

EE-519

Bioelectronics and biomedical microelectronics

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Cursus	Sem.	Type
Biomedical technologies minor	H	Opt.
Data and Internet of Things minor	H	Opt.
Electrical and Electronical Engineering	MA1, MA3	Opt.
Neuro-X minor	H	Opt.
Neuro-X	MA1, MA3	Opt.

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

Summary

The course covers the fundamentals of bioelectronics and integrated microelectronics for biomedical and implantable systems. Issues and trade-offs at the circuit and systems levels of invasive microelectronic systems as well as their eluding designs, methods and classical implementations are discussed

Content

Bioelectricity and bio-signals biopotentials, definition of selected bio-signals

Electrodes types of electrodes and integrated electrodes, characteristics and impact on the recording/driving circuits, neuron-semiconductor interface

Bio-signal recording low-noise amplifiers, architectures analysis, presentation of main design issues, low-power/low-noise design techniques

Multichannel recording massively parallel recording techniques, examples of the cortical implants, compressed-sensing techniques

Electrical stimulation integrated circuits for electrical stimulation of tissues, specific issues related to operating voltage, charge balancing

In-vitro systems techniques for integrated recording in-vitro, stimulation

Neuromorphic integrated electronics usage of microelectronics to mimic neurons or higher-level functions, fundamentals of microelectronic bio-inspired systems and applications in processing and vision

Application examples case studies of classical implanted systems, as well as prospective systems, including cochlear implants, sight restoring retina implants, deep-brain stimulation systems, cortical recording systems (invasive), epilepsy management systems, bio-pills, multimodal systems

Keywords

Bio-electronics, bio-medical electronics, implantable microelectronic

Learning Prerequisites**Required courses**

Electronics (fundamentals, circuits and systems)

Learning Outcomes

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

- Elaborate design strategies and methods
- Elaborate specifications
- Analyze block level requirements

- Develop blocks, models
- Assess / Evaluate alternate existing method

Transversal skills

- Communicate effectively with professionals from other disciplines.
- Access and evaluate appropriate sources of information.
- Make an oral presentation.
- Write a literature review which assesses the state of the art.

Teaching methods

Ex cathedra and practical exercises, seminars

Expected student activities

Attend class lectures, solve exercises, study professional literature and prepare a short report and short seminar on a selected topic

Assessment methods

Mandatory continuous control: written midterm
Mandatory continuous control: seminar and report
Mandatory final written examination

Resources

Bibliography

Will be reported in class

Moodle Link

- <https://go.epfl.ch/EE-519>

Prerequisite for

Diploma projects