NX-422

Neural interfaces

Lacour Stéphanie

Cursus	Sem.	Type
Biomedical technologies minor	H	Opt.
Life Sciences Engineering	MA1, MA3	Opt.
Microtechnics	MA1, MA3	Opt.
Neuro-X minor	H	Opt.
Neuro-X	MA1	Opt.
Robotics	MA1, MA3	Opt.

Language of teaching	English
Credits	6
Session	Winter
Semester	Fall
Exam	During the semester
Workload	180h
Weeks	14
Hours	**6 weekly**
Courses	4 weekly
Exercises	2 weekly
Number of positions	

Summary

Neural interfaces NI are bioelectronic systems that interface the nervous system to digital technologies. This course presents their main building blocks (transducers, instrumentation & communication), reviews current and upcoming materials and technological solutions for implantable & wearable NIs.

Content

Introduction and key concepts.

- The Human Body. The Nervous System.
- Scales. Biomaterials. Biomechanics.
- Functions. Electrophysiology.
- Communication. Standards.

Case study 1. The Cochlear Implant.

- Electrodes and leads: materials, manufacturing, electrochemical impedance spectrocopy
- Function: neuromodulation. Stimulation parameters.
- Implantable electronics. Packaging. Connectors. Stimulator. Telemetry.

Case study 2. Brain Computer Interfaces

- Invasive and wearable technologies.
- Electrodes. Scale and density. Metallic (macroscopic) electrodes. Silicon-based (micromachined) electrodes.
- Implantable electronics. CMOS-based technology. Customised ICs. Closed-loop modulation.
- Telemetry. Powering.

Case study 3. Flexible multimodal neural interfaces

- Transducers. Thin-film technologies. Electrode coatings. LEDs. Temperature. Drug delivery.
- Polymers: thermoplastics, elastomers, hydrogels.
- Functions: Mechanical stealthing. Record and stimulate.
- Thin-film packaging.
- Implantable electronics: hybrid intergation
- Wireless communication and powering.

Keywords

Electrodes
Microfabrication
Biomaterials
Implantable electronics
Transducers
Telemetry
Neural Engineering

Learning Prerequisites

Recommended courses

Sensors MICRO-330, Microfabrication MICRO-301, MICRO-331
Materials MSE-207, MSE-208, BIO315
Background in neuroscience BIO311
Background in electronics

Important concepts to start the course

Basic concepts in electronics

Learning Outcomes

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

- Design
- Develop
- Sketch
- Integrate
- Propose

Transversal skills

- Communicate effectively, being understood, including across different languages and cultures.
- Keep appropriate documentation for group meetings.
- Give feedback (critique) in an appropriate fashion.
- Make an oral presentation.
- Write a scientific or technical report.

Teaching methods

Ex cathedra lectures
Exercices (once a month TBC)
Team project (throughout the semester)

Expected student activities

attend weekly lectures
read proposed references
develop a team project

Assessment methods

Team project:

- project report (50%)

- team oral presentation (40%)
- engagement across the semester (10%)

Supervision

Office hours	No
Assistants	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

Books:
Neuroprosthetics: Theory and Practice (Second Edition)
K.Horch, D. Kipke
Brain computer interface technologies
Claude Clément

Ressources en bibliothèque

- Brain computer interface technologies / Claude Clément
- Neuroprosthetics: theory and practice / Horch, Kipke. - 2nd edition

Références suggérées par la bibliothèque

- Advanced Procedures for Pain Management A Step-by-Step Atlas / Diwan, Deer
- Deer's Treatment of Pain An Illustrated Guide for Practitioners / Deer, Pope, Lamer, Provenzano

Notes/Handbook

lecture slides on moodle

Moodle Link

- https://go.epfl.ch/NX-422