UNIVERSITÄT DUISBURG ESSEN

Open-Minded

University of Duisburg-Essen

Module Handbook

Master course

Water Science

(March 21st, 2022)

Contents

	chemistry, water analysis; can critically interpret the results of the above mentioned research • can describe due to chemical and chemical-analytical, biological and technological complex relationship of the water area • can comprehend the contribution to the scientific discussion of society relevant issues in the areas particularly in the areas collect assessment of water quality and sustainability and resource protection; objective establish and their individually and society relevance	Modules ResPrac, StabIso, Biofoul, ApplAnaChem Module WatChem, ApplAnaChem, ApplMiBi, Management, WastewatTreat, Modules WatChem, ApplAnaChem, ApplMiBi, Management, WastewatTreat,
Graduated students of the program of master water science apply the modern methods of the laboratory work.	Graduated Students of the Master Program Water Science: • know various modern methods and techniques for chemical and microbiological analysis and Treatment of aqueous systems • can the advantage and disadvantage of those methods in relation to the answer question critically and essentially estimate • apply these methods independently in the lab.	Modules EnviMiBi, ApplAnaChem, Electrochem, MemTech, StabIso, TechEngWat, WastewatTreat, WatPolMonit
Graduated students of	Graduated Students of the	All Modules, but especially

Curriculum Master Program Water Science

First Term	SWS				Cr	Exam
	L	S	P	S		
Chemometrics and Statistics	2	1			5	1
Environmental Microbiology	2	1			5	1
Water Chemistry	2	1			5	1
Optional Courses					**15**	**2-3**
Membrane Technologies	1	1			3	1
Waste Water Treatment	2	1			5	1
Nanopartikel und Kolloide	2	1			5	1
Foodomics	2	1			5	1
Excursions				1-5	1-5	
Sum					**30**	**5-6**
Second Term	**SWS**				**Cr**	**Exam**
	L	**S**	**P**	**S**		
Applied AnaC	2	1			5	1
Env-MiBi-P			8	1	7	
Applied Microbiology	4				6	1
Optional Courses					**12**	**2-3**
Advanced Mass Spectrometry	1	1			3	1
Quality Management	1	1			3	
Metrology in Chemistry	1				2	1
Oxidative Processes	2	1			5	1
Stable Isotope Analysis	2	1	3		9	1
Technical Engineering Water	2	1			5	1
Nano-Biophotonik	2	1			5	1
Advanced Gas Chromatography	2				3	1
Lebensmittel	2	1			5	1
ElectroCat	3		3		5	1
Excursions				1-5	1-5	
Sum					**30**	**4-5**
Third Term	**SWS**				**Cr**	**Exam**
	L	**S**	**P**	**S**		
AnaC-P			15		10	
Research-P			15		10	

Module Descriptions

Associated Key Qualifications
basic knowledge, systemic thinking, scientific thinking, structural ability, switching ability Ability to choose appropriate analytical methods for their own research questions based on the acquired theoretical and practical knowledge Ability to evaluate the quality of reported or achieved analytical data They have the ability in the knowledge extraction in the context of the teaching form "lecture". The students develop the expertise to assess theoretical and practical handling of the most important methods of instrumental analysis. They have the ability to demonstrate knowledge and understanding of essential concepts and theories relating to the subject matter.
Module examinations to gain grades
Written exam (120 Minutes)
Contribution of the Module Grade for the Final Grade
Share according to the credits (5/120)

Literature
Kellner, Mermet, Otto, Widmer: Analytical Chemistry, Wiley-VCH 1998
Further Information on the course

Contribution of the Module Grade for the Final Grade
Share according to the credits (6/120)

Contents
• History of Geomicrobiology • Microscopy methods in modern geomicrobiology • Omics methods in geomicrobiology • Microbial diversity and introduction to viruses • Ecology of hydrocarbon degradation • Carbon sequestration by microorganisms • Methane oxidation by microorganisms • Concepts in subsurface microbiology • Optional: Geomicrobiology of metal compounds • Optional: Evolutionary history of enzymes involved in carbon cycling
Examination
Written exam (120 Minutes) for Module
Literature
a) Geomicrobiology, 5th edition, 2009, Henry Lutz Ehrlich, Marcel Dekker New York, ISBN 978-0-8493-7906-2 b) Geomikrobiologie, 1998, Manfred Köhler und Fernando Völsgen, Wiley-VCH Weinheim, ISBN 3-527-30083-x; c) Brock Biology of Microorganisms, 2003, Michael T. Madigan, John M. Martinko, Jack Parker, Pearson Education Prentice Hall Upper Saddle River, ISBN 0-13-049147-0
Further Information on the course

Contents
1. Water, sanitation and health – global situation 2. Transmission routes and reservoirs of water-related pathogens 3. Classical and emerging waterborne pathogens – bacteria 4. Waterborne pathogens – viruses 5. Waterborne pathogens – protozoa 6. Vector-borne diseases associated with water 7. Water-related disease caused by cyanobacteria and algae 8. Hygienic aspects of catchment and source water quality 9. Hygienic aspects of water treatment, disinfection and water distribution 10. The indicator concept 11. Risk assessment
Examination
Written exam (120 Minutes) for Module
Literature
Brock Biology of Microorganisms. Madigan, M., Martinko, J., Dunlap, P. (2008) 12th Edition, Addison Wesley Pub Co Inc.
Further Information on the course
Homepage der World Health Organization (WHO), Water, sanitation and health: http://www.who.int/water_sanitation_health/en/

Module name	Abbreviation Module	
Chemometrics and Statistics	Chemo	
Course Name	Abbreviation Course	
Chemometrics and Statistics		
Lecturer	Faculty	Module Type (C/S)
Dr. Gerrit Renner	Chemistry	C

Designated Semester	Frequency	Language	No. students
1	WiSe	English	

SWS	Presence[4]	preparation, self tutoring, preparation for exam (h)	Workload
3	45 h	105 h	150 h

Education Methodology
Lecture (2 SWS) and Seminar (1 SWS)
Learning Targets
After a brief repetition of classical statistics, the students get acquainted with modern multivariate chemometric methods including factor analysis. Students will learn to grasp the underlying concepts by solving problems in a computer-based environment.
Contents
1. Introduction: Probability, special discrete and continous distributions, limit theorems, confidence intervals, statistical tests, correlation and regression, variance analysis 2. Multivariate methods: Linear statistical models, factor analysis, cluster and discriminant analysis 3. Basic methods of time series analysis 4. Case studies
Examination
Written exam (120 Minutes)

[4] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module name	Abbreviation Module
Environmental Microbiology	Envi MiBi
Responsible for the Module	Faculty
Prof. Dr. Rainer Meckenstock, Prof. Dr. Alexander Probst	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
1-2	2 Semester	C	12

Prerequisites according to examination regulations	Recommended Prerequisites
none	Biochemistry, molecular biology

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Environmental Microbiology	C	3	150 h
II	Practical Course Environmental Microbiology	C	9	210 h
Sum (Compulsory and Supplementary Courses)			3	360 h

Learning Outcomes of the Module
The students get knowledge about drinking water microbiology, microbiology of waste and waste water treatment. They have basic information about biotechnology.
Associated Key Qualifications
Application of the molecular biological approaches to microbial diversity. Knowledge of environmental microorganisms and biotechnological processes. They have ability to interpret data derived from laboratory observation an measurements in term of their significance and relate them to appropriate theory. Students have competence in the planning, design and execution of practical investigations, from the problem recognition stage through to the evaluation and appraisal of results and finding; this to include the ability to select appropriate techniques and procedures.
Module examinations to gain grades
Written exam (120 Minutes)
Contribution of the Module Grade for the Final Grade
Share according to the credits (12/120)

Literature
Brock: Biology of Microorganisms 12 th Edition 2002. Prentice Hall, ISBN 0-13-081922-0 Doods, W.K.: Freshwater Ecology. Academic Press, San Diego, 2002, ISBN 0-12-219135-8 Maier, Pepper, Gerba: Environmental Microbiology, Academic Press, 2000, ISBN 0-12-49750-4
Further Information on the course

Literature
Special script for practical course
Further Information on the course

Module name	Abbreviation Module	
Practical Analytical Chemistry	AnaC-P	
Course Name	Abbreviation Course	
Practical Course Analytical Chemistry		
Lecturer	Faculty	Module Type (C/S)
Prof. Dr. Torsten Schmidt, Prof. Oliver J. Schmitz, PD Dr. Ursula Telgheder	Chemistry	C

Designated Semester	Frequency	Language	No. students
3	WiSe	english	

SWS	Presence[7]	preparation, self tutoring, preparation for exam (h)	Workload
15	225 h	75 h	300 h

Education Methodology
Experimental project work (14 SWS) & Seminar (1 SWS)
Learning Targets
The students acquire advanced theoretical and practical basic knowledge in applied analytical chemistry. By direct integration into a project-oriented research topic they learn how to set-up and validate analytical methods aiming at answering research questions. The students receive thus also an active insight into the everyday life in a modern analytical laboratory.
Contents
Rather than carrying out pre-set identical experiments on a lab course level as on the Bachelor level, in the Master practical course analytical chemistry students select topics suggested by all research groups involved in analytical chemistry training, covering topics from advanced spectrometry via hyphenation techniques to sophisticated mass spectrometry. Although only a limited and individually selected number of analytical techniques will thus be learned hands-on, this procedure contributes to the development of an individual study profile and due to the research; orientation is much more motivating for the students than carrying out pre-selected experiments with known results.

[7] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module name	Abbreviation Module
Research Practical	ResPract
Responsible for the Module	Faculty
Lecturers of the selected subject	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
3	1 Semester	C	10

Prerequisites according to examination regulations	Recommended Prerequisites
Practical Course AnaC + Envi Mibi	

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Research Practical	C	15	300 h
Sum (Compulsory and Supplementary Courses)			15	300 h

Learning Outcomes of the Module
Students learn how to set-up a small-scale research project, to carry out the required experimental work independently in a limited period of time and to present their results in a written report and/or an oral presentation.
Associated Key Qualifications
Students have ability to interpret data derived from the laboratory observation and measurements in term of their significance and relate them to appropriate theory. They own ability to recognize and implement good measurement science and practice. They have communications skills, covering both written and oral communication. Students have competence in the planning, design and execution of practical investigations, from the problem recognition stage through to the evaluation and appraisal of results and finding; this to include the ability to select appropriate techniques and procedures.
Module examinations to gain grades
Written report
Contribution of the Module Grade for the Final Grade
Share according to the credits (10/120)

Module name	Abbreviation Module
Water Chemistry	WatChem
Responsible for the Module	Faculty
Prof. Dr. Torsten Schmidt	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science, M.Sc. Environmental Toxicology	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
1	1 Semester	C	5

Prerequisites according to examination regulations	Recommended Prerequisites
none	Basic knowledge in physical, organic and aqueous chemistry

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Water Chemistry	C	3	150 h
Sum (Compulsory and Supplementary Courses)			3	150 h

Learning Outcomes of the Module
Students should acquire an advanced understanding of chemical processes relevant in natural and technical aqueous systems, and of conceptual models and quantitative approaches to describe these. Controls of behavior and fate of organic and inorganic contaminants will be emphasized. Students will know how to apply the acquired knowledge by carrying out case studies on the behavior of chemicals in aqueous systems.
Associated Key Qualifications
Students have study skills needed for continuing professional development. They have ability to recognize and analyze novel problems and plans strategies for their solution. Students own presentations and communications skills, covering both written and oral communication. They have interpersonal skills, relating to the ability to interact with other people and to engage in team-working.
Module examinations to gain grades
Written exam (120 Minutes), case study and presentation
Contribution of the Module Grade for the Final Grade
Share according to the credits (5/120)

Literature
a) Benjamin, M. M. Water Chemistry, McGrawHill: New York, 2002 b) Jensen, J. N. A Problem-Solving Approach to Aquatic Chemistry, Wiley: New York, 2003 c) Schwarzenbach, R. P., Gschwend, P. M., Imboden, D. M. Environmental Organic Chemistry, 2nd ed., Wiley: New York, 2003.
Further Information on the course

Module name	Abbreviation Module	
Master Thesis	Master	
Course Name	Abbreviation Course	
Master Thesis		
Lecturer	Faculty	Module Type (C/S)
Coordinator of the Master project	Chemistry	C

Designated Semester	Frequency	Language	No. students
4	SoSe	english	

SWS	Presence[10]	preparation, self tutoring, preparation for exam (h)	Workload
			900 h

Education Methodology
Experimental and theoretical work and evaluation and written documentation
Learning Targets
The Master Thesis is an experimental or theoretical work presented in written form showing that the students can perform and evaluate a scientific topic within 24 weeks' time. The students will gain experiences with modern scientific methods. The students have the ability to effectively apply theoretical/practical knowledge and competencies to real-world problems in water chemistry. They will understand the opportunities and limitations of these methods to obtain information on water chemistry. They are able to use these methods and to assess and interpret their results. They are able to present their results in an oral and written way. The students have an inside about current relevant research topics in special branches. They are able to analyse results. They are able to participate in scientific discussions about current topics and to assess them critically.
Contents
The projects will be provided by the lecturers. The students are free to choose the supervisor by themselves.
Examination
Master Thesis
Literature
Depending on the topic of the master thesis

[10] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Optional Modules

Module name	Abbreviation Module
Advanced Mass Spectrometry	Adv MS
Responsible for the Module	Faculty
PD Dr. Wolfgang Schrader	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2	1 Semester	S	3

Prerequisites according to examination regulations	Recommended Prerequisites
none	

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Advanced Mass Spectrometry and hyphenated techniques	S	2	90 h
Sum (Compulsory and Supplementary Courses)			2	90 h

Learning Outcomes of the Module
Understanding of the use of mass spectrometric methods, technical understanding of fundamental issues, learning to solve problems in analytical chemistry, technical understanding of fundamental issues
Associated Key Qualifications
Learning to solve problems in analytical chemistry. Students know the principles and procedures used in chemical analysis and the characterization of chemical compounds. They have the principal techniques of the structural investigation, including spectrometry.
Module examinations to gain grades
Written (120 Minutes) or oral (30 – 60 Minutes) exam
Contribution of the Module Grade for the Final Grade
Share according to the credits (5/120)

Module name	Abbreviation Module
Excursions	Excursions
Responsible for the Module	Faculty
All lecturers of Master Programme Water Science	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
1, 2 or 3	1 Semester	S	1-5

Prerequisites according to examination regulations	Recommended Prerequisites
None	None

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Excursions	S	1-5	30-150 h
Sum (Compulsory and Supplementary Courses)			1-5	30-150 h

Learning Outcomes of the Module
Students get to know how large-scale research facilities; advanced water works or wastewater treatment plants work.
Associated Key Qualifications
Writing skills (They are able to create protocols independently and linguistically and professionally correct).
Module examinations to gain grades
Written report (no grades)
Contribution of the Module Grade for the Final Grade
Share according to the credits (1-5/120)

Module name	Abbreviation Module
Management	Manage
Responsible for the Module	Faculty
PD Dr. Ursula Telgheder	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2-3	2 Semester	S	6

Prerequisites according to examination regulations	Recommended Prerequisites
none	none

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Quality Management	S	2	90 h
II	Project Management	S	2	90 h
Sum (Compulsory and Supplementary Courses)			4	180 h

Learning Outcomes of the Module
Students get an inside about the application of Quality Assurance techniques. Students learn dealing with international norms at special examples. After the course students should be able to establish and validate quality management and assurance systems.
Associated Key Qualifications
Validate quality management, quality assurance techniques
Module examinations to gain grades
Written exam (120 Minutes) of module
Contribution of the Module Grade for the Final Grade
Share according to the credits (6/120)

Literature
• Neidhart, B.; Wegscheider, W.: Quality in Chemical Measurements, Springer-Verlag Berlin Heidelberg New York 2001, ISBN 3-540-65994- 32 • ISO Standards Compendium ISO 9000 – Quality management, 10th edition 2003, ISBN 92-67-10381-43 • ISO Survey of ISO 9000 and ISO 14001 certificates, 12th circle 2002, ISBN 92-67-10377-64 • ISO Management System The International Review of ISO 9000 and ISO 14000, International Organisation for Standardisation
Further Information on the course

Examination
Written exam (120 Minutes) for module
Literature
a) Smith, K. A., 2000, Project Management and Teamwork, Boston: McGraw-Hill's BEST b) Verzuh, E., 1999, The Fast Foreward MBA in Project Management, New York: John Willey&Sohns, Inc. c) PMBOK®Guide, 2000 Edition to the Project Management Body of Knowledge, Newton Square, Pennsylvania: Project Management Institute d) Cleland, D. I., Ireland, L.R., Project Manager's Portable Handbook, New York: McGraw-Hill e) Schelle, H., 1999, Projekte zum Erfolg führen, München: C. H. Beck f) Ackoff, R. L., 1994, The Democratic Corporation, Oxford/New York: Oxford University Press
Further Information on the course

Module name	Abbreviation Module	
Membrane Technologies	Mem Tech	
Course Name	Abbreviation Course	
Membrane Technologies		
Lecturer	Faculty	Module Type (C/S)
Prof. Dr. Mathias Ulbricht	Chemistry	S

Designated Semester	Frequency	Language	No. students
1 or 3	WS	english	

SWS	Presence[15]	preparation, self tutoring, preparation for exam (h)	Workload
2	30 h	60 h	90 h

Education Methodology
Lecture (1 SWS) & Seminar (1 SWS)
Learning Targets
On the basis of fundamental knowledge in physical chemistry and (chemical) process engineering, the students will gain detailed insights into the fundamentals of membranes and membrane separations as well as the most important membrane technologies which are applied to water treatment and/or purification.

[15] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module name	Abbreviation Module
Metrology in Chemistry	Metrol
Responsible for the Module	Faculty
Prof. Dr. Hendrik Emons	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2	2 Semester	S	2

Prerequisites according to examination regulations	Recommended Prerequisites
none	none

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Metrology in Chemistry	S	1	60 h
Sum (Compulsory and Supplementary Courses)			1	60 h

Learning Outcomes of the Module
Students shall realize the importance of traceability and other concepts in metrology for the evaluation of analytical results. They shall also obtain fundamental knowledge of the international systems in metrology.
Associated Key Qualifications
Quality management, insight into international regulations in metrology, critical data evaluation. Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complexes issues.
Module examinations to gain grades
Written(120 Minutes) or oral (30 – 60 Minutes) exam
Contribution of the Module Grade for the Final Grade
Share according to the credits (2/120)

Module name	Abbreviation Module
Nanoparticle and Colloids	Nano
Responsible for the Module	Faculty
Prof. Dr.-Ing. Stephan Barcikowski	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
1 oder 3	1 Semester	S	5

Prerequisites according to examination regulation	Recommended Prerequisites
none	

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Nanoparticle and Colloids (Lecture and Practical Course)	S	3	150 h
Sum (Compulsory and Supplementary Courses)			3	150 h

Learning Outcomes of the Module
The students should learn about the special properties of colloids and the structure and dynamics of these systems. They have the ability to describe interfacial phenomena and analyze. They are also able to investigate the complex transport and self-aggregation processes of nanoparticles, surfactants and polymers. The students have acquired the competence to work with colloidal systems, and they can describe the specific structures and properties of these systems and explain.
Associated Key Qualifications
The students have a working knowledge of nanoparticles and colloids. Judgments skills, self-learning
Module examinations to gain grades
Written (120 Minutes) or oral (30 – 60 Minutes) exam
Contribution of the Module Grade for the Final Grade
Share according to the credits (5/120)

Contents
Grundlagen der Kolloidchemie • Historische Entwicklung • Oberflächeneffekte, Elektrochem. Doppelschicht (Helmholtz, Gouy-Chapman) Stern-Potential, Debye-Länge • Nanopartikel-Stabilisierung (Ostwald-Reifung, LSW-Theorie, sterische/elektrosterische Stabilisierung, DLVO-Theorie) **Spezielle Eigenschaften von Nanopartikeln** • Materialklassen (Metalle, Oxide, Halbleiter, Legierungen) Thermodynamische und mechanische Eigenschaften • Optische Nanopartikeleigenschaften (Plasmonenresonanz, Größen- und Morphologieabhängigkeiten, Streuung) • Magnetische Nanopartikeleigenschaften (Magnetismus von Nanopartikeln, Superparamagnetismus, Ferrofluide)- **Synthese von Nanopartikeln** • Top-down Methoden (Mechanische Zerkleinerung, Plasmasynthese, Laserablation etc.) • Bottom-up Methoden (Nasschemische Synthese, Gasphasensynthese, Form-in-place etc.) **Anwendung von Nanopartikeln und –materialien** • Funktionale Nanopartikel, Nanokomposite, Technische Applikation, Nanopartikel im Alltag, biomedizinische Anwendung **Charakterisierung von Nanopartikeln** • Elektronenmikroskopische Methoden, Spektroskopische Methoden, Lichtstreuung
Examination
Written (120 Minutes) or oral (30 – 60 Minutes) exam
Literature
z.B. D. Vollath: Nanomaterials, Wiley-VCH, Weinheim L. Cademartiri, G. Ozin: Concepts of Nanochemistry, Wiley-VCH, Weinheim C. N. R. Rao, A. Müller, A. K. Cheetham: The Chemistry of Nanomaterials, Wiley-VCH, Weinheim
Further Information on the course
Both parts (Exam and Practical Course) must be successfully completed to complete the module.

Contribution of the Module Grade for the Final Grade
Share according to the credits (5/120)

Charakterisierung:

- Methoden zur Strukturbestimmung und Funktionalitätsbestimmung
- Umgebungsvariable Eigenschaften, Stabilisierung, Protein Corona
- Fallbeispiele aus der Praxis - Methodenkombination

Funktionalisierung:

- Grundlagen, Bindungsarten, Affinitäten, Klick-Chemie
- Markierung (Tagging), Biofunktionalisierung, biomolekulare Erkennung

Biophotonische Methoden, Lösungsstrategien und Fallbeispiele:

- Schwangerschaftstests (Lateral Flow Assays), Endoskopie, Krebs-Targeting, …

Diagnose-Methoden der NanoBiophotonik:

- Molekular: Biosensorik, molekulare Diagnose, SERS
- Intrazellulär: Kopplungen, Pasmonik, FRET, hochauflösende Lebendzellmikroskopie
- Zellulär: Markierung, Differenzierung, Zellsortierung, FACS
- Gewebe/Organ: Immunhistologie, Immunogold, Mikroskopie, Spektroskopie
- Moderne Methoden: Optische Ganzkörperbildgebung, Photoakustik, multimodale Bildgebung

Therapieansätze der NanoBiophotonik:

- Chemische-pharmakologische Ansätze: Solubilisieren, Verkapseln, Release-Systeme
- Physikalische Ansätze: Photothermie, Photodisruption, Laserskalpell
- Ausblick: klinische NanoBioMedizin, Biophotonik in der regenerativen Medizin

Examination

Written (120 Minutes) exam to the Contents from the lecture and practical course

Literature

Aus den folgenden Lehrbüchern werden ausgewählte Kapitel im Semesterapparat zur Verfügung gestellt:

- Jürgen Popp et al., Handbook of Biophotonics, Wiley, 2011, Vol. 1 (ISBN 987-3-527-41047-7), Vol. 2 (ISBN 987-3-527-41048-4), ausgewählte Kapitel
- Ricardo Aroca, Surface-enhanced vibrational spectroscopy: Chapter 2 (The interaction of light with nanoscopic metal particles and molecules on smooth reflecting surfaces), ISBN: 0-471-60731-2
- Greg T. Hermanson, Bioconjugate techniques, ISBN: 978-0-12-370501-3
- S. Schlücker: Surface-enhanced Raman spectroscopy: Analytical, Biophysical and Life Science Applications. ISBN: 978-3-527-32567-2

und um weitere Übersichtsartikel ergänzt (siehe elektronischer Semesterapparat).

Further Information on the course

Die Inhalte der Vorlesung werden im zugehörigen Blockpraktikum/Methodenkurs vertieft

Examination
Written (120 Minutes) exam to the Contents from the lecture and practical course
Literature
Aus den folgenden Lehrbüchern werden ausgewählte Kapitel im Semesterapparat zur Verfügung gestellt (siehe Vorlesung): • Jürgen Popp et al., Handbook of Biophotonics, Wiley, 2011, Vol. 1 (ISBN 987-3-527-41047-7), Vol. 2 (ISBN 987-3-527-41048-4), ausgewählte Kapitel • Ricardo Aroca, Surface-enhanced vibrational spectroscopy: Chapter 2 (The interaction of light with nanoscopic metal particles and molecules on smooth reflecting surfaces), ISBN: 0-471-60731-2 • Greg T. Hermanson, Bioconjugate techniques, ISBN: 978-0-12-370501-3 • S. Schlücker: Surface-enhanced Raman spectroscopy: Analytical, Biophysical and Life Science Applications. ISBN: 978-3-527-32567-2 und um weitere Übersichtsartikel mit ergänzt (siehe elektronischer Semesterapparat).
Further Information on the course

Module name	Abbreviation Module	
Oxidative Processes in Water Technology	OxProcess	
Course Name	Abbreviation Course	
Oxidative Processes		
Lecturer	Faculty	Module Type (C/S)
Prof. Dr. Torsten Schmidt, Dr. Jochen Türk	Chemistry	S

Designated Semester	Frequency	Language	No. students
2	SoSe	english	

SWS	Presence[19]	preparation, self tutoring, preparation for exam (h)	Workload
3	45 h	105 h	150 h

Education Methodology
Lecture (2 SWS) and Seminar (1 SWS)
Learning Targets
Students should obtain an overview of routine and state-of-the-art oxidative processes used in water and wastewater treatment. They should acquire an advanced understanding of the fundamental transformation processes involved. By studying exemplary applications they will learn the advantages and drawbacks of oxidative processes. This will aid them in a selection of appropriate technological solutions.
Contents
Oxidative species/processes of interest: Chlorine, Chlorine dioxide, Ozone, Fenton, UV, Permanganate, Hydroxyl radicals, Other radicals, Ferrate, others Transformation reactions: electron transfer, H-abstraction, electrophilic addition Kinetics of transformation reactions Applications in water treatment (including disinfection) Applications in wastewater treatment Disinfection/transformation by-products: (Eco)toxicological evaluation Economical considerations
Examination
Written (120 Minutes) or oral (30 – 60 Minutes) exam and presentation

[19] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module name	Abbreviation Module
Stable Isotope Analysis	SIA
Responsible for the Module	Faculty
Dr. Maik Jochmann, Prof. Dr. Torsten Schmidt	Chemistry

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2	1 Semester	S	9

Prerequisites according to examination regulations	Recommended Prerequisites
none	Basic knowledge in physical, organic and analytical chemistry

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Stable Isotope Analysis	S	3	150 h
II	Practical Course Stable Isotope Analysis	S	3	120 h
Sum (Compulsory and Supplementary Courses)			6	270 h

Learning Outcomes of the Module
Students should get to know the principles and instrumentation in modern stable isotope analysis with emphasis on light elements and will acquire hands-on experience on how to perform stable isotope analysis.
Associated Key Qualifications
Presentations skills, teamwork, problem solving capabilities, scientific method. Students have study skills needed for continuing professional development. They have ability to recognize and analyze novel problems and plans strategies for their solution. Students own presentations and communications skills, covering both written and oral communication. They have interpersonal skills, relating to the ability to interact with other people and to engage in teamworking.
Module examinations to gain grades
Written (120 Minutes) exam, presentation and lab course reports
Contribution of the Module Grade for the Final Grade
Share according to the credits (9/120)

Literature
a) Clark, I.; Fritz, P. Environmental Isotopes in Hydrogeology; CRC Press: Boca Raton, 1997 b) b) Kendall, C.; McDonnell, J. J., Eds. Isotope Tracers in Catchment Hydrology; Elsevier: Amsterdam, 1998 c) Frey, B.;Stable Isotope Ecology; Springer: Berlin, 2008 d) Sharp, Z.; Principles of Stable Isotope Geochemistry; Prentice Hall: Upper Saddle River, New Jersey, 2006
Further Information on the course

Module name	Abbreviation Module
Technical Engineering Water	TechEngWater
Responsible for the Module	Faculty
Prof. Dr.-Ing. Stefan Panglisch, Dr.-Ing. Ralph Hobby	Engineering

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2-3	2 Semester	S	9

Prerequisites according to examination regulations	Recommended Prerequisites
none	none

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Technical Engineering Water	S	3	150 h
II	Practical Course Technical Engineering Water	S	3	120 h
Sum (Compulsory and Supplementary Courses)			6	270 h

Learning Outcomes of the Module
Students have theoretical and practical knowledge for different water treatment processes.
Associated Key Qualifications
Basic knowledge, systemic thinking, scientific thinking. The possibility to use this knowledge in the praxis. Competence in planning, design and execution of practical investigation, from the problem recognition stage through to the evaluation and appraisal of results and finding; this to include the ability to select appropriate techniques and procedure.
Module examinations to gain grades
Written (120 Minutes) or oral (30 – 60 Minutes) exam
Contribution of the Module Grade for the Final Grade
Share according to the credits (9/120)

Examination
Written (120 Minutes) or oral (30 – 60 Minutes) exam
Literature
a) Sontheimer et. al., Activated Carbon for Water Treatment, DVGW-Forschungsstelle am Engler-Bunte Institut der Universität Karlsruhe (TH) 1988 b) Tien, C., Granular Filtration of Aerosols and Hydrosols, Butterworth Publishers 1989, ISBN 0-409-90043-5 c) Filters and Filtration Handbook, 3rd Edition Elsevier Science Publishers LTD, 1996, ISBN 1-85617-078-0
Further Information on the course

Module name	Abbreviation Module
Wastewater Treatment	WWT
Responsible for the Module	Faculty
Prof. Dr.-Ing. Stefan Panglisch, Dr.-Ing. Ralph Hobby	Engineering

Relevance for following study programmes	Module level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
1 or 3	1 Semester	S	5

Prerequisites according to examination regulations	Recommended Prerequisites
None	none

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Wastewater Treatment	S	3	150 h
Sum (Compulsory and Supplementary Courses)			3	150 h

Learning Outcomes of the Module
The students know the sources a composition of wastewater, their biological processes.
Associated Key Qualifications
Students have knowledge about wastewater biology and chemistry. They understand the fundamentals in the field of Urban Water Management.
Module examinations to gain grades
Written exam (120 Minutes)
Contribution of the Module Grade for the Final Grade
Share according to the credits (5/120)

a) Henze, M., Harremoes, P., Jansen, J. la Cour, Arvin, E. (1996): Wastewater Treatment, Biological and Chemical Processes, Springer Verlag
b) Vesilind, A., Rooke, R.L., (2003): Wastewater Treatment Plant Design, IWA Publishing
c) Bitton, G., (1990): Wastewater Microbiology, Wiley-Liss Verlag
d) DWA Dictionary; The Microbiology of Activated Sludge Second Edition Author(s): Robert Seviour, Linda Blackall NYP ISBN: 1843390329
e) ATV Dictionary; Principles of Water and Wastewater Treatment Processes Editor(s): R Stuetz ISBN: 1843390264
f) Hosang, W., Bischof, W. (1998): Abwassertechnik, Teubner Verlag

Further Information on the course

Module name	Abbreviation Module	
Microbial Biotechnology and Biodegradation	Microb Biotec	
Course Name	Abbreviation Course	
Microbial Biotechnology and Biodegradation		
Lecturer	Faculty	Module Type (C/S)
Prof. Dr. Rainer Meckenstock, Prof. Dr. Bettina Siebers	Chemistry	S

Designated Semester	Frequency	Language	No. students
2	SoSe	English	

SWS	Presence[25]	preparation, self tutoring, preparation for exam (h)	Workload
2	30 h	60 h	90 h

Education Methodology
Lecture (2 SWS)
Learning Targets
The students will get an overview of the use of living systems (i.e. microbial communities, microorganisms or biological molecules such as enzymes) for the production of relevant substances and process optimization for human benefit. Starting with a general overview of biotechnological applications and significance, classical fermentations in food industries, special production strains, biocatalysis by enzymes as well as environmental biotechnology will be discussed
Contents
1) Biotechnology (overview) 2) Classical Biotechnology (Fermentations, productions strains etc.) 3) Enzyme Catalysis for production and process optimization 4) Metabolic engineering & Synthetic Biology 5) Selected clean-up technologies of contaminated sites and microbial processes during bioremediation 6) Monitoring methods for bioremediation 7) Oil production and enhanced oil recovery 8) Metal leaching and metal production 9) Biogas production
Examination
Written (120 Minutes) examination

[25] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module Name	Abbreviation Module
Microbial Physiology and Biotechnology	Micro BioTech
Responsible for the Module	Faculty
Prof. Dr. Bettina Siebers, Dr. Christopher Bräsen	Chemistry

Relevance for following study programmes:	Module Level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2	1 Semester	S	7

Prerequisites	Recommended Prerequisites
Environmental Microbiology, Microbial Biotechnology	Biochemistry, Molecular Biology, Microbial Biotechnology

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Microbial Physiology and Biotechnology	S	8	210 h
Sum (Compulsory and Supplementary Courses)			8	210 h

Learning Outcomes of the Module
The class is organized as a block course, with lectures in the morning followed by practical work in the laboratory as well as bioinformatics analyses. During lectures, students will get an overview of biochemical, molecular biological and genetic methods as well as basic bioinformatics skills necessary to approach microbial physiology and to develop biotechnological applications. Students will be introduced to theoretical physiological and metabolic concepts as well as biotechnological application of enzymes and microbes. The lecture will convey basic bioinformatics skills for cloning of genes, prediction of gene function, phylogenetic comparisons. In the practical course, students will perform own projects on topics of scientific interest to the MEB group and will work on novel scientific questions as a small team. Starting with a general overview of physiology, methods and bioinformatics, students will learn state of the art biochemical, molecular biological and genetic methods, advanced physiological, biotechnological concepts as well as basic bioinformatics approaches.

Module name	Abbreviation Module	
Microbial Physiology and Biotechnology	Micro BioTech	
Course Name	Abbreviation Course	
Microbial Physiology and Biotechnology	Micro BioTech	
Lecturer	Faculty	Module Type (C/S)
Prof. Dr. Bettina Siebers, Dr. Christopher Bräsen	Chemistry	S

Designated Semester	Frequency	Language	No. students
2	SoSe	English	8

SWS	Presence[26]	preparation, self tutoring, preparation for exam (h)	Workload
8	96 h	114 h	210 h

Education Methodology
Lecture with practical course (8 SWS)
Learning Targets
The class is organized as a block course, with lectures in the morning followed by practical work in the laboratory as well as bioinformatics analyses. During lectures, students will get an overview of biochemical, molecular biological and genetic methods as well as basic bioinformatics skills necessary to approach microbial physiology and to develop biotechnological applications. Students will be introduced to theoretical physiological and metabolic concepts as well as biotechnological application of enzymes and microbes. The lecture will convey basic bioinformatics skills for cloning of genes, prediction of gene function, phylogenetic comparisons. In the practical course, students will perform own projects on topics of scientific interest to the MEB group and will work on novel scientific questions as a small team. Starting with a general overview of physiology, methods and bioinformatics, students will learn state of the art biochemical, molecular biological and genetic methods, advanced physiological, biotechnological concepts as well as basic bioinformatics approaches.

[26] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module Name	Abbreviation Module
Ecology of Biodegradation	Eco Biodeg
Responsible for the Module	Faculty
Prof. Dr. Rainer Meckenstock	Chemistry

Relevance for following study programmes:	Module Level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2	1 Semester	S	7

Prerequisites	Recommended Prerequisites
Passed lecture Environmental Microbiology	Stable Isotope Analysis, Microbial Biotechnology

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
	Ecology of Biodegradation	S	8	210
Sum (Compulsory and Supplementary Courses)			8	210

Learning Outcomes of the Module
The class is organized as a block course, starting with several days of lectures followed by the practical work that will be performed within individual research projects. During lectures, students gain theoretical knowledge about microbial community ecology and microbial biodegradation as well as about analytical techniques to measure and interpret both. The lectures will convey processing of 16S sequences and bioinformatic and statistical downstream analysis as well as stable isotope techniques to measure microbial degradation activity. In the practical part, students will carry out individual research projects on biodegradation of environmental pollutants or remediation technologies concerning current research topics of the group.
Associated Key Qualifications
Students will be able to perform microbial community analysis and measure microbial degradation activities and combine both aspects into a coherent interpretation. Deeper knowledge on biodegradation processes will be gained.
Module examinations to gain grades
Protocol and presentation of results.

Module name	Abbreviation Module	
Ecology of Biodegradation	Eco Biodeg	
Course Name	Abbreviation Course	
Ecology of Biodegradation	Eco Biodeg	
Lecturer	Faculty	Module Type (C/S)
Prof. Dr. Rainer Meckenstock, Dr. Verena Brauer	Chemistry	S

Designated Semester	Frequency	Language	No. students
2	SoSe	English	8

SWS	Presence[27]	preparation, self tutoring, preparation for exam (h)	Workload
8	96 h	114 h	210 h

Education Methodology
Lecture with practical course (8 SWS)
Learning Targets
The class is organized as a block course, starting with several days of lectures followed by the practical work that will be performed within individual research projects. During lectures, students will get equipped with theoretical knowledge about microbial community ecology and microbial biodegradation and about analytical techniques to measure and interprete both. The lectures will convey processing of 16S sequences and related downstream analysis as well as stable isotope techniques to measure microbial degradation activity. In the practical part, students will carry out small individual research projects involving analysis of microbial community composition and/or microbial activity. Students will learn current concepts of microbial community ecology and biodegradation research and practical techniques in community and stable isotope analysis.

[27] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module Name	Abbreviation Module
Microbial Bioinformatics	Mic Bioinfo
Responsible for the Module	Faculty
Prof. Dr. Alexander Probst	Chemistry

Relevance for following study programmes:	Module Level
M.Sc. Water Science	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
3	1 Semester	S	7

Prerequisites	Recommended Prerequisites
Environmental Microbiology	Biochemistry, Molecular Biology, Microbial Biotechnology

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Ecology and Bioinformatics	S	8	210 h
Sum (Compulsory and Supplementary Courses)			8	210 h

Learning Outcomes of the Module
The class is organized as a block course, with lectures on most mornings and actual research for the rest of the time (morning and afternoon). During lectures, students will be made familiar with: - A programming language for analysis of microbial datasets - Processing of metagenomic datasets - Reconstruction of individual genomes from complex metagenomes - Analysis of microbial genomes including phylogenomics - Identification of viral genomes and linkage of viruses to hosts via CRISPR-Cas systems - Multivariate data analysis for ecology and other purposes - Metatranscriptomic analysis (optional) - Metagenome sequencing (optional; wet lab) The students will be individually integrated into existing research projects of the Group for Aquatic Microbial Ecology (AK Probst) and work on their own research question.

Module name	Abbreviation Module	
Microbial Bioinformatics	Mic Bioinfo	
Course Name	Abbreviation Course	
Microbial Bioinformatics	Mic Bioinfo	
Lecturer	Faculty	Module Type (C/S)
Prof. Dr. Alexander Probst	Chemistry	S

Designated Semester	Frequency	Language	No. students
3	WiSe	English	8

SWS	Presence[28]	preparation, self tutoring, preparation for exam (h)	Workload
8	96 h	114 h	210 h

Education Methodology
Lecture with practical course (8 SWS)
Learning Targets
The class is organized as a block course, with lectures on most mornings and actual research for the rest of the time (morning and afternoon). During lectures, students will be made familiar with: - A programming language for analysis of microbial datasets - Processing of metagenomic datasets - Reconstruction of individual genomes from complex metagenomes - Analysis of microbial genomes including phylogenomics - Identification of viral genomes and linkage of viruses to hosts via CRISPR-Cas systems - Multivariate data analysis for ecology and other purposes - Metatranscriptomic analysis (optional) - Metagenome sequencing (optional; wet lab) The students will be individually integrated into existing research projects of the Group for Aquatic Microbial Ecology (AK Probst) and work on their own research question.

[28] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module Name	Abbreviation Module
Chemistry and analytics of food and its authenticity	Lebensmittel
Responsible for the Module	Faculty
Prof. Dr. Oliver J. Schmitz	Chemistry

Relevance for following study programmes:	Module Level
M.Sc. Water Science, M.Sc. Chemistry, MA Teacher Program	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2	1 Semester	S	5

Prerequisites	Recommended Prerequisites

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Chemistry and analytics of food and its authenticity	S	3	150 h
Sum (Compulsory and Supplementary Courses)			3	150 h

Learning Outcomes of the Module
Students gain basic knowledge of the chemical principles of food ingredients (carbohydrates, lipids, proteins, etc.). In the course, typical chemical reactions of the ingredients will be discussed. In addition, an overview of analytical methods will be given in order to characterize the ingredients. Accordingly, the students will acquire the competence about the most important methods and their practical use to determine the authenticity of food.
Associated Key Qualifications
Knowledge of the chemistry of carbohydrates, proteins and lipids in foods and their analysis.
Module examinations to gain grades
Written exam (120 Minutes) or oral exam (30 Minutes) Course Achievement: a lecture in the seminar (10 Minutes)
Contribution of the Module Grade for the Final Grade
Share according to the credits (5/120)

Literature
• Lehrbuch der Lebensmittelchemie von Belitz, Grosch, Schieberle ISBN-10 3540732012 • Lebensmittelchemie von Matissek ISBN-10 3662596687 • Taschenatlas der Lebensmittelchemie: Functional Food, BSE-Analytik, Lebensmittel-qualität von Schwedt ISBN-10 9783527312078
Further Information on the course

Module name	Abbreviation Module	
Foodomics: Biochemistry of nutrition and analytics of functional foods.	Foodomics	
Course Name	Abbreviation Course	
Foodomics: Biochemistry of nutrition and analytics of functional foods.	Foodomics	
Lecturer	Faculty	Module Type (C/S)
Dr. Sven Meckelmann	Chemistry	S

Designated Semester	Frequency	Language	No. students
1 or 3	WiSe	German	

SWS	Presence[30]	preparation, self tutoring, preparation for exam (h)	Workload
3	42 h	108 h	150 h

Education Methodology
Lecture (2 SWS) & Seminar (1 SWS)
Learning Targets
Students will gain knowledge of the biochemical principles of nutrition as well as their analytics. Using various examples, the influence of nutrition on different metabolic pathways will be shown and discussed how these processes can be characterized analytically. The students acquire the competence about the function and characterization of certain functional ingredients in food as well as in the human organism.
Contents
Basics of the biochemistry of nutrition, analysis of bioactive food ingredients and their detection in the human organism, targeted analysis of relevant metabolic pathways, non-targeted analysis of foods.
Examination
Written exam (120 Minutes) or oral exam (30 Minutes) Course Achievement: a lecture in the seminar (10 Minutes)

[30] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

Module Name	Abbreviation Module
Electrocatalysis: From Fundamentals to Density Functional Theory	ElectroCat
Responsible for the Module	Faculty
Jun.-Prof. Dr. Kai S. Exner	Chemistry

Relevance for following study programmes:	Module Level
M.Sc. Water Science, M.Sc. Chemistry	MA

Designated Semester	Duration of Module	Module Type (C/S)	Credits
2	1 Semester	S	5

Prerequisites	Recommended Prerequisites
	Theoretical Chemistry 2, PC-V

Associated Courses:

No.	Course Name	Module Type	Hours per week (SWS)	Workload
I	Electrocatalysis: From Fundamentals to Density Functional Theory	S	6	150 h
Sum (Compulsory and Supplementary Courses)			6	150 h

Learning Outcomes of the Module
Dieser Kurs ist als Blockkurs organisiert, mit Vorlesungen an den meisten Vormittagen und eigentlichen Forschung in der restlichen Zeit (vormittags und nachmittags). In den Vorlesungen erlangen die Studierende Kenntnisse über die Grundlagen der Elektrochemie und der Eletrokatalyse sowie deren atomistische Beschreibung auf Basis von Dichtefuntionaltheorie-Rechnungen. Die Studierenden werden individuell in bestehende Forschungsprojekte des Arbeitskreises Theoretische Anorganische Chemie (AK Exner) eingebunden und bearbeiten eine eigene Forschungsfrage.
Associated Key Qualifications
Die Studierenden erlernen die Theorie zu katalytischen Prozesse an Festkörperelektroden und erlernen die Beschreibung dieser Prozesse mit Elektronenstrukturrechnungen in der Dichtefunktionaltheorie-Näherung.
Module examinations to gain grades
Presentation of results

Module name	Abbreviation Module	
Electrocatalysis: From Fundamentals to Density Functional Theory	ElectroCat	
Course Name	Abbreviation Course	
Electrocatalysis: From Fundamentals to Density Functional Theory	ElectroCat	
Lecturer	Faculty	Module Type (C/S)
Jun.-Prof. Dr. Kai S. Exner	Chemistry	S

Designated Semester	Frequency	Language	No. students
2	SoSe	English	

SWS	Presence[31]	preparation, self tutoring, preparation for exam (h)	Workload
6	72 h	78 h	150 h

Education Methodology
Lecture with practical course (6 SWS)
Learning Targets
Dieser Kurs ist als Blockkurs organisiert, mit Vorlesungen an den meisten Vormittagen und eigentlichen Forschung in der restlichen Zeit (vormittags und nachmittags). In den Vorlesungen erlangen die Studierende Kenntnisse über die Grundlagen der Elektrochemie und der Eletrokatalyse sowie deren atomistische Beschreibung auf Basis von Dichtefuntionaltheorie-Rechnungen. Die Studierenden werden individuell in bestehende Forschungsprojekte des Arbeitskreises Theoretische Anorganische Chemie (AK Exner) eingebunden und bearbeiten eine eigene Forschungsfrage.
Contents
Die Studierenden erlernen die Theorie zu katalytischen Prozesse an Festkörperelektroden und erlernen die Beschreibung dieser Prozesse mit Elektronenstrukturrechnungen in der Dichtefunktionaltheorie-Näherung.
Examination
Presentation of results.
Literature

[31] Bei der Berechnung der Präsenzzeit wird eine SWS mit 45 Minuten als eine Zeitstunde mit 60 Minuten berechnet. Dies stellt sicher, dass ein Raumwechsel und evt. Fragen an Lehrende Berücksichtigung finden.

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The actual version of the module handbook is to be found under:
www.uni-due.de/chemie/studium_modulhandbücher.shtml