

EE-518

**Analog circuits for biochip**

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Cursus	Sem.	Type
Biomedical technologies minor	E	Opt.
Data and Internet of Things minor	E	Opt.
Electrical and Electronical Engineering	MA2, MA4	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	Written
Workload	90h
Weeks	14
<b>Hours</b>	<b>3 weekly</b>
Lecture	2 weekly
Exercises	1 weekly
<b>Number of positions</b>	

**Summary**

Introduction to analog CMOS design for Remote Biosensors on Chip. Understanding and designing of active and remotely powered biosensing systems. Basic understanding of the wireless transmission of the obtained signals.

**Content**

Introduction to Analog design for Brain/CMOS interfaces

Principles of Electrochemical Biosensing: Target/Probe Interactions; Amperometric, Potentiometric, Capacimetric, and Impedimetric sensing

Electrochemical cell and related equivalent circuits

Basic CMOS configurations for electrochemical biosensing and related analog circuits

Wireless transmission in lossy media: issues on temperature, specific absorption rate (SAR) and efficiency. Antennas for such devices

Regulation aspects of wireless transmission close or in living matter: maximum value of the SAR and the temperature with respect to the frequency of operation and the body tissue.

Architecture of a biomedical implant and major blocks

Fundamentals of biomedical data transmission, data transmitters (active transmitters for RF communication)

Passive data transmitters (backscattering, load modulation), data receivers

Remote powering of implants (types and inductive remote powering, battery charging)

Data conditioning (spike detection, compression)

**Keywords**

OpAmp, CMOS, biosensors, RF communication, Remote Powering, wireless transmission

**Learning Prerequisites****Required courses**

Electronics I and II

**Learning Outcomes**

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

- Design complete devices for remote biosensing at system level
- Design simple analog circuits for the biosensor frontend
- Design simple analog circuits for the RF data communication
- Design simple analog circuits for the remote powering operation
- Assess / Evaluate appropriate sources of information

**Teaching methods**

ex cathedra with supervised exercises

**Assessment methods**

exam

**Resources****Bibliography**

- Bio/CMOS interfaces and co-design (Springer, 2nd Edition, 2024) / Carrara
- Design and optimization of passive UHF RFID systems / Curty

**Ressources en bibliothèque**

- [Bio/CMOS interfaces and co-design / Carrara](#)
- [Design and optimization of passive UHF RFID systems / Curty](#)

**Websites**

- <https://www.epfl.ch/labs/bci/student-projects/>
- <https://www.epfl.ch/labs/bci/>
- <https://www.epfl.ch/labs/mag/>
- <https://www.epfl.ch/labs/bnms/>

**Moodle Link**

- <https://go.epfl.ch/EE-518>

**Videos**

- <https://moodle.epfl.ch/mod/resource/view.php?id=926177>
- <https://www.youtube.com/watch?v=21tFuV-JFpc>