EE-515

Fundamentals of biosensors and electronic biochips

Guiducci Carlotta

Cursus	Sem.	Type
Bioengineering	MA1, MA3	Opt.
Biomedical technologies minor	H	Opt.
Chimiste	MA1, MA3	Opt.
Data and Internet of Things minor	H	Opt.
Electrical and Electronical Engineering	MA1, MA3	Opt.
Life Sciences Engineering	MA1	Opt.
Neuroprosthetics minor	H	Opt.
Sciences du vivant	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Withdrawal	Unauthorized
Session	Winter
Semester	Fall
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	**70**

It is not allowed to withdraw from this subject after the registration deadline.

Summary

The labels "biosensor"## and "eBiochip" have been employed to refer to the most diverse systems and in several fields of application. The course is meant not only to provide means to dig into this sea but also a thoughtful understanding of the detection principles and a design perspective.

Content

PART I Fundamentals
§Ch 0 Laying the foundations.
§More definitions (assay, diagnostics, …); §Parameters qualifying a sensor.
§Ch 1 Possible configurations of a biosensing system.
§Area confined and surface confined. §Miniaturization consequences
§Ch 2 The solid/liquid interface
§Electrical properties §Optical properties §Surface chemistry to make a surface sense. Specificity
§Ch 3 Systems working in dynamic regime
§Sensors in flow chambers or in channels §Large consequences of going Nano
PART 2 Detection principles and analysis
§ Detection principles
§Charge transfer § Probing interface electrical parameters § Probing interface optical parameters § Characterizing mass change on a surface § Perturbation of electrical field in hybrid electron devices (transistor)
§Case studies of micro/nanosensors and high throughput systems

Learning Prerequisites

Recommended courses

Understanding Statistics and Experimental Design
Related courses:
BioMEMS
Bioanalytics and analytical sensors

Important concepts to start the course

The course is hystorically addressed to students with many sorts of background.
When needed, the premises for the understanding of certain topics are outlined and discussed during the course.
In particular, the course would require some familiarity with the fundamentals of molecular biology and a

solid physics background.
Instrumental prerequisites that span from electrode/solution interfaces, to binding kinetics, to electrical characterization of biological elements, to microelectronic proccesses are recalled and integrated in the course material.

Learning Outcomes

By the end of the course, the student must be able to:

- Describe the component of a biosensing systems and the possible configurations
- Advise on available biosensing technologies and level of integration depending on the application
- Discuss the consequences of miniaturization n biosensing systems
- Describe in details some examples of commercial biosensing techniques
- Design biosensing systems with respect to their size

Transversal skills

- Access and evaluate appropriate sources of information.
- Demonstrate the capacity for critical thinking
- Use both general and domain specific IT resources and tools

Teaching methods

§3 credits
§2/3 Frontal lecture.
1/3 exercises

Expected student activities

§Come to classes
§Study assigned material
§Prepare exercise before the session

Assessment methods

§Written exam (end of the semester)

Supervision

Office hours	Yes
Assistants	Yes
Others	office hours on appointment

Resources

Bibliography

A selection of chapters from the books listed below is proposed to explore some topics and deepen understanding. The list is non exhaustive of the concerned literature and does not cover the entire content of the course that is supported by the slides and by selected scientific journal papers.
Bioelectronics handbook, M. Grattarola, G. Massobrio, Ms Graw Hill - (Part 2, Ch 8, Ch 9 Ch 10)
Intermolecular and Surface Forces, J. Israelachvili, Academic press, (in particular Ch 12)
Surface Design: Applications in Bioscience and Nanotechnology, R. Forch, H. Schonherr, A.T. Jenkins, Wiley, (Ch 1, Ch 3.3, App F)
Bioelectronics, I. WIllner, E. Katz, Wiley-VCH, (Ch 5, Ch 8)

Handbook fo Surface Plasmon Resonance, RBM Scasfoort, A. Tudos, RSC, (Ch 1, Ch 4, Ch 5)

Ressources en bibliothèque

- Handbook of Surface Plasmon Resonance
- Bioelectronics
- Bioelectronics handbook
- Surface design : applications in bioscience and nanotechnology
- Intermolecular and Surface Forces

Notes/Handbook

The course material is made available on the moodle.

Moodle Link

- http://moodle.epfl.ch/course/view.php?id=14855