Course Handbook Neural Engineering Master

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Neural Engineering Master - mandatory courses (overview)

Module name (EN)	Code	SAP-P	Semester	Hours per semester week / Teaching method	ECTS	Module coordinator
Auditory Processing and Perception	NE3104.APP		1	2V+2P	6	Prof. Dr. Dr. Daniel Strauß
Biomedical Signal & Image Processing	NE3102.SIP		1	2V+3P	6	Prof. Dr. Dr. Daniel Strauß
Clinical Neurophysiology	NE3202.CNP		2	2V+2P	5	Prof. Dr. Dr. Daniel Strauß
Functional Imaging in Neuroscience	NE3105.FIN		1	-	5	N.N.
Manufacture of active Implants	NE3101.MAI		1	2V	3	Prof. Dr. Oliver Scholz
Master Thesis	NE3301.THS		3	-	30	Studienleitung
Neural and Cognitive Systems	NE3103.NCS		1	3V+2P	6	Prof. Dr. Dr. Daniel Strauß
Neural Signal Analysis and Modeling	NE3201.SAM		2	3V+2P	6	Prof. Dr. Dr. Daniel Strauß
Neuro-inspired Artificial Intelligence	NE3204.NAI		2	-	5	N.N.
Technical Interfaces to the Nervous System	NE3203.TIN		2	-	4	N.N.

(10 modules)

Neural Engineering Master - optional courses (overview)

Module name (EN)	Code	SAP-P	Semester	Hours per semester week / Teaching method	ECTS	Module coordinator
Advances in Brain-Computer-Interfaces	NE2213.BCI	P213-0204	-	-	6	Prof. Dr. Dr. Daniel Strauß
Biomaterials	NE2110.NBM	P213-0197	-	-	4	Prof. Dr. Dr. Daniel Strauß
Cochlear Implant Professional	NE2111.CIP	P213-0158, P213-0159	-	4V+4P	8	Prof. Dr. Dr. Daniel Strauß
Functional Imaging in Neuroscience	NE2106.FIN	P213-0190, P213-0191	-	4V	5	Prof. Dr. Dr. Daniel Strauß
Nervous System Evolution, Simulation, Cognition, Consciousness	NE2221.NSE		-	-	5	Dr. Sebastian Markert
Neuroergonomics in Human-Machine-Interaction	NE2214.NER	P213-0205	-	-	5	N.N.
Neurosonography	NE2220.NSN	P213-0203	-	2V+2P	5	Prof. Dr. Robert Lemor

(7 modules)

Neural Engineering Master - mandatory courses

Auditory Processing and Perception

Module name (EN): Auditory Processing and Perception
Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE3104.APP

Hours per semester week / Teaching method:
2V+2P (4 hours per week)

ECTS credits:
6

Semester: 1

Mandatory course: yes

Language of instruction:
English

Assessment:
Written exam (50%), project work (50%)

[*updated 12.03.2020*]

Applicability / Curricular relevance:

NE2105.APP (P213-0133, P213-0134) Neural Engineering, Master, ASPO 01.04.2020 , semester 1, mandatory course
NE3104.APP Neural Engineering, Master, SO 01.10.2025 , semester 1, mandatory course

Workload:
60 class hours (= 45 clock hours) over a 15-week period.
The total student study time is 180 hours (equivalent to 6 ECTS credits).
There are therefore 135 hours available for class preparation and follow-up work and exam preparation.

Recommended prerequisites (modules):
None.

Recommended as prerequisite for:

Module coordinator:
Prof. Dr. Dr. Daniel Strauß

Lecturer: Prof. Dr. Dr. Daniel Strauß

[*updated 29.11.2024*]

Learning outcomes:
After the lectures, the students will have a deep knowledge of human auditory perception and processing. Particular emphasis is placed on the mapping of numerical auditory models onto neuronal structures, binaural hearing and selective auditory attention. The students become aware of the importance of research in this area for the development of new diagnostic and therapeutic procedures. This module is offered in close collaboration with the Department of Otorhinolaryngology of the Saarland University Hospital and with the ENT-center of the MediClin Bosenberg-Clinic.
Participation in actual research studies and/or lab projects to complement course topics is required. That way, students receive soft skill training related to safe patient handling.

[*updated 18.07.2019*]

Module content:

0. Overview of the hearing system:
0.1. Function of the outer, middle and inner ear, auditory pathway
1. Disorders and objective diagnosis of the auditory system, diseases, deafness
1.1. Objective diagnosis and disorders of the external, middle and inner ear
1.2. Objective diagnosis of the central hearing system
1.3. Therapeutic measures
1.4. Communication Techniques
2. Psychoacoustics of normal hearing
2.1. basic parameters of perception
2.2. binaural processing
3. Introduction to auditory scene analysis
3.1. History
3.2. Differences: auditory and visual system
4. Exogenous processing and automatic attention
4.1. Gestalt theory
4.2. Theory of primitive grouping
4.3. Streaming
5. Endogenous processing and non-automatic attention
5.1. Selective auditory processing
5.2. Conscious and knowledge-based selection principles
6. Neural models for selective attention
6.1. Neuronal filter structures
6.2. ART STREAM
6.3. Wrigley model
7. Neuronal correlates of exogenous and endogenous auditory processing
7.1. Auditory evoked potentials
7.2. Mismatch Negativity
7.3. fMRI paradigms
7.4. Central processing disorders
8. Perception of language and music
8.1. Common fate cues
8.2. Sequential language organization
8.3. Melody and timbre
9. Neurodiagnostics and therapy in audiology
9.1. Neurofeedback systems
9.2. Speech coding algorithms for cochlear implants
9.3. Brainstem implants

[*updated 18.07.2019*]

Teaching methods/Media:

Blackboard, digital projector, software

[*updated 12.03.2020*]

Recommended or required reading:

Bregman, Albert S.: Auditory Scene Analysis, MIT Press, 2001
Clark, Graeme M.: Cochlear Implants, Springer, 2003
Hall III, J.W.: Handbook of Auditory Evoked Responses, Allyn & Bacon, 1992
Levine, Daniel S.: Introduction to Neural and Cognitive Monitoring, Lawrence Erlbaum Associates, 2000
Marr, D.: Vision, Henry Holt & Company, 1982
Martin, Frederick N.;Clark John Greer: Introduction to Audiology, Pearson, (akt. Aufl.)

Rosner, Jorge: Peeling the Onion: Gestalt Theory and Methodology, Gestalt-Institute of Toronto, 1990 [*updated 18.07.2019*]

Biomedical Signal & Image Processing

Module name (EN): Biomedical Signal & Image Processing
Degree programme: Neural Engineering, Master, SO 01.10.2025
Module code: NE3102.SIP
Hours per semester week / Teaching method: 2V+3P (5 hours per week)
ECTS credits: 6
Semester: 1
Mandatory course: yes
Language of instruction: English
Assessment: Oral exam [*updated 12.03.2020*]
Applicability / Curricular relevance: NE2102.SIP (P213-0135) Neural Engineering, Master, ASPO 01.04.2020 , semester 1, mandatory course NE3102.SIP Neural Engineering, Master, SO 01.10.2025 , semester 1, mandatory course
Workload: 75 class hours (= 56.25 clock hours) over a 15-week period. The total student study time is 180 hours (equivalent to 6 ECTS credits). There are therefore 123.75 hours available for class preparation and follow-up work and exam preparation.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: Prof. Dr. Dr. Daniel Strauß
Lecturer: Prof. Dr. Dr. Daniel Strauß [*updated 29.11.2024*]

Learning outcomes:
To develop skills for analyzing and synthesizing algorithms and systems that process discrete time sequences and images, with a particular emphasis on biomedical applications. Topics include time-frequency analysis, filter banks, and hierarchical decompositions. This course covers the theory, practical implementation techniques, and intense hands-on exercises in the lab to sharpen computing and implementation skills. It provides students with the ability to process biomedical signals and images for denoising, registration, segmentation, and feature extraction purposes. Adopting current challenges in medical decision making and decision support system design, the course provides students with a good understanding of the importance of feature extraction in biomedical pattern recognition schemes; a prerequisite for pattern recognition architectures in NE2105 "Neural & Cognitive Systems".

Participation in actual research studies and/or lab projects to complement course topics is required. That way, students receive soft skill training related to safe patient handling.

[*updated 18.07.2019*]

Module content:
1. Time-Frequency Analysis
1.1. Basics of Hilbert Space Theory
1.2. Windowed Fourier Transform
1.3. Continuous Wavelet Transform
1.4. Multiscale-Analysis
1.5. Hardy Space Projections & Analytic Signals
1.6. Generalized Time-Frequency Distributions

2. Multirate Filterbanks
2.1. Basic Operations
2.2. Polyphase Representations
2.3. Two-Channel Filter Banks
2.4. Perfect Reconstruction Filter Banks
2.5. Lattice Structure Implementation

3. Signal Decompositions
3.1. Orthonormal Bases via Paraunitary Filter Banks
3.2. Tree Decompositions of l^2(Z)
3.3. Frames & Oversampled Filter Banks
3.4. Design of Signal-Adapted Filters & Filter Banks
3.5. Adaptive Feature Extraction using Filter Banks
3.6. Implementation Architectures (DSPs, FPGAs, ASICs)

4. Hierarchical Image Processing
4.1. Review: Vector Calculus, PDEs, Finite Difference Method
4.2. Basic Operations & Filters
4.3. Diffusion and Total Variation Filtering
4.4. Multiscale Image Representations
4.5. Optic/Scene Flow Concepts
4.6. Registration, Segmentation, and Denoising
4.7. CPU/GPU/DSP Implementations

[*updated 18.07.2019*]

Teaching methods/Media:
Lecture notes, digital projector, software in the PC lab

[*updated 12.03.2020*]

Recommended or required reading:
Bruce, Eugene N.: Biomedical Signal Processing and Signal Modeling, John Wiley & Sons, 2001
Daubechies, I.: Ten Lectures on Wavelets, SIAM, 1992
Gonzalez, Rafael C.; Woods, Richard E.: Digital Image Processing, Pearson, (akt. Aufl.)
Oppenheim, Alan V., Schafer, Ronald W., Buck, John R.: Discrete-time signal processing, Prentice-Hall, 1999, 2nd Ed.
Parker, J. R.: Algorithms for Image Processing and Computer Vision, Wiley, 2010, 2nd Ed., ISBN 978-0470643853
Preim, Bernhard; Botha, Charl P.: Visual Computing for Medicine, Morgan Kaufmann, 2013, 2rd Ed., ISBN 978-0124158733
Price, Kenneth V.; Storn, Rainer; Lampinen, Jouni A.: Differential Evolution: A Practical Approach to Global Optimization, Springer, 2005
Schölkopf, B.; Smola, A.J.: Learning with Kernels: Support vector Machinces, Regularization, Optimization and Beyond, MIT Press, 2002
Semmlow, John L.: Biosignal and Biomedical Image Processing, Marcel Dekker, 2004
Sonka, Milan; Hlavac, Vaclav; Boyle, Roger: Image Processing, Analysis, and Machine Vision, Cengage Learning, 2014, ISBN 978-1133593690
Suh, Jung W.; Kim, Youngmin: Accelerating MATLAB with GPU Computing: A Primer with Examples, Morgan Kaufmann, 2013, ISBN 978-0124080805
Vetterli, Martin; Kovacevic, Jelena: Wavelets and Subband Coding, Prentice Hall, 1995
Welch, Thaddeus B.; Wrigth, Cameron H.G:, Morrow, Michael G.: Real-Time Digital Signal Processing from MATLAB to C with the TMS320C6x DSPs, CRC Press, 2017, 3rd Ed., ISBN 978-1498781015
Woods, Roger; McAllister, John; Lightbogy, Gaye; Yi, Ying: FPGA-based Implementation of Signal Processing Systems, Wiley, 2017, 2nd Ed., ISBN 978-1119077954

[*updated 18.07.2019*]

Clinical Neurophysiology

Module name (EN): Clinical Neurophysiology

Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE3202.CNP

Hours per semester week / Teaching method:
2V+2P (4 hours per week)

ECTS credits:
5

Semester: 2

Mandatory course: yes

Language of instruction:
English

Assessment:
Oral exam (50%), practical exam with written composition (50%)

[*updated 12.03.2020*]

Applicability / Curricular relevance:

NE2203.CNP (P213-0136, P213-0137) Neural Engineering, Master, ASPO 01.04.2020 , semester 2, mandatory course
NE3202.CNP Neural Engineering, Master, SO 01.10.2025 , semester 2, mandatory course

Workload:
60 class hours (= 45 clock hours) over a 15-week period.
The total student study time is 150 hours (equivalent to 5 ECTS credits).
There are therefore 105 hours available for class preparation and follow-up work and exam preparation.

Recommended prerequisites (modules):
None.

Recommended as prerequisite for:

Module coordinator:
Prof. Dr. Dr. Daniel Strauß

Lecturer: Prof. Dr. Dr. Daniel Strauß

[*updated 29.11.2024*]

Learning outcomes:
The students will become acquainted with devices and methodologies used in clinical neurophysiology. They have a basic technological and physiological knowledge for applications in a clinical neurophysiology setting. The students know selected methods and can independently work with technical systems/components/modules, with special focus on the construction of neuroprostheses.

The students can independently plan, implement and test a battery-driven biosignal acquisition device. One focus of this project is on the communication of soft skills in planning and coordination of a defined R&D task in a small project team.

[*updated 18.07.2019*]

Module content:
Lecture:
Fundamentals of measurement engineering in neuro-electro diagnostics, Fundamentals of physiology, Fundamentals of signal acquisition and signal processing, particularly with regard to electroencephalography, magnetencephalography, electromyography, electroneurography, reflexes, vegetative parameters, evoked potentials (visual, brainstem auditory evoked responses, somatosensory evoked potentials), motor potentials, elektrocardiography, elektroretinography, electrooculography and eye movement, sleep diagnostics, intraoperative monitoring (e.g., depth of anaesthesia, intracranial pressure), functional imaging (PET, SPECT, doppler, fMRI)

Practical training:
Design, assembly and testing of a battery-powered system for the acquisition, conditioning and analysis of myogenic biosignals (incl. approval regulations). Fundamental objective is the planing and implementation of a R&D project with selected ressources. The students learn to deal with problems in data acquisition, conditioning, data transmission and signal analysis, as well as the coverage of risk management, approval procedures as a medical product and the detailled documentation of the R&D process.
The practical lab course bridges the gap from idea to implementation and application of a medical product.

[*updated 18.07.2019*]

Teaching methods/Media:
Lecture and practical training, PPT presentations, lecture notes; Practical training: manual

[*updated 12.03.2020*]

Recommended or required reading:
Adelman, George; Smith, Bary: Encyclopedia of Neuroscience, Elsevier, 2014, ISBN 978-0444514325
Begg, Razaul; Lai, Daniel T.H.; Palaniswami, Marimuthu: Computational Intelligence in Biomedical Engineering, CRC Press, 2007, ISBN 978-0849340802
Bronzino, Joseph D.; Peterson, Donald R.: The Biomedical Engineering Handbook, CRC Press, 2015, 4th Ed., ISBN 978-1439825334
Christe, Barbara: Introduction to Biomedical Instrumentation, Cambridge Unversity Press, 2009, ISBN 978-0521515122
DiLorenzo, Daniel J.; Bronzino, Joseph D. (Eds.): Neuroengineering, CRC Press, 2007, ISBN 978-0849381744
Enderle, John; Bronzino, Joseph D.: Introduction to Biomedical Engineering, Academic Press, 2011, 3rd Ed., ISBN 978-0123749796
Hudak, R.: Biomedical Engineering - Technical Applications In Medicine, ISBN 978-9535107330
Klinke, Rainer; Pape, Hans.Christian; Kurtz, Armin; Silbernagl, Stefan: Physiologie, Thieme, 2009, ISBN 978-3137960065
Kramme, Rüdiger; Hoffmann, Klaus-Peter; Pozos, Robert S.: Springer handbook of medical technology, Springer, 2011
Ritter, Arthur B.; Reismann, Stanley; Michniak, Bozena B.: Biomedical Engineering Principles, CRC Press, 2005
Stöhr, M.; Wagner, W.; Pfadenhauer, K.; Scheglmann, K.: Neuromonitoring, Steinkopff, Darmstadt, ISBN 3-798511608
Vrbova, Gerta; Hudlicka, Olga: Application of Muscle/Nerve Stimulation in Health and Disease, Springer, 2008, ISBN 978-1402082320
Webster, John G. (Ed.): Medical Instrumentation: Application and design, Wiley, (akt. Aufl.)

[*updated 18.07.2019*]

Functional Imaging in Neuroscience

Module name (EN): Functional Imaging in Neuroscience

Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE3105.FIN

Hours per semester week / Teaching method:
-

ECTS credits:
5

Semester: 1

Mandatory course: yes

Language of instruction: German
Assessment: [*still undocumented*]
Applicability / Curricular relevance: NE3105.FIN Neural Engineering, Master, SO 01.10.2025 , semester 1, mandatory course
Workload: The total student study time for this course is 150 hours.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: N.N.
Lecturer: N.N. [*updated 29.11.2024*]
Learning outcomes: [*still undocumented*]
Module content: [*still undocumented*]
Recommended or required reading: [*still undocumented*]

Manufacture of active Implants

Module name (EN): Manufacture of active Implants
Degree programme: Neural Engineering, Master, SO 01.10.2025
Module code: NE3101.MAI
Hours per semester week / Teaching method: 2V (2 hours per week)

ECTS credits:
3

Semester: 1

Mandatory course: yes

Language of instruction:
English

Assessment:
Oral exam

[*updated 12.03.2020*]

Applicability / Curricular relevance:

NE2101.MAI (P213-0138) Neural Engineering, Master, ASPO 01.04.2020 , semester 1, mandatory course
NE3101.MAI Neural Engineering, Master, SO 01.10.2025 , semester 1, mandatory course

Workload:
30 class hours (= 22.5 clock hours) over a 15-week period.
The total student study time is 90 hours (equivalent to 3 ECTS credits).
There are therefore 67.5 hours available for class preparation and follow-up work and exam preparation.

Recommended prerequisites (modules):
None.

Recommended as prerequisite for:

Module coordinator:
Prof. Dr. Oliver Scholz

Lecturer: Prof. Dr. Oliver Scholz

[*updated 29.11.2024*]

Learning outcomes:
After successful completion of this course, the students are able to
- reproduce the definition of active medical implants and classify a number of given examples,
- explain ethical aspects of animal trials as well as human studies and state qualified methods of dealing with ethical conflicts of that kind,
- explain the difference of biostability and biocompatibility,
- enumerate the general components of an active medical implant,
- enumerate, describe, and assess several techniques for electrical interconnections such as (crimping, bonding, etc.),
- reproduce base knowledge of electrochemistry in a qualified manner, e.g. Faradays laws, etc.
- explain what happens in a galvanic cell and in an electrolytic cell,
- explain test methods of neural electrodes,
- calculate charge injection capacity and charge storage capacity of electrodes with given data,
- enumerate and explain various electrical models of electrodes,
- enumerate, describe and assess several techniques of encapsulation of active implants,
- enumerate, describe and assess several techniques of sterilisation of active implants,

- enumerate, describe and assess several techniques of energizing active implants,
- describe the mode of operation of batteries

[*updated 18.07.2019*]

Module content:
1.) Active medical implants - definition and components
2.) Ethical aspects of applying active implants
3.) Interfaces between biological tissue and technical system
4.) Electrochemical processes involved when applying electrical pulses to tissue
5.) Test methods of neural electrodes
6.) Assembly and interconnect techniques
7.) Encapsulation of active implants
8.) Energizing active implants

[*updated 18.07.2019*]

Teaching methods/Media:
Lectures using electronic slides and videos alternate with self-study periods in small student groups. At the end of the course, students will hold small talks about the scientific texts they have studied.

[*updated 12.03.2020*]

Recommended or required reading:
Kramme, Rüdiger; Hoffmann, Klaus-Peter; Pozos, Robert S.: Springer handbook of medical technology, Springer, 2011
Zhou, David; Greenbaum, Elias (Hrsg.): Implantable Neural Prostheses 2: Techniques and Engineering Approaches, Springer, 2010, ISBN 978-0387981192

[*updated 18.07.2019*]

Master Thesis

Module name (EN): Master Thesis

Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE3301.THS

Hours per semester week / Teaching method:
-

ECTS credits:
30

Semester: 3

Mandatory course: yes

Language of instruction:
English

Assessment:
Project work

[*updated 12.03.2020*]

Applicability / Curricular relevance:

NE2301.THS (T213-0139) Neural Engineering, Master, ASPO 01.04.2020 , semester 3, mandatory course
NE3301.THS Neural Engineering, Master, SO 01.10.2025 , semester 3, mandatory course

Workload:
The total student study time for this course is 900 hours.

Recommended prerequisites (modules):
None.

Recommended as prerequisite for:

Module coordinator:
Studienleitung

Lecturer: Studienleitung

[*updated 29.11.2024*]

Learning outcomes:
The students acquire in-depth theoretical and practical knowledge on a particular topic related to actual projects in Neural Engineering. They apply theoretical knowledge imparted in lectures related to their topic critically and in depth.
The students develop ideas and implement solutions for specific problems of their research question. They review the related literature critically and summarize the most important findings of other authors in a conclusive way.

The students can plan and implement work stages in order to solve a specific problem.
They collect, analyze and evaluate quantitative data related to their topic.

The students write complex, project specific content that holds up to scientific standards.
They plan the work stages of their thesis project independently and coordinate their tasks with their academic advisors.

[*updated 12.03.2020*]

Module content:
The students will independently work on a research question of an explorative or ongoing project and write an extended analysis of their topic in form of a master thesis.

[*updated 12.03.2020*]

Teaching methods/Media:
Depends on the project.

[*updated 12.03.2020*]

Recommended or required reading: [*still undocumented*]

Neural and Cognitive Systems

Module name (EN): Neural and Cognitive Systems
Degree programme: Neural Engineering, Master, SO 01.10.2025
Module code: NE3103.NCS
Hours per semester week / Teaching method: 3V+2P (5 hours per week)
ECTS credits: 6
Semester: 1
Mandatory course: yes
Language of instruction: English
Assessment: Oral exam (50%), project work (50%) [*updated 12.03.2020*]
Applicability / Curricular relevance: NE2104.NCS (P213-0141, P213-0142, P213-0189) Neural Engineering, Master, ASPO 01.04.2020 , semester 1, mandatory course NE3103.NCS Neural Engineering, Master, SO 01.10.2025 , semester 1, mandatory course
Workload: 75 class hours (= 56.25 clock hours) over a 15-week period. The total student study time is 180 hours (equivalent to 6 ECTS credits). There are therefore 123.75 hours available for class preparation and follow-up work and exam preparation.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: Prof. Dr. Dr. Daniel Strauß
Lecturer: Prof. Dr. Dr. Daniel Strauß

[*updated 29.11.2024*]

Learning outcomes:
Learning Objectives: To develop skills for (part I) analyzing biological neural and cognitive systems and (part II) designing technical cognitive systems. Topics in part I include systems neuroscience, sensory processing and perception, and the basics of computational neuroscience. Topics in part II include pattern recognition and machine learning. This course covers the theory but also includes hands-on exercises during the lab and project work. It provides students with the ability to analyze biological cognitive systems by decoding their correlates in the central and autonomic nervous systems. Moreover, the students learn to design technical cognitive systems, especially for pattern recognition purposes in neural engineering; in this sense, part II of this course complements the feature extraction skills obtained in "Biomedical Signal & Image Processing" (NE2102) to design complete computational decision making & decision support architectures.
Participation in actual research studies and/or lab projects to complement course topics is required. That way, students receive soft skill training related to safe patient handling.

[*updated 18.07.2019*]

Module content:
Part I (Biological Systems)

1. Systems Neuroscience
1.1. The Human Nervous System
1.2. From Neurons to Circuits
1.3. Patch & Voltage Clamp Techniques
1.4. From Circuits to Systems
1.5. VSD & MEA Techniques
1.6. From Systems to Behavior
1.7. ECoG, EEG, MEG, fMRI, fNIRS Techniques
1.8. Plasticity, Learning, Memory
1.9. Executive Functions & Decision Making
1.10. Computational Models
1.11. Ethics in Neuroscience Research

2. Sensory Processing & Perception
2.1. Gestalt Psychology
2.2. Exogenous & Endogenous Processing
2.3. Models of Attention & Cognitive Effort
2.4. Models of Affective Processing
2.5. Designing Experimental Paradigms

3. Psychophysiology & Affective Computing
3.1. Intrusive and Minimal-Intrusive Psychophysiology
3.2. Non-Intrusive Psychophysiology
3.3. Affective Computing
3.4. Neuroergonomics & Human-Machine-Interaction

Part II (Technical Systems)

1. Basics of Pattern Recognition
2.1. Supervised & Unsupervised Learning
2.2. Feature Extraction Models
2.3. Discriminant Measures
2.4. Discriminant Bases
2.5. Statistical Learning Theory

2. Learning & Cognitive Machines
2.1. Classification/Regression Trees, Boosting, Random Forests
2.2. Kernel Machines for Classification/Regression
2.3. Learning as Approximation Problem
2.4. Regularization in Reproducing Kernel Hilbert Spaces
2.5. Neural Networks & Deep Learning
2.6. Reinforcement Learning
2.7. Beyond Learning

[*updated 18.07.2019*]

Teaching methods/Media:
Lecture notes, digital projector, software in the computer lab

[*updated 12.03.2020*]

Recommended or required reading:
Abeles, M.: Corticonics: Neural Circuits of the Cerebral Cortex, Cambridge University Press, 1991
Alberts, B.; Bray, D.; Lewis, J.: Molecular Biology of the Cell, Garland Science, 2002
Andreassi, John L.: Psychophysiology: Human Behavior and Physiological Response, Taylor & Francis, 2006, ISBN 978-0805849516
Bear, M.F.; Connors, B.W.; Paradiso, M.A.: Neuroscience, Lippincott Williams and Wilkins, 2001
Churchland, P.S:; Sejnowski, T.J.: The Computational Brain, MIT Press, 1992
Dayan, P.; Abbott, L.F.: Theoretical Neuroscience, MIT Press, 1992
Duda, Richard O.; Hart, Peter E.; Stock, David G.: Pattern Classification, Wiley, 2001, 2. Aufl., ISBN 978-0471056690
Eliasmith, Chris; Anderson, Charles H.: Neural Engineering - Computation, Representation, and Dynamics in Neurobiological Systems, MIT Press, 2003, ISBN 0-262-05071-4
Fletcher, R.: Practical Methods of Optimization, John Wiley & Sons, 1987
Goodfellow, Ian; Bengio, Yoshua; Courville, Aaron: Deep Learning, MIT Press, 2016
Levine, Daniel S.: Introduction to Neural and Cognitive Monitoring, Lawrence Erlbaum Associates, 2000
Malmivuo, Jaakko; Plonsey, Robert: Bioelectromagnetism, Oxford University Press, 1995
Pesenson, Misha Z.: Multiscale Analysis and Nonlinear Dynamics: From Genes to the Brain, Wiley VCH, 2013, ISBN 978-3527411986
Ripley, Brian D.: Pattern Recognition and Neural Networks, Cambridge University Press, 1996
Rosner, Jorge: Peeling the Onion: Gestalt Theory and Methodology, Gestalt-Institute of Toronto, 1990
Schölkopf, B.; Smola, A.J.: Learning with Kernels: Support vector Machinces, Regularization, Optimization and Beyond, MIT Press, 2002
Sheppard, Clinton: Tree-based Machine Learning Algorithms: Decision Trees, Random Forests, and Boosting, CreateSpace Independent Publishing Platform, 2017, ISBN 978-1975860974
Vapnik, V.N.: Statistical Learning Theory, John Wiley & Sons, 1998
Wahba, G.: Spline Models for Observational Data, SIAM, 1990

[*updated 18.07.2019*]

Neural Signal Analysis and Modeling

Module name (EN): Neural Signal Analysis and Modeling

Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE3201.SAM

Hours per semester week / Teaching method: 3V+2P (5 hours per week)
ECTS credits: 6
Semester: 2
Mandatory course: yes
Language of instruction: English
Assessment: Oral exam (50%), project work (50%) [*updated 12.03.2020*]
Applicability / Curricular relevance: NE2202.SAM (P213-0143, P213-0144, P213-0192) Neural Engineering, Master, ASPO 01.04.2020 , semester 2, mandatory course NE3201.SAM Neural Engineering, Master, SO 01.10.2025 , semester 2, mandatory course
Workload: 75 class hours (= 56.25 clock hours) over a 15-week period. The total student study time is 180 hours (equivalent to 6 ECTS credits). There are therefore 123.75 hours available for class preparation and follow-up work and exam preparation.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: Prof. Dr. Dr. Daniel Strauß
Lecturer: Prof. Dr. Dr. Daniel Strauß [*updated 29.11.2024*]
Learning outcomes: Learning Objectives: To develop skills for (part I) an advanced analysis of various types of neural signals and (part II) for modeling neural signals across spatiotemporal scales. Topics in part I include stationary and non-stationary processing methods, source separation methods, and a mutual information analysis in multichannel recordings. Topics in part II include a review of the finite element method and neurophysical modeling. This course covers the theory but also includes hands-on exercises in both, the lab and project work. It provides students with the ability to extract information in a variety of noisy neural recordings. Moreover, the students gain a deep insight in the origin of neural signals using computational modeling. They are able to apply their computational modeling skills to new types of problems in neural engineering by means of biological and neurophysical reasoning. Participation in actual research studies and/or lab projects to complement course topics is required. That way, students receive soft skill training related to safe patient handling.

[*updated 18.07.2019*]

Module content:

Part I (Signal Analysis)

1. Taxonomy of Neural Signals
1.1. Review: Spontaneous vs. Evoked Activity
1.2. Spikes, Waveforms, Oscillations, Spatiotemporal Patterns
1.3. Event-Related Transient Potentials
1.4. Evoked vs. Phase-Rest Models
1.5. Steady-State & Stimulus Following Responses
1.6. Induced & Spontaneous Oscillatory Neural Activity
1.7. Conventional Power Band Analysis

2. Spike Processing
2.1. Spike Train Statistics
2.2. Spike Sorting Techniques
2.3. Entropy Methods

3. Event-Related Neural Responses
3.1. Conventional Averaging Techniques
3.2. Single-Trial Processing & ERP Images
3.3. Manifold-Valued, Circular Data from ERPs
3.4. Amplitude & Phase Denoising of ERP Images
3.5. Inter-Trial Coherence Measures
3.6. Event-Related Synchronization/Desynchronization
3.7. Advanced ERP Pattern Recognition Schemes
3.8. Optic Flow Methods for Spatiotemporal Patterns

4. Techniques for Multimodal & Multichannel Recordings
4.2. Blind Source Separation Techniques
4.3. Artifact Removal in Multichannel Recordings
4.4. Multichannel Coherence Estimation Techniques
4.5. Instantaneous Phase Dynamics
4.6. Granger Causality and Mutual Information Methods
4.7. Synchronizing Multimodal Measurements

5. Applications
5.1. Invasive and Non-Invasive Brain-Computer-Interfaces
5.2. Decoding Attentional Effort Using EEG

Part II (Signal Modeling)

1. Review of Computational Methods
2.1. Finite Element Method
2.2. The Scientific Computing Package COMSOL
2.3. Source Localization Techniques

2. Neurophysical Modeling
2.1. Quasi-static approximations of Maxwell equations
2.2. Neural Sources & Volume Conduction
2.3. Discrete Neuron & Spiking Models
2.4. Local Field Potential Models
2.4. Neural Mass & Neural Field Models

2.5. Noise Models
2.6. EEG & ERP Models

[*updated 18.07.2019*]

Teaching methods/Media:
Blackboard, digital image projector, software

[*updated 12.03.2020*]

Recommended or required reading:
Bruce, Eugene N.: Biomedical Signal Processing and Signal Modeling, John Wiley & Sons, 2001
Coombes, Stephen; beim Graben, Peter (Eds.): Neural Fields: Theory and Applications, Springer, 2014, ISBN 978-3642545924
Eliasmith, Chris; Anderson, Charles H.: Neural Engineering - Computation, Representation, and Dynamics in Neurobiological Systems, MIT Press, 2003, ISBN 0-262-05071-4
Evans, J.R.; Abarbanel, A.: Introduction to Quantitative EEG and Neurofeedback, Academic Press, 1999
Gerstner, Wulfram; Kistler, Werner M.; Naud, Richard; Paninski, Liam: Neuronal Dynamics: From Single Neurons To Networks And Models Of Cognition, Cambridge Unversity Press, 2014, ISBN 978-1107635197
Hyvärinen, A.; Karhunen, J.; Oja, E.: Independent Component Analysis, John Wiley & Sons, 2001
Jin, Jian Ming: The Finite Element Method in Electromagnetics, Wiley - IEEE, 2014, ISBN 978-1118571361
Koch, Christoph: Biophysics of Computation, Oxford University Press, 2004
Mallat, Stéphane G.: A Wavelet Tour of Signal Processing, Academic Press, (akt. Aufl.)
Malmivuo, Jaakko; Plonsey, Robert: Bioelectromagnetism, Oxford University Press, 1995
Nunez, Paul L; Shrinivasan, Ramesh: Electric Fields of the Brain: the neurophysics of EEG, Oxford University Press, 1991
Semmlow, John L.: Biosignal and Biomedical Image Processing, Marcel Dekker, 2004

[*updated 18.07.2019*]

Neuro-inspired Artificial Intelligence

Module name (EN): Neuro-inspired Artificial Intelligence

Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE3204.NAI

Hours per semester week / Teaching method:
-

ECTS credits:
5

Semester: 2

Mandatory course: yes

Language of instruction:
German

Assessment: [*still undocumented*]
Applicability / Curricular relevance: NE3204.NAI Neural Engineering, Master, SO 01.10.2025 , semester 2, mandatory course
Workload: The total student study time for this course is 150 hours.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: N.N.
Lecturer: N.N. [*updated 29.11.2024*]
Learning outcomes: [*still undocumented*]
Module content: [*still undocumented*]
Recommended or required reading: [*still undocumented*]

Technical Interfaces to the Nervous System

Module name (EN): Technical Interfaces to the Nervous System
Degree programme: Neural Engineering, Master, SO 01.10.2025
Module code: NE3203.TIN
Hours per semester week / Teaching method: -
ECTS credits: 4

Semester: 2
Mandatory course: yes
Language of instruction: German
Assessment: [*still undocumented*]
Applicability / Curricular relevance: NE3203.TIN Neural Engineering, Master, SO 01.10.2025 , semester 2, mandatory course
Workload: The total student study time for this course is 120 hours.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: N.N.
Lecturer: N.N. [*updated 29.11.2024*]
Learning outcomes: [*still undocumented*]
Module content: [*still undocumented*]
Recommended or required reading: [*still undocumented*]

Neural Engineering Master - optional courses

Advances in Brain-Computer-Interfaces

Module name (EN): Advances in Brain-Computer-Interfaces

Degree programme: Neural Engineering, Master, SO 01.10.2025
Module code: NE2213.BCI
Hours per semester week / Teaching method: -
ECTS credits: 6
Semester: according to optional course list
Mandatory course: no
Language of instruction: German
Assessment: [*still undocumented*]
Applicability / Curricular relevance: NE2213.BCI (P213-0204) Neural Engineering, Master, ASPO 01.04.2020 , optional course NE2213.BCI (P213-0204) Neural Engineering, Master, SO 01.10.2025 , optional course
Workload: The total student study time for this course is 180 hours.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: Prof. Dr. Dr. Daniel Strauß
Lecturer: Prof. Dr. Dr. Daniel Strauß [*updated 29.11.2024*]
Learning outcomes: [*still undocumented*]
Module content: [*still undocumented*]

Recommended or required reading: [*still undocumented*]

Biomaterials

Module name (EN): Biomaterials
Degree programme: Neural Engineering, Master, SO 01.10.2025
Module code: NE2110.NBM
Hours per semester week / Teaching method: -
ECTS credits: 4
Semester: according to optional course list
Mandatory course: no
Language of instruction: German
Assessment: [*still undocumented*]
Applicability / Curricular relevance: NE2110.NBM (P213-0197) Neural Engineering, Master, ASPO 01.04.2020 , optional course NE2110.NBM (P213-0197) Neural Engineering, Master, SO 01.10.2025 , optional course
Workload: The total student study time for this course is 120 hours.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: Prof. Dr. Dr. Daniel Strauß
Lecturer: Prof. Dr. Dr. Daniel Strauß [*updated 29.11.2024*]

Learning outcomes:

[*still undocumented*]

Module content:

[*still undocumented*]

Recommended or required reading:

[*still undocumented*]

Cochlear Implant Professional

Module name (EN): Cochlear Implant Professional

Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE2111.CIP

Hours per semester week / Teaching method:
4V+4P (8 hours per week)

ECTS credits:
8

Semester: according to optional course list

Mandatory course: no

Language of instruction:
German

Assessment:
Mündliche Prüfung

[*updated 14.10.2015*]

Applicability / Curricular relevance:

BMT1934 (P213-0158) Biomedical Engineering, Master, ASPO 01.04.2014 , optional course, medical/technical
NE2111.CIP (P213-0158, P213-0159) Neural Engineering, Master, ASPO 01.04.2020 , optional course, medical/technical
NE2111.CIP (P213-0158, P213-0159) Neural Engineering, Master, SO 01.10.2025 , optional course, medical/technical

Workload:

120 class hours (= 90 clock hours) over a 15-week period.
The total student study time is 240 hours (equivalent to 8 ECTS credits).
There are therefore 150 hours available for class preparation and follow-up work and exam preparation.

Recommended prerequisites (modules):
None.

Recommended as prerequisite for:

Module coordinator:
Prof. Dr. Dr. Daniel Strauß

Lecturer: Prof. Dr. Dr. Daniel Strauß

[*updated 29.11.2024*]

Learning outcomes:
Die Studierenden können bei Cochleaimplantat (CI) Patienten eine patientenbezogene Audiometrie und ein grundlegendes CI Fitting selbstständig durchführen. Die Studierenden können individuelle Sprachverarbeitungsstrategien auswählen und anwenden. Sie sind der Lage audiologische Beratungen und Schulungen durchzuführen. Die Studierenden können die Grundlagen medizinischer Psychologie und Soziologie der Hörstörung analysieren und bewerten. Sie werden weiterhin in die Lage versetzt, Kommunikationsstrategien mit Hörgeschädigten klinisch anzuwenden und lernen Versorgungsstrategien kennen. Die Studierenden lernen weiterhin den Ablauf einer CI Operation kennen.

[*updated 15.10.2015*]

Module content:
1. Pathophysiologie des Gehörs (klinische Aspekte)
1.1 Formen der Schwerhörigkeit
1.2 Komorbiditäten und Krankheitsbilder (Verspannung, Tinnitus Meningitis, Akustikus Neurinom, AVWS, Hyperakusis, Phonophobie)
1.3 Klinische Diagnostik
2. Psychologie der Schwerhörigkeit/ Ertaubung
2.1 Funktionen des Gehörs
2.2 typische Verhaltensweisen Hörgeschädigter
2.3. Psychopathologie der Schwerhörigkeit
3. Soziologie der Hörschädigung
3.1 berufliche Auswirkungen der Hörschädigung
3.2 soziale Folgen der Hörschädigung
4. Kommunikationsformen
4.1 Kommunikationstaktiken (Absehen, Kombination, Gebärden)
4.2 Copingstrategien. Hörtaktik und Outing
4.3 technische Hilfen (kom anlage, Telefon)
4.4 rechtliche Grundlagen der Hörversorgung
5. Versorgungsmöglichkeiten bei Hörgeschädigten
5.1 Noiser
5.2 Hörgerät und Kombigerät (Hörgerät und Noiser)
5.3 Powerhörgerät
5.4 Cros-Versorung und Bi-Cros-Versorgung
5.5 Cochlea Implantat (normal, Hybridsystem)
5.6 Vibrant Soundbridge
5.7 Bone Bridge

5.8 BAHA
5.9 Hirnstammimplantat (ABI) und Mittelhirnimplantat (AMI)
6. operative Therapie der Ertaubung
6.1 Phasenmodell der CI Versorgung
6.2 Grundlagen der CI Rehabilitation
6.3 Reha Ziele
7. Die CI-Anpassung
7.1 Grundlagen (Anpassstrategien, Impedanzmessung etc)
7.2 Integrierte Anpassungstechnik
7.3 Praktische Übungen
8. Sonderformen der CI Anpassung und Versorgung
8.1 Kinderversorgung
8.2 SSD Single side deafness
8.3 Tinnitus und CI
8.4 CI und Schwindel (Mb Meniere)
8.5 Facialisirritation, Cephalgie
9. berufliche Anforderungen an das CI
9.1 Eingliederungsmodelle
9.2 Nachsorge
10. Umgang mit Hörgeschädigten
10.1 Audiotherapie
10.2 Sicherung der Kommunikation
11. CI-Professional im Therapeutenteam
11.1 Logopäden, Audiotherapeuten, Psychologen
11.2 HNO Ärzten
11.3 Sozialarbeitern
12. Nachsorgesysteme
12.1 Remote fitting system
12.2 ambulante Nachsorge
12.3 Trackingintervalle
12.4 Selbsthilfeverbände
13. Besuch einer CI Operation an HNO Klinik des UKS

[*updated 15.10.2015*]

Teaching methods/Media:
Tafel, digitaler Projektor, Software

[*updated 15.10.2015*]

Recommended or required reading:
A. S. Bregman "Auditory Scene Analysis", MIT Press, 2001
J. W. Hall III "Handbook of Auditory Evoked Responses", Allyn & Bacon, 1992
D. S. Levine "Introduction to Neural and Cognitive Modeling", Lawrence Erlbaum Associates, 2000
Jorge Rosner "Peeling the Onion: Gestalt Theory and Methodology", Gestalt-Institute of Toronto, 1990
S. Grossberg, K. K. Govindarajan, L. L. Wyse, and M. A. Cohen "ARTSTREAM: A neural network model of auditory scene analysis and source segregation", Neural Networks, 17, 511-536, 2004
S.N. Wrigley and G.J. Brown "A computational model of auditory selective attention" IEEE Transactions on Neural Networks. 15: 1151-1163, 2004
D. L. Wang "Primitive Auditory Segregation Based on Oscillatory Correlation" Cognitive Science 20: 409-456,1996
M. Clark "Cochlear Implants" Springer, 2003
M. Clark "Introduction to Audiology", Allyn & Bacon, 2002
D. Marr "Vision", Henry Holt & Company, 1982

[*updated 15.10.2015*]

Functional Imaging in Neuroscience

Module name (EN): Functional Imaging in Neuroscience
Degree programme: Neural Engineering, Master, SO 01.10.2025
Module code: NE2106.FIN
Hours per semester week / Teaching method: 4V (4 hours per week)
ECTS credits: 5
Semester: according to optional course list
Mandatory course: no
Language of instruction: German
Assessment: [*still undocumented*]
Applicability / Curricular relevance: NE2106.FIN (P213-0190, P213-0191) Neural Engineering, Master, ASPO 01.04.2020 , optional course NE2106.FIN (P213-0190, P213-0191) Neural Engineering, Master, SO 01.10.2025 , optional course
Workload: 60 class hours (= 45 clock hours) over a 15-week period. The total student study time is 150 hours (equivalent to 5 ECTS credits). There are therefore 105 hours available for class preparation and follow-up work and exam preparation.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: Prof. Dr. Dr. Daniel Strauß
Lecturer: Prof. Dr. Dr. Daniel Strauß [*updated 29.11.2024*]
Learning outcomes: Students can assess the various properties of (functional) imaging modalities in neurology:

- Imaged function: hemodynamics, metabolism or neural activity
- Spatial and temporal resolution
- Reliability, precision and sensitivity to artifacts
- Cost and complexity, safety, possibility for multimodal imaging

[*updated 25.04.2021*]

Module content:
LECTURE (Prof. Möller, htwsaar)
Overview
- functional imaging in general
- functional imaging in neurology
Metabolism imaging using radioactive markers
- positron-emission tomography (PET)
- single-photon-emission computerized tomography (SPECT)
Hemodynamic imaging
- functional magnetic resonance imaging (fMRI),
  - introduction to the relevant properties and methods of MRI itself
  - blood-oxygen-level-dependend contrast (BOLD)
  - contrast-enhanced perfusion imaging
  - diffusion weighted imaging (DWI), diffusion tensor imaging (DTI)
- near-infrared spectroscopic imaging (NIRS)
Imaging of neural activity
- Magnetoencephalograpy (MEG)
- fluorescence imaging using voltage-sensitive dyes (VSD)
Multimodal imaging

CLINICAL DEMONSTRATION (Dr. Krick, Saarland University Medical Center, Clinic for Diagnostic and Interventional Radiology)

[*updated 27.04.2021*]

Recommended or required reading:

[*still undocumented*]

Nervous System Evolution, Simulation, Cognition, Consciousness

Module name (EN): Nervous System Evolution, Simulation, Cognition, Consciousness

Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE2221.NSE

Hours per semester week / Teaching method:
-

ECTS credits:
5

Semester: according to optional course list

Mandatory course: no

Language of instruction:
English

Assessment:

[*still undocumented*]

Applicability / Curricular relevance:

NE2221.NSE Neural Engineering, Master, ASPO 01.04.2020 , optional course
NE2221.NSE Neural Engineering, Master, SO 01.10.2025 , optional course

Workload:
The total student study time for this course is 150 hours.

Recommended prerequisites (modules):
None.

Recommended as prerequisite for:

Module coordinator:
Dr. Sebastian Markert

Lecturer:
Dr. Sebastian Markert

[*updated 03.12.2024*]

Learning outcomes:
The students are able to describe how nervous systems emerged and changed through evolution. They can compare nervous systems of animals, including humans. They can discuss the roundworm Caenorhabditis elegans as a model for holistic nervous system research. They can define what a connectome is and discuss the efficacy of connectomics as a means of understanding nervous systems as a whole. They can discuss the possibilities and limits of nervous system simulation. They can describe the state of research on cognition and consciousness. They can discuss hypotheses on consciousness.

[*updated 03.12.2024*]

Module content:

Nervous System Evolution, Simulation, Cognition, Consciousness the biggest questions explored in the smallest worm

1. Evolution of the nervous system

1.1 How and when nervous systems emerged
1.2 Universal principles of nervous system function
1.3 Protostome versus deuterostome nervous systems
1.4 Bird versus Mammal brains
1.5 Human versus animal intelligence

2. The roundworm model Caenorhabditis elegans
    2.1 The biology of the worm
    2.2 The nervous system of the worm
    2.3 The connectome of the worm
    2.4 Why we should study worms
    2.5 Why we should not study worms

3. Connectomics
    3.1 Why we obtain connectomes
    3.2 How we obtain connectomes
    3.3 Which connectomes we have obtained
    3.4 What we have learned from connectomes
    3.5 Why connectomes disappoint

4. Simulation of nervous systems
    4.1 The worm that woke up in a robot
    4.2 Uploading a mind into a machine
    4.3 Artificial neuronal networks
    4.4 Large Language Models versus nervous systems

5. Consciousness
    5.1 Why consciousness evolved
    5.2 The twofold substrate independence of consciousness
    5.3 Consciousness is nowhere and everywhere
    5.4 The universe understands itself
    5.5 Where is grandma s apple pie in the brain

[*updated 03.12.2024*]

Recommended or required reading:

[*still undocumented*]

Neuroergonomics in Human-Machine-Interaction

Module name (EN): Neuroergonomics in Human-Machine-Interaction
Degree programme: Neural Engineering, Master, SO 01.10.2025
Module code: NE2214.NER
Hours per semester week / Teaching method: -
ECTS credits: 5

Semester: according to optional course list
Mandatory course: no
Language of instruction: German
Assessment: [*still undocumented*]
Applicability / Curricular relevance: NE2214.NER (P213-0205) Neural Engineering, Master, ASPO 01.04.2020 , optional course NE2214.NER (P213-0205) Neural Engineering, Master, SO 01.10.2025 , optional course
Workload: The total student study time for this course is 150 hours.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: N.N.
Lecturer: N.N. [*updated 29.11.2024*]
Learning outcomes: [*still undocumented*]
Module content: [*still undocumented*]
Recommended or required reading: [*still undocumented*]

Neurosonography

Module name (EN): Neurosonography
Degree programme: Neural Engineering, Master, SO 01.10.2025

Module code: NE2220.NSN

Hours per semester week / Teaching method:
2V+2P (4 hours per week)

ECTS credits:
5

Semester: according to optional course list

Mandatory course: no

Language of instruction:
English

Assessment:
Presentation (pass/fail)

[*updated 05.11.2024*]

Applicability / Curricular relevance:

NE2220.NSN (P213-0203) Neural Engineering, Master, ASPO 01.04.2020 , optional course
NE2220.NSN (P213-0203) Neural Engineering, Master, SO 01.10.2025 , optional course

Workload:
60 class hours (= 45 clock hours) over a 15-week period.
The total student study time is 150 hours (equivalent to 5 ECTS credits).
There are therefore 105 hours available for class preparation and follow-up work and exam preparation.

Recommended prerequisites (modules):
None.

Recommended as prerequisite for:

Module coordinator:
Prof. Dr. Robert Lemor

Lecturer: Prof. Dr. Robert Lemor

[*updated 29.11.2024*]

Learning outcomes:
Die Studierenden kennen die technischen Grundlagen der Ultraschallbildgebung und Ultraschalltherapie. Sie können verschiedene Einsatzgebiete der Ultraschalldiagnostik und Therapie in der Neurologie erläutern und sind mit aktuellen Forschungsthemen in diesen Feldern vertraut.

The students know the technical basics of ultrasound imaging and ultrasound therapy. They can explain various areas of application of ultrasound diagnostics and therapy in neurology and are familiar with current research topics in these fields.

[*updated 05.11.2024*]

Module content:
Inhalte:
Technisch physikalische Grundlagen der Ultraschallbildgebung - Physik des Ultraschall, Transducer, Systeme und Bildgebungsmodi z. Bsp.: B-Mode, Doppler, CFD, THI, Kontrastmittel Artefakte & Sicherheitsapsekte
Technisch physikalische Grundlagen der Ultraschalltherapie - Physik, Transducer, Systeme und Anwendungen z. Bsp. Sonothrombolyse, HIFU, LIFUS Artefakte & Sicherheitsaspekte
Medizinische Grundlagen: Diagnostische Anwendungen der in der Neurologie - Diagnostik und Monitoring von Vasospasmen, Mikroemboliedetektion, Sonografie in der neurologischen Notfall- und Intensivmedizin - Grundlagen, vaskuläre Schlaganfalldiagnostik und Monitoring des erhöhten intrakraniellen Druckes, Hirntoddiagnostik und Untersuchung der zerebralen Autoregulation, Hirndruckmonitoring via Orbitasonografie, Point of Care Ultraschall (POCUS)
Medizinische Grundlagen zu therapeutischen Ultraschall Anwendungen in der Neurologie - Transkranielle Sonographie des Hirnparenchyms: Update zu klinisch relevanten Anwendungen, Unilaterale fokussierte Ultraschall-Subthalamotomie bei Parkinson-Krankheit, LIFUS
Aktuelle Forschungsthemen: Künstliche Intelligenz in der Echokardiographie und in der Orbita Sonographie, HIFU, LIFUS

Content:
Technical & physical fundamentals of ultrasound imaging physics of ultrasound, transducers, systems and imaging modes e.g. E.g.: B-mode, Doppler, CFD, THI, contrast medium artifacts & safety aspects
Technical& physical fundamentals of ultrasound therapy physics, transducers, systems and applications e.g. Sonothrombolysis, HIFU, LIFUS artifacts & safety aspects
Medical basics: Diagnostic applications in neurology diagnosis and monitoring of vasospasms, microembolism detection, sonography in neurological emergency and intensive care medicine basics, vascular stroke diagnosis and monitoring of increased intracranial pressure, brain death diagnosis and examination of cerebral autoregulation, intracranial pressure monitoring via orbital sonography, Point of Care Ultrasound (POCUS)
Medical basics of therapeutic ultrasound applications in neurology Transcranial sonography ft he brain parenchyma: Update on clinically relevant applications, unilateral focused ultrasound subthalamotomy in Parkinson s disease, LIFUS
Current research topics: Artificial intelligence in echocardiography and orbital sonography, HIFU, LIFUS

[*updated 05.11.2024*]

Teaching methods/Media:
Board, Slides, Ultrasound Workshop

[*updated 05.11.2024*]

Additional information:
Parts of the ultrasound workshop will be held at the University Hospital in Homburg Saar.

[*updated 05.11.2024*]

Recommended or required reading:
Thomas L. Szabo , Diagnostic Ultrasound Imaging: Inside Out, 2nd Edition - December 5, 2013, Hardback ISBN: 9780123964878 , eBook ISBN: 9780123965424
Harrer JU et al. Neurosonografie in der Ultraschall in Med 2012; 33: 218 235
Caldas et al. J Anesth Analg Crit Care (2022) 2:55 https://doi.org/10.1186/s44158-022-00082-3

Uve Wallter Perspectives in Medicine (2012) 1, 334 343
Neurology® 2023;100:e1395-e1405. doi:10.1212/WNL.0000000000206771

[*updated 05.11.2024*]