NX-423

Translational neuroengineering

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Cursus	Sem.	Type
Biomedical technologies minor	E	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Microtechnics	MA2, MA4	Opt.
Neuro-X minor	E	Opt.
Neuro-X	MA2, MA4	Opt.
Robotics	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	Written
Workload	180h
Weeks	14
Hours	**6 weekly**
Courses	3 weekly
Exercises	3 weekly
Number of positions	

Summary

This course integrates knowledge in basic, systems, clinical and computational neuroscience, and engineering with the goal of translating this integrated knowledge into the development of novel methods, technology for the clinical application for patients suffering from neuropsychiatric disorders.

Content

The students will be introduced in the physiology and pathophysiology of core neurological and mental disorders, such as e.g., stroke, TBI, spinal cord injury or neurodegenerative disorders, followed by aspects of respective clinical translational, technological development and neuroengineering in these clinical domains and important regulatory, neuroethical and R&D points. The course content is organized as follows. Each week 2 x 1.5 h lectures and 3h exercise.

Lecture topics:

- Memory and Learning functions and dysfunctions and related technology (FH)
- Motor cortical functions and dysfunctions and related technology (FH)
- Attention, frontal-executive functions and dysfunctions and related technology (FH)
- Auditory and vestibular functions and dysfunctions and related technology (e.g., prostheses) (SM)
- Visual functions and dysfunctions and related technology (e.g., prostheses) (SM)
- Limb sensorimotor functions and dysfunctions and related technology (e.g., prostheses) (SM)
- Movement disorders, extrapyramidal functions and dysfunctions and related technolo (Parkinson Disease) (OB)
- Parkinson's disease and deep brain stimulation (OB)
- Parkinson's disease and non-motor sytsems and related technology (OB)
- Spinal functions and dysfunctions (EM)
- Spinal functions and dysfunctions (e.g. spinal cord injury) and related technology (EM)
- How to create a start-up in the medival device field (ext lecturer)
- Regualtory aspects for Medical devices (ext lecturer)

Keywords

- translational neuroengineering and neurotechnology
- personalized medicine
- cognition
- sensorimotor processing
- perceptional processing
- pathophysiology of neurological and mental disorders
- basic, systems, computational translational neuroscience
- Regulatory, clinical trials

- start-up

Learning Prerequisites

Required courses

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Recommended courses

- Computational motor control
- Neuroengineering on vision
- Haptic human robot interfaces
- Machine Learning for behavioral data
- VR
- Understanding statistics and experimental design (and/or Applied biostatistics)
- Machine Learning for behavioral data
- Biomedical signal processing
- Scientific project design in translational neuroscience
- Advanced Neuromodulation

Important concepts to start the course

- Basics in sensorimotor, perceptional and cognitive processing.
- Basics in statistics and experimental design
- 'From Bench to bedside' concept

Learning Outcomes

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

- Contextualise
- Assess / Evaluate
- Discuss
- Present
- Reason
- Hypothesize
- Plan
- Explain

Transversal skills

- Respect relevant legal guidelines and ethical codes for the profession.
- Take account of the social and human dimensions of the engineering profession.
- Demonstrate a capacity for creativity.
- Demonstrate the capacity for critical thinking
- Communicate effectively with professionals from other disciplines.
- Summarize an article or a technical report.
- Use a work methodology appropriate to the task.
- Access and evaluate appropriate sources of information.

Teaching methods

Interactive Lectures

Exercise

Expected student activities

Preparation of lectures including suggested literature review
Active Participation in Lectures
Active participation in exercises

Assessment methods

Written Final Exam (MCQ+Report): 60%

Project Presentations and evaluations: 40%

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

Textbooks for preparation e.g. in the field of Neurotechnology, Neuromodulation, Neuroscience, Neuroengineering or Neuroprosthetics e.g., Textbook of Neuromodulation (Knotkova, Rasche, Springer New York), Principles of Neural Science (Kandel et al., MCGRAW-HILL Higher Education), Neuroscience: Exploring The Brain, Enhanced Edition (Connors et al. Jones and Bartlett Publishers, Inc), Principles of Cognitive Neuroscience (Purves et al. Oxford University Press), Neuroprosthetics, Principles and Applications (Sanchez, CRC Press), Handbook of Neuroengineering (N. V. Thakor (ed.), Springer Nature Singapore Pte Ltd. 2022)

Ressources en bibliothèque

- Find the references at the Library

Références suggérées par la bibliothèque

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Notes/Handbook

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Moodle Link

- https://go.epfl.ch/NX-423