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**
Lecture	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 disorders, such as e.g., stroke, 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-Learning: Physiology (FH)
Dementia: Background/Pathophysiology (FH)
Motor cortical functioning: Physiology (FH)
Stroke: Background/Pathophysiology (FH)
Cognitive Functioning (Attention, frontal-executive, language): Physiology (FH)
Traumatic Brain Injury, Stroke: Background/Pathophysiology (FH)
Technology- Non-invasive brain stimulation (NIBS): Introduction in Methods and Concepts (FH)
Technology-Translation Stroke, TBI: NIBS technology (TMS, tES, TI) in stroke and dementia (FH)
Visual, auditory functioning: Physiology (SM/FH)
Pre-, postchiasmatic visual deficits (e.g., retinitis pigmentosa, congenital deafness): Background/Pathophysiology (SM/FH)
Technology- Perceptual prosthetics: Introduction in Methods and Concepts (SM)
Technology - Translation Perceptual deficits: Retinal and acoustic prothesis in perceptual disorders (SM)
Peripheral, central sensorimotor processing: Physiology, Background and Pathophysiology (Amputees) (SM)
Technology - Translation Amputees: Bionic Hand, limb prosthetics (SM)
Spinal functioning: Physiology (GC)
Spinal cord injury (SCI): Background/Pathophysiology (GC)
Technology - Closed loop spinal neuromodulation: Introduction in Methods and Concepts (GC)
Technology - Translation SCI, MSA: Therapy of gait impairment, deficits in blood pressure modulation (GC)
Extrapyramidal control, functioning: Physiology (OB)
Extrapyramidal disorders (Parkinson's disease): Background/Pathophysiology (OB)
Technology - deep brain stimulation (DBS): Introduction in Methods and Concepts (OB)
Technology - Translation Parkinson's: DBS and focused ultrasound to treat Parkinson's symptoms (OB)
Somatosensory functioning, perceptual integration: Physiology, Background and Pathophysiology (Hallucinations) (OB)
Technology - Translation Hallucinations: Virtual reality-based technology to address hallucinations (OB)
Personalized Medicine: General Concepts of Personalized Medicine (FH)
Neuroethics: Introduction in Neuroethics (FH + ext lecturer)
Regulatory towards the Clinical Market: Introduction in important regulatory aspects (GC + ext lecturer)

Start-up: Introduction in steps towards and realities in a start-up in Neurotechnology (SM + ext lecturer)

Keywords

- translational neuroengineering and neurotechnology
- personalized medicine
- cognition
- sensorimotor processing
- perceptional processing
- pathophysiology of neurological 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

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%

Interims evaluation (Project Presentations): 30%
Exercise: Paper review (10%)

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

will be provided before the course

Ressources en bibliothèque

- Principles of Neural Science, Kandel et al.
- Neuroscience: exploring the brain, Connors et al., ed.6, 2021
- Principles of Cognitive Neuroscience, Purves et al., 2021
- Neuroprosthetics: Principles and Applications, Sanchez
- Handbook of Neuroengineering, N. V. Thakor, 4 vol.
- Textbook of Neuromodulation, Knotkova, Rasche

Références suggérées par la bibliothèque

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Notes/Handbook

will be provided before the course

Moodle Link

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