neu320 - Introduction to Neurophysics

Module label
Introduction to Neurophysics

Module code
neu320

Credit points
6.0 KP

Workload
180 h
(2 SWS Lecture total workload 90h: 28h contact / 62h background reading/exam preparation 2 SWS Supervised exercise total workload 90h: 28h contact / 62h self-conducted exercise work/literature reading)

Used in course of study
- Master's Programme Neuroscience > Background Modules

Contact person
Module responsibility
- Jörn Anemüller

Entry requirements
recommended in semester: 3 (with Matlab prereq.: 1)

Skills to be acquired in this module
++ Neurosci. knowlg.
+ Independent research
+ Scient. Literature
++ Interdiscipl. knowlg.
++ Maths/Stats/Progr.
+ Data present./disc.

Students will learn to recognize the dynamics in neuronal networks as the result of an interplay of physical, chemical and biological processes. Overview over major physical measurement procedures for the quantification of structure and function in neuronal systems. Using the language of mathematics as a fundamental tool for the description of underlying biophysical processes with stochastics, linear algebra, differential equations. Information as represented on different length- and timescales: From microscopic processes to macroscopic functional models. Learning and adaptation as adjustment of a biophysical system to its environment.

Module contents
- Biophysics of synaptic and neuronal transmission
- Single neuron models: Hodgkin Huxley model, integrate and fire model, firing rate model
- Biophysics of sensory systems in the auditory, visual and mechano-sensory modality
- Description of neuronal dynamics: Theory of dynamical systems, from microscopic to macroscopic activity - Principles of neuronal activity measurements: from single-cell recordings to EEG, MEG and fMRI
- Functional description of small neuronal networks: Receptive fields and their description with linear and non-linear models - The neuronal code: Spikes, spike trains, population coding, time- vs. rate-code - Decoding neuronal activity and its applications
- Simulation of artificial neural networks as a functional model, Hopfield network, Boltzmann machine, Perceptron and deep networks - Information-theoretic approaches, stimulus statistics, entropy, mutual information
- Learning and plasticity, conditioning and reinforcement learning, Hebbian learning, long-term potentiation and long-term depression

Reader's advisory
- Chow, Gutkin, Hansel, Meunier, Dalibard (Eds.): Methods and Models in Neurophysics (2003)
- Galizia, Lledo (Eds.): Neurosciences, from molecule to behavior (2013)
- Gerstner, Kistler, Naud, Paninski: Neuronal Dynamics - From single neurons to networks and models of Cognition (2014)

Links
Language of instruction
English

Duration (semesters)
1 Semester

Module frequency
winter term / annually

Module capacity
30

Registration procedure / selection criteria: StudIP
| Reference text | Recommended in combination with: 5.04.4012 Informationsverarbeitung und Kommunikation (phy350)  
Will also be offered in "M.Sc. Physik, Technik, Medizin" |
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<td>Vorkenntnisse / Previous knowledge</td>
<td>Computer programming (preferably Matlab), basic mathematics (statistics, analysis, linear algebra)</td>
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<td>Final exam of module</td>
<td>end of winter term</td>
<td>80% oral exam or written exam, 20% exercise work and presentation</td>
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