledge and how to obtain and analyze new information.
•The students will be asked, as a part of their project, to give an outlook on how the investigated technique best can be used in future research and to present and discuss this with the other students.

B6. Demonstrate the capacity to contribute to social development and support the learning of others both through research and education and in some other qualified professional capacity.
•An introductory exercise is planned where students will be asked to read up on and present the material prepared by teachers on the basics of the field that they are more familiar with, out of electrical measurements and cell culturing, and present and discuss this with students (or teachers) holding the other field as less familiar.
•By presenting their project and discussing the results in an interdisciplinary context, the students will learn how to support the learning of others, specifically those with a different background.

Course contents:This course outlines the fundamentals of bioelectrical measurements, as well as electrical properties of cell cultures, different types of cell culture constructs, and possible configuration setups for performing bioelectrical measurements on these cell cultures. A special focus of this course will be how microsystems technology (MST) can be used for these measurements when performed in vitro. The following topics are covered in the course:

•Basics of electrical resistance, impedance, electrical permittivity
•Basics of cell cultures and their electrical properties
•A brief introduction to MST, how different bioelectrical characterization techniques can be implemented, and its benefits for bioelectrical research
•Different bioelectrical characterization techniques as well as their pros, cons. The covered techniques will include electrophoresis, dielectrophoresis, electric cell-substrate impedance sensing (ECIS), impedance microbiology (IM), electrochemical impedance spectroscopy (EIS), patch-clamp technique, transendothelial/epithelial electrical resistance (TEER), and field potential measurements using multi-electrode arrays (MEA).

Instruction (course structure): The course includes six two-hour (2 x 45 min) lectures. After the first lecture, an introductory exercise for which the students prepare to teach other students from the course will be organized. The students will conduct a computer-based exercise and write a report on their results. Towards the end of the course, the students will have focused projects, which are presented orally during two occasions. If very few students attend the course, the format may be adapted.

Assessment (form of examination): The examination will include

•Preparation for and active participation in the introductory exercise
•Active participation in the lectures (minimum 5 of 6)
•A written report for the computer exercise
•An oral presentation of the focused project

Course examiner (name, e-mail): Zahra Atena Khaji (atena.khaji@angstrom.uu.se), Sofia Johansson (sofia.johansson@angstrom.uu.se)

Department with main responsibility: Materials Science and Engineering

Contact person/s (course responsible teacher) (name, e-mail): Zahra Atena Khaji (atena.khaji@angstrom.uu.se), Sofia Johansson (sofia.johansson@angstrom.uu.se)

Course dates/period: Spring 2021

Maximum number of participants: 24

Submit the application for admission to: Zahra Atena Khaji

Submit the application not later than: December 10th ,2020