T-861-NEUR **NEURAL ENGINEERING** **6 ECTS**

Year of study: 4th year (1st year MSc).
Semester: Spring.
Level of course: 6. Second cycle, advanced.
Type of course: Elective. *Recommended elective for MSc Biomedical Engineering.*
Prerequisites: Good knowledge of electronics, electromagnetic theory, cell and nerve physiology, information theory and signal processing.
Schedule: Runs for 12 weeks – 6 teaching hours a week.
Supervisor: Þórður Helgason.
Lecturer: Þórður Helgason.

Learning outcomes:
At the end of the course the student should...

- .. know and be able to apply mathematical models of action potentials, their propagation and equivalent circuits.
- .. know experiments to measure the ion currents (Hodgkin and Huxley).
- ..know information processing in the neural system.
- ..know electrodes for picking up bio signals from the human body and for electrically stimulating cells and their equivalent circuits.
- ..have training in using the above models.
- ..know the design of active implants.
- ..know neural prosthesis's, external and implanted.
- .. know brain-computer interfaces.
- ..know uptake, conditioning and analysis of EEG signal.
- .. know methods to locate epilepsies focus.
- .. know methods of brain stimulation for treatment of tremor and epilepsy.
- .. know the cochlear implant and second sight implants.

Content:
The course begins with mathematical modelling of cell membrane voltage and it equivalentcircuit. Then information processing in the nervous system is covered. Properties and designof passive and active electrodes will be presented and their applications in recording andstimulation explained. Next, the focus is on active implant design and external neuralprosthesis's, choice of materials and miniaturized electrical design with presentation ofselected applications at the end of the course. Brain computer interface will be coveredfollowed by EEG recording and analysis. The student will learn about electrical current distribution in life tissue and its use in manipulating membrane potentials, quantitatively. Location of epilepsy focus based on head surface recordings along with electrical stimulation in the brain.

Reading material: The following literature will be used as support but the course content is not limited to this list:
1. Jeffrey Arle, Jay Shils, ed.: „Essential Neuromodulation“ Academic Press 20112. Jeffrey Arle, Jay Shils, ed.: „Innovative Neuromodulation“ Academic Press 20173. John Enderle, Joseph Bronzino, ed.: „Introduction to Biomedical Engineering“, Third Edition, Academic Press, 2012.4. David D. Zhou, Elias Greenbaum, editors: „Implantable Neural Prostheses 2“ Springer 20105. Mark S. Humayun, James D. Weiland, Gerald Chader, Elias Greenbaum, editors: „Artificiaal Sight“. Springer 20076. Kenneth W Horch, Gurpreet S Dhillon, editors: „Neuroprosthetics. Theory and Practice“. World Scientific 20047. Patricia S. Churchland, Terrence J. Sejnowski: „The Computatinal Brain“. MIT Press 19998. A. Pedotti, M. Ferrarin, J. Quinter, R. Riener, editors: „Neuroprosthetics, from Basic Research to Clinical Applications“. Springer 1996.

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Teaching and learning activities: Lectures, homeworks, discussions. Students will work on a project chosen according to their interests. Each students delivers a report, a power point presentation and gives a 40 minute lecture on his/her theme.
Assessment methods: To be announced.
Language of instruction: English.