# Biotechnology & Environmental Engineering

## - Courses in English -

- Applied Hydrobiology and Ecotoxicology
- Downstream Processing of Natural Products
- Feedback Control Systems
- Human Ressource Management
- Instrumental Analysis*
- Mathematics 3
- Pharmaceutical Toxicology
- Project Management for Engineers
- Renewable Energy Systems 2** – Fuel Cells Systems and their applications
- Renewable Energy Systems 2** - Photovoltaics
- Sustainable Energy Economics

* Limited number of participants ** This is a two-part module with one exam

This programme is offered in the summer semester (April-July) only.
Faculty of Life Sciences; April 2024

| **Course Name: Applied Hydrobiology and Ecotoxicology** | | |
|---|---|---|
| Degree programme:<br>**Environmental Engineering** (Bachelor) | Responsible Lecturer:<br>Prof.Dr. Carolin Floeter | |
| **Work load: 210 h** | **Lecture hours per week:** 4 SWS | **ECTS Credits: 5** |

**Course objectives:**

**Applied Hydrobiology:**

The students …

- gain basic knowledge in hydrobiology (freshwater and marine)
- learn methods for an ecological and ecotoxicological risk assessment
- identify impacts on freshwater and marine ecosystems
- develop risk reduction measures to improve the water quality of freshwater and marine ecosystems
- apply the knowledge on freshwater case studies: the rivers Bille and Elbe
- apply the knowledge on marine case studies: North Sea and Baltic Sea
- evaluate water and sediment quality of european freshwater and marine ecosystems according to international, european and national regulation (e.g. EU Water Framework Directive and EU Marine Strategy Directive)
- gain insight into occupational areas of applied hydrobiology and ecotoxicology

**Social – and Selfcompetencies**

The students …

- learn to work in small teams together with international students in English.
- gain insight into occupational areas of environmental risk assessment and can develop their emphasis further.
- are able to think interdisciplinary, assess environmental impacts and develop risk mitigation measures.

**Contents:**

**Applied Hydrobiology:**

- Basic hydrobiology: physical and chemical properties of water, classification of lakes due to stratification and circulation, nutrient cycles (C-, N and P), river continuum concept, aquatic biocoenosis and food webs, marine ecosystems;
- Methods and parameter to assess the water and sediment quality according to European regulation (EU Water Framework Directive and EU Marine Strategy Directive);
- Ecological methods for the assessment of water and sediment quality of rivers: macrozoobenthos (invertebrates living in the sediment) analysis and evaluation according to the EU Water Framework Directive;
- Ecotoxicological methods for the risk assessment of water/sediment samples and for single substances: biomarker, bioassays and mesocosm studies, as well as biomonitoring;
- Impacts on aquatic ecosystems: e.g. pollution by point and diffuse sources, cooling water extraction and discharge, waste water discharge, hydrological constructions, e.g. weirs, shipping, dredged material management, tourism, fishery;
- different risk assessment procedures according to international and national regulation: for pesticides, waste water and sediments (dredged material management); PBT (Persistence, Bioaccumulation, Toxicity and “veryP veryB”) Concept, Predicted Environmental Concentration (PEC), Predicted No Effect Concentration (PNEC), Risk Quotient method, mixture toxicity, Endocrine Disruptors (EDs);

- risk assessment, risk mitigation and risk management;
- Bille and Elbe river: impact analysis and management scenarios;
- North Sea/ Baltic Sea: insight into environmental impact assessment, e.g. of offshore windparks and risk mitigation measurements.

**About didactics and work load distribution:**

Taught seminar (PowerPoint presentations, blackboard, films, cards) with case examples; papers, work in small groups; discussion of current topics; presentations by external experts; excursions
210 h, thereof 96 h lesson time (6 hours per week), 114 h of self-study

Requirements for participation:
Selection of environmental assessment as course specialisation required

Recommended prior knowledge: Module 3 and 4 (Physics 1, Physics 2); Module 6 (Cellular and Microbiology; Biological and Chemical Parameters for Environmental Assessment); Module 7 and 8 (General, inorganic and organic chemistry and Biochemistry); Module 15 (Biology 1, Biology 2)

**Course language:**
English

**Type of exam:** Oral Presentation in groups of two and written summary

**Requirements for credit point allocation:**
Applied Hydrobiology – Presentation

**Literature:**


- Working material of lecturers
- Robert G. Wetzel (2001): Limnology: lake and river ecosystems. 3. Aufl., Acad. Press. ISBN: 0-12-744760-1
- Jacob Kalff (2003): Limnology: inland water ecosystems. Prentice Hall. Pearson Education. ISBN 0-13-033775-7
- Jürgen Schwoerbel, Heinz Brendelberger (2010): Einführung in die Limnologie. 9. Aufl., Elsevier, Spektrum Akad. Verl.. ISBN:3-8274-1498-9
- Winfried Lampert; Ulrich Sommer (2007): Limnoecology: the ecology of lakes and streams. 2. ed. Univ. Press. ISBN: 978- 0-19-921393-1
- Christer Brönmark; Lars-Anders Hansson (2005): The biology of lakes and ponds. 2. ed., reprint (with corr.). Oxford Univ. Press. ISBN: 0-19-851612-6 0-19-851613-4
- Michael C. Newman (2010): Fundamentals of ecotoxicology. 3rd Ed. CRC Press. ISBN: 978-1-420-06704-0
- Walker, C.H., Hopkin, S.P., Sibly, R.M. & Peakall, D.B. (2006): Principles of Ecotoxicology. 3rd Edition CRC Press. ISBN 0-8493-3635-X
- Karl Fent (2007): Ökotoxikologie: Umweltchemie, Toxikologie, Ökologie. Thieme. 3., überarb. und aktualisierte Aufl. ISBN: 3-13-109993-3
- Futher literature (e.g. reports from OSPARCOM, HELCOM and Federal Environmental Agency (Umweltbundesamt (UBA) will be recommended in the lectures
- VDI-Richtlinien: Biologische Messverfahren

## Course Name: Downstream Processing of Natural Products

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| Degree programme: Biotechnology (Bachelor) | Responsible Lecturer: Prof. Dr. Gesine Cornelissen, Prof. Dr. Birger Anspach |

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| **Work load: 270 h** | **Lecture hours per week:** 7 | **ECTS Credits: 9** |

**Course objectives:**

Educational objectives

Professional and methodical competences

The students have the ability …

- to select suitable separation and purification methods, in order to isolate biologically active molecules from various raw materials. At the same time process efficiency and preservation of bioactivity are focal.
- to coordinate methods, in order to minimize their number and to optimize the product yield.
- to choose theoretical approaches for the quantification of separation processes and to evaluate experimental data accordingly.
- to apply basic knowledge of scale-up dimensioning and to conduct basic scale-up processing.

Social and self-competence

The students have the ability ...

- to scrutinize separation strategies for biomolecules and to depict alternatives, where indicated.
- to independently organize downstream procedures based on a rough separation objective.
- to exert English as communication medium, both during lectures and evaluation of publications (mainly in the laboratory course), and though identifying own strengths and weaknesses.
- to organize downstream purification trains in a short laboratory project covering three days, thereby considering multiple access of equipment by the various student groups.
- to clearly recapitulate results of laboratory experiments and the project, to present them in front of an audience and to discuss interpretations self-critically.

**Contents:**

- Sedimentation and centrifugation
- Flocculation of microorganisms
- Precipitation of soluble bioproducts
- Disruption of microorganisms
- Filtration and membrane processes
- Extraction techniques
- Chromatographic methods for product purification
- Denaturation of bioproducts
- Purification trains in downstream processing of natural products
- Application of analytical methods for product identification and quantification

**Courses**

- Downstream Processing (lecture)
- Downstream Processing (laboratory course)
- Protein Purification / Preparative Chromatography (lecture)

**About didactics and work load distribution:**

Interactive lecture based on presentations, including isolated videos.

Compilation of acquired knowledge at suitable media (blackboard, pin wall, etc.)

Consolidation of competences through accompanying exercises, both in lectures and the e-learning platform.

Implementation of experiments according to protocols and execution of a laboratory project based on publication-

based experiences in a self-dependent way.

270 h, including 110 h (7 SWS) presence and 160 h self-study

**Requirements for participation:**
**Attendance conditions**

A biochemical laboratory course (or related) must have been completed before starting the laboratory course in downstream processing.

**Recommended precognition**

Biochemistry, Instrumental Analytics and Bioprocessing

**Course language:**

English in lectures, partially German in the laboratory

**Type of exam:**

Graded viva voce of both lectures based on case studies, which have to be described, assessed, and resolved, if indicated.

written exams

Preparation of two lab protocols and one project report as well as an oral presentation of laboratory results in short presentation (10-15 min).

**Requirements for credit point allocation:**
successful completion of the seminar and laboratory work
Laboratory Practice: Participation certificate (non-graded)

**Literature:**

- Lecture scripts as PDF on e-learning-platform
- Script with protocols for the laboratory course
- Descriptions and publications for the laboratory projects
- E-learning-based lessons referring to basic knowledge in a biochemistry laboratory and introducing methods in various downstream and chromatographic processes
- Successive levels of exercises and tests on the e-learning platform, both content- and problem-orientated

## Course Name: Feedback Control Systems

| Degree programme: | Responsible Lecturer: |
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| Biotechnology Engineering (Bachelor) | Prof. Dr. Gerwald Lichtenberg |

| **Work load:** | **Hours: 1 week block + individual dates** | **ECTS Credits: 5** |
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**Course objectives:**

Cognitive Competencies:

- Knowing linear time-invariant (LTI) models,
- Understanding methods to design single loop controllers,
- Modelling single input single output (SISO) systems from first principles,
- Analyzing linear systems and feedback control loops,
- Designing simple linear controllers based on LTI models,
- Developing complex systems and controller structures from simpler ones.

Social Competencies:

- Reflection on own abilites and competencies
- Discussing goal-oriented in heterogeneous teams

**Contents:**

- Block diagrams: linear and nonlinear systems, input/output behaviour, state variables
- Composition: parallel, series, feedback
- Linear state space models: normal forms, canonical, initial states
- Ordinary differential equations (ODE): convolution integral, stationary and transient behaviour
- Time domain: impulse and step response, free movement, DC gain, direct feedthrough
- Laplace transformation: integrals, back transformation, partial fraction expansion
- Transfer functions: poles, zeros, time constants
- Delay systems: time and frequency domain representations
- Stability: eigenvalues of system matrix, poles of transfer function, unstable systems
- Graphical representations: pole-zero plot, Bode diagram, Nyquist diagram
- Tools for modelling and analysis: Scilab, Xcos
- Standard control loop: 1 and 2 degree of freedom (DOF), linear controllers
- Closed loop transfer functions: (complementary) sensitivity, disturbance, noise, reference
- Steady state error: inner model principle
- Desired behaviour definitions: rise and settling time, overshoot
- Robustness: amplitude and phase reserve
- Controller types: P, I, PD, PI, PID, Smith predictor
- Laws of feedforward and feedback control: closed loop eigenvalues, Bode integral,
- Linear control design methods: Bode diagram, root locus, Ziegler-Nicols, Optimal control
- Input saturation: integrator windup, anti-windup

**About didactics and work load distribution:**

Interactive Lectures with Computer Exercises

**Requirements for participation:**

Mathematics: Linear Algebra, Calculus, ODEs

**Type of exam:**

Oral and midterm exams

**Course language:**

English

**Requirements for credit point allocation:**
Sucessful completion of the exam

**Literature:**

G. Lichtenberg: Feedback Control Systems, Lectue Notes, 2018

K. Astrom, R. Murray: Feedback Systems: An introduction for Scientists and Engineers, Princeton, 2008

J. Lunze: Regelungstechnik 1, Springer-Vieweg, 2014 (in german)

**Course Name: International Human Resource Management**

Degree programme:
**Nutrition & Home Economics** (Bachelor)

Responsible Lecturer: Prof. Dr. Birgit K. Peters

**Work load:** 150 | **Lecture hours per week:** 4 (Blended Learning*) | **ECTS Credits:** 5

**Course objectives:**

The blended learning course "International Human Resource Management" includes five workshops. **Students who sign up for the course have to attend a minimum of four lessons to get the Examination credits**. The topics are about International Human Resource Management with the focus on Communication, Compensation and Benefits, Motivation, Leadership, Training and Development. We are going to look at the topics from different perspectives and countries.

**Content:**

- Strategic HRM / HRM strategies
- International Employee relations
- Basic Communication Skills
- Performance Management
- Motivation theories
- Basics of Leadership & Leadership Instruments
- Leadership Styles
- Training and Development
- Organizational behavior

**About organization, didactics and work load distribution:**
There are no regular weekly lectures. The course is a *blended learning course.

**Course structure:**

Workshop 1 – Self-study Phase and work package 1 – Workshop 2 – Self-study Phase and work package 2 – Workshop 3 – Self-study Phase and work package 3 – Workshop 4 – Self-study Phase 4 – Workshop 5

For each workshop, two or more teams will be asked to prepare a workshop, which they present to the total group. All work packages must be completed as a team in the individual groups.

**Requirements for participation:**

Students should have some prior knowledge of the field of human resource management.

**Course language:**

English

**Type of exam:**

Grading of each component of the course as described below.

**Requirements for credit point allocation:**

- attendance of four of the five workshops is mandatory
- successful completion of the three work packages (e.g. presentation, research poster, case study, video)
- work on a workshop as a team with presentation in the course

**Main Literature:**


- Ansoff, H. I.: Strategic Management, New York 1979
- Armstrong, M.: A Handbook of Human Resource Management Practice, 11th edition, London 2009
- Becker, M.: Personalentwicklung - Blg, Förderung u. Organisat. in Theorie u. Praxis, Stuttgart 2009
- Mintzberg, H.: The Rise and Fall of Strategic Planning, 1994
- Price, A.: Human Resource Management, Hampshire 2011
- Redman, T./Wilkinson, A.:Contemporary Human Resource Management, Harlow 2013
- Rosenstiel, L.v. (Hrsg.): Führung von Mitarbeitern, Stuttgart 2014

**Course Name: Project Management (for engineers)**

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| Degree programme: Life Sciences International Semester – Industrial Engineering, BEETLS (Bachelor) | Responsible Lecturer: Prof. Dr. Andrea Berger-Klein/ Lothar Fuhr |

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|---|---|---|
| **Work load: 150 (64 h/ 4 SWS presence; 86 h self-study)** | **Lecture hours per week: 4** | **ECTS Credits: 5 CP** |

**Course objectives:**

Engineers have to take the lead and the resulting responsibility in her working area. More and more their daily work is done by project work. To be successful they need a very deep and holistic knowledge in international project management due to the situation that they have to plan and to implement projects.

**Skills / Learning targets**

**Fundamentals**

The students know…

- the basics of project management theory and tools,
- transfer the basic knowledge and most essential tools of project management into her special working area and
- structure projects in this content,
- practice the different project methods in her special working area.

**Social and self-competence**

The students are able …

- to work based on facts, highly self-motivated and open minded in a project team,
- to find successful solutions for basic project management problems,
- to work cooperatively in different degrees,
- to present her own input in an understandable way.

**Contents:**

- Project Management Tool Box like: WBS, CPM, Risk Management, Stakeholder Management, Earned Value Management, IT Tools like MS Project
- project process management
- case Studies
- useful solutions to set up teams and to lead project teams (lateral leadership)
- project related presentation, communication and facilitator skills

**About didactics and work load distribution:**

Blocked seminar with e-learning and multi-media…; problem based learning on case studies…

- presentation
- e-learning
- case studies
- homework during online session
- homework presentation
- excursion / project management in practice
- used medias: different medias on online platform, whiteboard, flipchart / board, beamer presentation

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|---|---|
| **Requirements for participation:** No requirements | **Course language:** English |
| **Type of exam:** presentation | |
| **Requirements for credit point allocation:**<br>Participation at four of five blocked presence meetings, presentation about a given topic related to a study case | |
| **Literature:**<br>• Project Management Institute (Hrsg.): A Guide to the Project Management Body of Knowledge, fifth edition, Pennsylvania 2014 | |

## Course Name: Pharmaceutical Toxicology

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|---|---|
| Degree programme:<br>**Environmental Engineering** (Bachelor) | Responsible Lecturer: Prof. Dr. Claus Wacker |

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|---|---|---|
| **Work load:** 150 | **Lecture hours per week:** 4 | **ECTS Credits:** 5 |

**Course objectives:**

**Contents:**

The course looks at the following subjects:

**Pharmacology**

- Administration of Drugs and Subsequent Processes
- Pharmacokinetics 1: Absorption and Distribution
- Pharmacokinetics 2: Biotransformation (Metabolism)
- Pharmacokinetics 3: Toxification of Xenobiotics during Metabolism; Elimination from the Organism
- Pharmacodynamics 1: Pharmacological Effects on Receptors and Transport Systems
- Pharmacodynamics 2: Pharmacological Effects on Enzymes and Microorganisms
- Pharmacodynamics 3: Structure-Activity- and Dose-Response-Relationship
- Pharmacodynamics 4: Side Effects of Drugs
- Development and Testing of new Drugs

**Toxicology**

- Heavy Metals
- Air-way poisons and irritant gases
- Asbestos
- Aromatic Hydrocarbons
- Chlorinated organic compounds

**About didactics and work load distribution:**

Lectures, supported by blackboard presentation projectors and integrated by the students performed exercises, worksheets; lab work. (72 hours lectures, 78 hours self-study)

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| **Requirements for participation:** | **Course language:** English |
| **Type of exam:** Written examination | |

**Requirements for credit point allocation:**

Successful completion of the written examination

**Literature:**

## Course Name: Renewable Energy Systems - Part one: Fuel Cells

| Degree programme: **Environmental Engineering** (Bachelor) | Responsible Lecturer: Prof. Dr. Marion Siegers |
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| **Work load:** 75 | **Lecture hours per week:** 2 | **ECTS Credits:** 2.5 |
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**Course objectives:**

The students improve their knowledge about renewable energies in the area of fuel cells and gain an insight into low-emission power generation via fuel cells.

**Contents:**

This course deals with fuel cell systems and their application:

**Basic Principles of a Fuel Cell**

- Principle of a Fuel Cell
- Thermodynamics (excerpts)
- Efficiency
- Voltage-Current-Characteristics

**Fuel Gas Supply**

- Reformer Technology (Steam Reforming (SR), Partial Oxidation (POX), Autothermal Reformation (ATR))
- CO Removal Technology
- Internal Reforming

**Applications**

- Mobile Applications
- Stationary Applications
- Portable Applications

**About didactics and work load distribution:**

Lectures in the form of a seminar, exercises

**Requirements for participation:**

Basic knowledge of science and engineering

**Course language:**

English

**Type of exam:**

Written exam

**Requirements for credit point allocation:**

Attendance and participation in class; successful completion of the written exam
For credit point allocation of 6 CPs, see the requirements of Photovoltaic Applications too.

**Literature:**


- Heinzel, Mahlendorf, Roes, Brennstoffzellen – Entwicklung, Technologie, Anwendung, C.F. Müller
- Larminie, Dicks, Fuel Cell Systems Explained, Wiley
- Kurzweil, Brennstoffzellentechnik, Vieweg Verlag
- Kordesch, Simader, Fuel Cells and Their Applications, VCH-Verlag

## Course Name: Renewable Energy Systems - Part two: Photovoltaics (PV)

| Degree programme: | Responsible Lecturer: |
|---|---|
| **B.Sc. Environmental Engineering** (Bachelor) | **Prof. Dr. Timon Kampschulte** |

| **Work load:** 105 h | **Lecture hours per week:** 3 h per week | **ECTS Credits:** 3.5 CP |
|---|---|---|

**Course objectives:**

Students are going to learn about how a sustainable energy supply can be realized by photovoltaic (PV) solar systems.

**Contents:**

1. Introduction
   a. potential of solar energy
   b. general concepts of solar systems
   c. economic importance of solar energy
2. Solar Radiation
   a. black body radiation
   b. physics of the sun
   c. irradiance onto horizontal and tilted surfaces on earth
3. Solar Cells
   a. physics of solar cells
   b. electrical properties of solar cells
   c. materials and concepts of modern solar cells
4. Photovoltaic application
   a. photovoltaic modules
   b. grid connected photovoltaic (PV) systems
   **c.** PV stand-alone and hybrid systems

**About didactics and work load distribution:**

The course is taught as a seminar style lecture of 3 h per week. Within the lecture several exercises are integrated.
15 weeks x 3 h = 45 h of attendance
60 h for studying at home and preparing the exam

**Requirements for participation:**

Participants should have basic knowledge of physics and electrical engineering from a bachelor programme on engineering. Basic understanding of electronics or semiconductor physics is advantageous.

**Course language:**

English

**Type of exam:**

Several types of exams are possible:

written exam, oral exam, portfolio exam, student's presentation, home work

At the beginning of the semester the lecturer will decide which type of exam applies.

Please note: the exam is part of the module "Renewable Energy 2", which includes this course and the course of "Fuel Cells and their Applications".

**Requirements for credit point allocation:**

Passing the exam

The lecturer can ask for mandatory attendance to the course during the full semester.

**Literature:**

- Mertens, K.: Photovoltaics - Fundamentals, Technology and Practice, Wiley, Chichester 2018
- lecture notes
- more literature will be given in the lecture

## Course Name: Sustainable Energy Economics

| Degree programme: **Nutrition** (Bachelor) | Responsible Lecturer: Prof. Dr. Jörg Andreä |
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| **Work load:** 150 | **Lecture hours per week:** 4 | **ECTS Credits:** 5 |
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**Course objectives:**

This course looks at: the formation of fossil fuels; the development of the demand for energy in Germany and worldwide; the mechanisms of energy economics; an introduction to energy production and management; the future perspectives of the use of renewable energies; energy and the environment (global warming, etc.); sustainable energy concepts for the future.

The target is for the participants to know, be able to describe and valuate Forms of Energy, Generation of Energy, Distribution of Energy, Applications of Energy, Energy Economics, Environmental Aspects, Future Concepts of Energy Supply and perform basic calculations.

**Contents:**

- From Big Bang to Presence
- Energy Forms and Systems, Energy Cycle of Life
- Energy Demand, Economics, Supplies
- Conventional and Nuclear Power Plants
- Electricity from Renewable Energy Sources
- Future Perspectives: Nuclear Fusion, etc.
- Applications of Energy
- Energy and Environment
- Energy Technologies for the Future (Presentations)

**About didactics and work load distribution:**

(72 hours lectures, 78 hours self-study)

**Requirements for participation:**

Basic knowledge of mathematics and physics, knowledge of English

**Course language:**

English

**Type of exam:**

- Presentation on a Topic of „Energy Technologies for the Future“ (30%)
- Final Examination (written or oral test in English) (70%)

**Requirements for credit point allocation:**

Successfully passing the final examination; participation in the excursion to a power plant

**Literature:**


- John R. Fanchi: Energy: Technology and Directions for the Future, Academic Press (2004)
- Vaclav Smil: Energy: A Beginner's Guide (Beginners Guide), Oneworld (2006)
- Vaclav Smil: Energy at the Crossroads: Global Perspectives and Uncertainties, MIT Press (2005)
- Vikram Janardhan, Robert D. Fesmire: Energy explained: Understanding the Science, Technology and Economics of the World's Most Vital Commodity, Praeger Frederick A (2011)
- David JC MacKay:Sustainable Energy – Without the Hot Air, Uit Cambridge Ltd (2008)
- Roland Wengenmayr and Thomas Bührke: Renewable Energy: Sustainable Energy Concepts for the Future, Wiley – VCH Ltd. (2008)