M.Sc. Neuroscience

Module Handbook

Module 2: **Methods in Neuroscience**

as of winter term 2019/20

In case of questions, please contact the program coordinator:
Dr. Birgit Ahrens
birgit.ahrens@biologie.uni-freiburg.de

Modulname	Nummer

Methods in Neuroscience	09LE03MO-NM
Modulverantwortlicher	
Prof. Dr. Stefan Rotter	
Fachbereich/Fakultät	
Faculty of Biology	

ECTS-Punkte	17
Semesterwochenstunden (SWS)	10
Empfohlenes Fachsemester	1
Moduldauer	1
Pflicht/Wahlpflicht (P/WP)	P
Präsenzstudium	150 h
Selbststudium	360 h
Workload	510 h
Angebotsfrequenz	winter term

Teilnahmevoraussetzung (zwingende Voraussetzung)
None

Verwendbarkeit
MSc Neuroscience

Zugehörige Veranstaltungen					
Name	Art	P/WP	ECTS	SWS	Workload
Scientific Programming in Python (SL 1)	Exercise	P	3	2	90 h
Quantitative Methods and Statistics in Neuroscience (PL 1)	Exercise	P	9	5	270 h
Neurophysiology I: Measurement and Analysis of Neuronal Activity (PL 2)	Exercise	P	5	3	150 h

Qualifikationsziele
The students have the competence to: • Convert a simple problem into a Python program • Implement simple programs for data analysis and data visualization • Explain the theory behind commonly used methods to analyze the various types of data obtained from biological systems (e.g. neuron spike trains, local field potentials). • Apply theoretical concepts from linear systems theory, dynamical systems and stochastic processes to analyze and model biological data (e.g. neuronal spike trains) and infer mechanisms underlying the functioning of biological systems (e.g. the brain). • Perform and interpret basic statistical analyses • Discuss the limitations of experimental data and mathematical models and can derive

countermeasures • Explain how basic components of neurophysiological equipment work, their purpose and their limitations. They can design small circuits and use commercial electronic equipment typical for neurophysiological setups • Explain standard neurophysiological analysis tools and write own functions for the analysis of neurophysiological data in Matlab.
Lehrinhalte
Zu erbringende Prüfungsleistung
PL 1: Written examination (2.5 hours) PL 2: Two written reports for the exercises and tasks in the electronics lab and on data analysis
Zu erbringende Studienleistung
SL 1: Regular participation in discussion of exercises; Passing a written exam (2.0 hours)
Gewichtung der Prüfungsleistung

Modulname	Nummer

Methods in Neuroscience	09LE03MO-NM
Veranstaltung	
Scientific Programming in Python	
Veranstaltungsart	Nummer
Exercise	09LE03Ü-SP2-04_0001
Fachbereich/Fakultät	
Faculty of Biology	

ECTS-Punkte	3
Semesterwochenstunden (SWS)	2
Empfohlenes Fachsemester	1
Pflicht/Wahlpflicht (P/WP)	P
Präsenzstudium	30 h
Selbststudium	60 h
Workload	90 h
Angebotsfrequenz	winter term

Inhalte

This course equips students with the techniques to design their own scientific programs in Python, for example to analyze data or simulate a problem. The lectures cover basics of Python programming.

- Variables, types and expressions
- Loops, conditions and exceptions
- Built-in functions and user designed functions
- Numpy (numerical library for Python)
- Plotting in Python, guidelines for good plotting practice

Qualifikationsziele

The students have the competence to:

- Convert a simple problem into a Python program
- Implement simple programs for data analysis
- Implement simple programs for data visualization

Zu erbringende Prüfungsleistung

none

Zu erbringende Studienleistung

- Regular participation in discussion of exercises
- Passing a written exam (2.0 hours)

Teilnahmevoraussetzungen (zwingende Voraussetzungen)

none

Lehrmethoden

Lectures, students independently solve programming tasks on the computer

Modulname	Nummer
Methods in Neuroscience	09LE03MO-NM
Veranstaltung	
Quantitative Methods and Statistics in Neuroscience	
Veranstaltungsart	Nummer
Exercise	09LE03Ü-NM-T2
Fachbereich/Fakultät	
Faculty of Biology	

ECTS-Punkte	9
Semesterwochenstunden (SWS)	5
Empfohlenes Fachsemester	1
Pflicht/Wahlpflicht (P/WP)	P
Präsenzstudium	75 h
Selbststudium	195 h
Workload	270 h
Angebotsfrequenz	winter term

Inhalte

Lectures will introduce important theoretical concepts and mathematical tools essential for model building and data analysis in biology and, in particular in neuroscience. Emphasis will be on deterministic and stochastic models, statistical analysis approaches in biology and network dynamics, and signal processing.

- Basic mathematics (numbers, vectors, calculus, linear algebra)
- Simple dynamical systems
- Signal processing and spectral analysis
- Linear time invariant systems
- Basic concepts in statistics

Qualifikationsziele

Students

- can explain the theory behind commonly used methods to analyze the various types of data obtained from biological systems (e.g. neuron spike trains, local field potentials)
- are able to apply theoretical concepts from linear systems theory, dynamical systems and stochastic processes to analyze and model biological data (e.g. neuronal spike trains) and infer mechanisms underlying the functioning of biological systems (e.g. the brain)
- can discuss the limitations of experimental data and mathematical models and can derive countermeasures
- can perform and interpret basic statistical analyses

Zu erbringende Prüfungsleistung

Written examination (2.5 hours)

Zu erbringende Studienleistung
none
Teilnahmevoraussetzungen (zwingende Voraussetzungen)
none
Lehrmethoden
Lectures, students independently solve programming tasks on the computer

Modulname	Nummer
Methods in Neuroscience	09LE03MO-NM
Veranstaltung	
Neurophysiology I: Measurement and Analysis of Neuronal Activity	
Veranstaltungsart	Nummer
Exercise	09LE03Ü-SP2-14_0002
Fachbereich/Fakultät	
Faculty of Biology	

ECTS-Punkte	5
Semesterwochenstunden (SWS)	3
Empfohlenes Fachsemester	1
Pflicht/Wahlpflicht (P/WP)	P
Präsenzstudium	45 h
Selbststudium	105 h
Workload	150 h
Angebotsfrequenz	winter term only

Inhalte

The course is intended to give a thorough introduction to the use of typical, electronic laboratory equipment and analysis techniques in neurobiological research, typical problems encountered and their solutions. The course consists of two parts

(1) Fundamental circuits and equipment

- Basic theory and application of analog circuits and analog to digital conversion in the context of neurophysiology
- Function and usage of oscilloscopes, amplifiers, frequency generators and FIR-filters
- Implementation of basic amplifier and RC-circuits
- Fundamentals of signal generation and recording in neuroscience
- Identification of functional units in research grade laboratory systems
- Junction potentials in ionic solutions

(2) Analysis of neuronal activity

- Fundamental concept of neurophysiological analysis techniques
- Introduction to Matlab
- Visualizing electrophysiological recordings
- Spike detection and segmentation
- Raster diagrams, spike rate estimation
- Peri-Stimulus time histograms (PSTH)
- Analysis of synaptic potentials (input resistance, time constants)
- Analysis of local field potentials (LTP), visualization of 3D data

Qualifikationsziele
• The students understand how basic components of neurophysiological equipment work, their purpose and their limitations. They can design small circuits and use commercial electronic equipment typical for neurophysiological setups • The students understand standard neurophysiological analysis tools and write own functions for the analysis of neurophysiological data in Matlab.
Zu erbringende Prüfungsleistung
Two written reports for the exercises and tasks in the electronics lab and on data analysis
Zu erbringende Studienleistung
none
Teilnahmevoraussetzungen (zwingende Voraussetzungen)
none
Lehrmethoden
Lectures, exercises