EPFL

BIOENG-486

Sensorimotor neuroprosthetics

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Cursus	Sem.	Type
Bioengineering	MA1, MA3	Opt.
Biomedical technologies minor	H	Opt.
Computational Neurosciences minor	H	Opt.
Life Sciences Engineering	MA1, MA3	Opt.
Neuroprosthetics minor	H	Opt.
Neuroscience		Opt.
Robotics	MA1, MA3	Opt.
Sciences du vivant	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Remark

MA3 only

Summary

Teaching objectives: history, neural control of movement, computational motor control, neurorehabilitation after CNS disorders, upper limb and hand neuroprostheses, lower limp neuroprostheses, student project.

Content

History: Emergence of the field of neuroprosthetics, current evolution of neuroprosthetics towards enabling systems for neurorehabilitation, entrepreneurial opportunities and challenges
Neural control of movement: organization of supraspinal and spinal neuronal systems underlying the production of locomotion, reaching and grasping. Disease specific alteration of neural control processes after CNS disorders and limb amputation.
Computational motor control: General principles associated with the production of movements, analysis of kinetics, kinematics, muscle synergy, ensemble cortical modulation, internal models, finger enslavement.
Neurorehabilitation after CNS disorders: basic principles underlying learning and plasticity in the CNS, impact of neurorehabilitation on the recovery of sensorimotor functions, activity-dependent reorganization of neuronal circuits, practical use of neuroprosthetic systems for neurorehabilitation in animals and human.
Upper limb and hand neuroprostheses: current strategies for the development of neuroprosthesis for the restoration of reaching and grasping in specific types of motor disorders such as stroke, spinal cord injury, and amputation. (1) neurocontrolled hand prostheses; (2) invasive and non-invasive neuroprostheses based on neuromuscular electrical stimulation; (3) robot-based neuroprostheses.
Lower limb neuroprostheses: current strategies for the development of neuroprosthesis for the restoration of walking in severely paralyzed people. (1) neurocontrolled full body exoskeleton; (2) invasive and non-invasive electrical neuroprostheses; (3) invasive electrochemical neuroprosthesis; (4) Hybrid neuroprosthetic system.
Student project: Approximately half of the course will involve a group project in which the students will conceive their own neuroprosthetic system

Keywords

Neuroprosthetics; grasping; reaching; locomotion; robotics; epidural electrical stimulation; FES

Learning Prerequisites

Required courses

Only for second year master students and PhD students following the program in Neuroscience

Teaching methods

The students will get scientific background by the two teachers, they will be involved in hands-on activities and will also have to work on scientific projects to conceive their own neuroprosthetic system

Assessment methods

Peojects assessemnt during the semester