Module Name
Computational Neuroscience

Type of Module	**Module Code**
o Advanced Module	Computational Neuroscience

Identification Number	**Workload**	**Credit Points**	**Term**	**Offered Every**	**Start**	**Duration**
MN-B-SM (N 6)	360 h	12 CP	2nd term of studying	Summer term, 2nd half	Summer term only	7 weeks

1	**Course Types**	**Contact Time**	**Private Study**
	a) Lectures	30 h	60 h
	b) Practical/Lab	100 h	130 h
	c) Seminar	12 h	28 h

2 Module Objectives and Skills to be Acquired

Students who successfully completed this module

- have acquired a general overview over the field of computational neuroscience.
- can use Python for scientific programming, data analysis, and computational modeling as well as for visualization of data and analysis of results.
- have gained an understanding of how electrical properties of neurons can be represented mathematically.
- can describe aspects of neural network connectivity using graph theoretical concepts.
- can perform basic spiking neural network simulations with NEST.
- are able to extract and condense information from the neuroscientific literature.
- have improved their overall analytical skills.
- have learned how to present research results and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other scientific fields.

3 Module Content

- Fundamentals and selected topics of computational neuroscience
- Scientific programming with Python
- Analysis of electrophysiological and behavioral data with Python
- Spike train statistics and stochastic point processes
- Neural coding and plasticity
- Mathematical descriptions of neurons and networks
- Ordinary differential equations
- Graph theory of neural networks
- Phase oscillator models of neural interactions
- Introduction to the neural network simulation tool NEST

4	**Teaching Methods** • Lectures; Programming/mathematical exercises; Seminar; Guidance to independent research; Training on presentation techniques in oral and written form
5	**Prerequisites (for the Module)** Enrollment in the Master's of Science degree course "Neuroscience" or in the Master's degree course "Computational Biology" or in the Master's degree course "Experimental and Clinical Neuroscience" or in the Master's degree course "Computational Sciences" **Additional academic requirements** Previous attendance of the lecture module Neuroscience; Some programming experience in any language is highly recommended.
6	**Type of Examination** The final examination consists of two parts: One hour written examination on topics of lectures, seminars and the practical/lab part (50 % of the total module mark), oral presentation (20-30 min; 50 % of the total module mark
7	**Credits Awarded** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula*** Optional compulsory module in the Master's degree course "Computational Biology", the Master's degree course "Experimental and Clinical Neuroscience" and in the Master's degree course "Computational Sciences"
9	**Proportion of Final Grade** 12.0 %
10	**Module Coordinator** Prof. Dr. Martin Nawrot, phone 470 7307, e-mail: mnawrot@uni-koeln.de
11	**Further Information** **Participating faculty:** Prof. Dr. S. van Albada, Prof. Dr. M. Nawrot, Dr. V. Rostami, Dr. Azamt Yeldesbay, Felix Schmitt, Ibrahim Tunc **Literature:** • Information about textbooks and other reading material will be provided via mail. **Location:** Biocenter, Zülpicherstr. 47B. The room number will be provided in the Introduction. **General time schedule:** Week 1 (Mon.-Thu.): Seminar, lectures and practical sessions; Week 2-6 (Mon.-Thu.): Lectures and practical sessions; Week 1-6 (Fri.): Self-study time; Week 7 (Mon.-Fri.): Preparation for the written examination. **Note:** The module contains computer-based practical sessions as a main component. **Introduction to the module:** May 19, 2025 at 15:00h, online (further information/link will be sent to your Smail-Account); for preparation to the module before this introduction see ILIAS link under literature. **Written examination:** July 17, 2025, second/supplementary examination Aug 29, 2028; the latter date may vary if students and module coordinator agree. More details will be given at the beginning of the module.