TH BINGEN
University of Applied Sciences

M O D U L E H A N D B O O K

Description of Modules
Master Course

ENVIRONMENTAL SUSTAINABILITY

Table of Content

1: Compulsory / Pflichtmodule

Scientific Project Work

Scientific Project Work (PROJ)					
CODE **MI-ES-PROJ**	**Work-load** 360 h	**ECTS** 12 ECTS	**scheduled** 1st and 2nd Sem.	**Frequency** Summer and Winter	**Duration** 12 months

1	**Course** Workshop, Lecture, Seminar, Teamwork, Thesis	**Contact hours** 4 SWS for Lecture, Workshop etc.	**Self-study** 300 h incl. thesis and presentations	**group size** 20

2 **Learning outcomes / Competencies**

This Module enables students

- to work autonomously on a project of applied sciences
- to pick topics and form a well-defined project solvable in 300h.
- to structure and plan a small scientific project
- to choose the appropriate methods
- to use scientific methods on investigating literature describing the state of science
- to handle literature and sources suitably
- to analyze and evaluate findings
- to document and write down the project results

3 **Content**

Kick off workshop

Concept Elaboration/Hypothesis Generation

Scientific Methods

- constructing a scientific framework,
- setting up hypotheses,
- working on hypotheses
- designing experiments

Fundamentals in Project management

- Defining projects and goals
- Planing project structure, time and resources

Working stages from the subject selection to the definition of objectives and implementation

Preliminary presentation

Students present

- Literature survey
- Project plan according to time, resources, costs,
- Material and Methods
- Design of Experiments
- Preliminary results

Final presentation

Students present in a restricted time frame

- Hypothesis
- Methods, experiments, supervisions
- Analysis and conclusions

4	**Teaching and Didactics** The Module has 4 compulsory sessions. 1. Kick-off workshop 2. Audience at final presentation of previous group 3. preliminary presentation 4. final presentation
5	**Prerequisites** **Formal: -** **others:**
6	**Exam** Scientific report (2/3 weight) and final presentation (1/3 weight)
7	**Condition to award ECTS** Attendance, and approved scientific report and final presentation
8	**Recognition of Module in other study program**
9	**Weighing factor of exam** according to credit points
10	**Person in charge / Lecturers** Prof. Dr. Frieder Kunz
11	**Other information:** Language: English. German or other Languages after approval by the board of examiners **Literature:** n.a.

Master Thesis

Master Thesis (THES)

CODE	Work-load	ECTS	scheduled	Frequency	Duration
MI-ES-THES	900 h	30 ECTS	3rd Sem.	summer or winter	6 months

1	Course	Contact hours	Self-study	group size
	Scientific Project	n.a.		Normally an individual perfomance

2 Learning outcomes / Competencies

This Module students enables students to

- solve a scientific question or task autonomously,
- structure and plan a scientific project,
- apply the knowledge and skills acquired at university to solve a problem
- analyze, present and discuss results accordingly,
- develop and assess new approaches for the specific tasks,
- write a scientific thesis according to the guidelines of good scientific practice.

3 Content

- Topic will be defined by student and professor.
- Methods will be chosen by student with support of professor.
- Time, resource and cost planning
- Executing the plan
- Evaluating the results
- Writing the Thesis in Time

4 Teaching and Didactics

The student has to demonstrate the ability of autonomous scientific work. Therefore, only little control and support will be given by regular meetings and discussions of work progress.

5 Prerequisites

Formal: see examination regulations
„Prüfungsordnung Masterstudiengang“ and „Allgemeine Prüfungsordnung“

others:

6 Exam

Written thesis, oral presentation and discussion

7 Condition to award ECTS

In time completion of thesis. Approval of thesis and presentation by supervisor

8 Recognition of Module in other study program

n.a.

9 Weighing factor of exam

according to credit points

10 Person in charge / Lecturers

Professor at Bingen University of Apllied Science. Name has to be defined, before the thesis starts.

11 Other information:

Language: English. German or other Languages after approval by the board of examiners

Literature:

n.a.

2: Electives / Wahlpflichtmodule

Academic English

Academic English (ACE)					
CODE **MI-ES-ACE**	**Workload** 180 h	**Credits** 6	**scheduled** 1st or 2nd sem.	**Frequency of the course** winter	**Duration** **1**

1	**Course** Lecture/ Tutorial	**Contact hours** 6 SWS / 90 h	**Self-study** 90 h	**Group size** 20 students

2 **Learning outcomes:**

Students

- acquire in-depth knowledge about academic conventions regarding scholarly strategies in the process of academic research and writing.
- structure written and oral contributions appropriately before and during performance
- write and speak English in a competent manner

enhance fluency in written and spoken contributions

3 **Contents:**

- Research, References, and citation
- Advanced paraphrasing
- Strategies for explicit structure of papers and presentations
- Personalised advanced English Training

- Language as a mental and interactive tool

4 **Teaching method**
Interactive seminar and workshop

5 **Prerequisites:**
Formal:
Content: More than sound B2 writing and speaking performance in English, C1 in comprehension of both written and oral English

6 **Examination**

a) Three brief or one extended presentation of 30 minutes in total
b) One five-page paper

7 **Conditions for obtaining credits**

Attendance combined with both 6a) and 6 b)

8 **Optional use for other study programs**
M-UW

9 **Weight of grade for the final grade**

10 **Course coordinator(s) and main lecturer(s)**

Mag. phil. Birgit Hoess

11 **Other information**

Language of instruction: English
Literature: Appropriate state-of-the-art samples and sources

Air Resources

Air Resources (AIRE)

CODE	Workload	Credits	scheduled	Frequency	Duration
MI-ES-AIRE	90 h	3 ECTS	1,2 semester	winter	1

1	**Course** -Lectures	**Contact hours** 30 h	**Self-study** 60 h	**group size** 20

2 **Learning outcomes / competencies**

Upon completion of the module, students will

- be able to link the relationships in the legal regulations on immission protection
- be able to identify sources of pollutants and plan their avoidance as well as derive their significance for the climate impact.
- be able to derive the need for action for emission reduction measures.
- be able to implement basic components of emission reduction techniques in the sense of a “toolbox”.

3 **Content**

- Emission and immission of pollutants (legal basis, emission propagation, propagation modeling, immission parameters, air pollution control plans)
- Basics of atmospheric chemistry
- Sources and origins of pollutants
- Introduction to the emission reduction technologies

4 **Teaching and Didactics**
Lectures

5 **Prerequisites**
Formal: -
others: -

6 **Exam**
Written examination

7 **Condition to award ECTS**
passed written examination

8 **Recognition of Module in other study program**

9 **Weighing factor of exam**
according to credit points

10 **Lecturers**
Prof. Dr.-Ing. Dr. rer. nat. Sven Meyer

11 **Other information:**

Language: English

Literature:
Will be provided during the course

Climate Risk Assessment

Climate Risk Assessment (CRA)					
CODE	**Workload**	**ECTS**	**scheduled**	**Frequency**	**Duration**
MI-ES_CRA	90 h	3	1	winter semester (start in winter semester 2023/2024)	1 Semester

1	**Teaching method**	**Contact time**	**Self-study**	**group size**
	Lecture and Seminar	30 h	60 h	20 students

2 Learning outcomes / competencies

After completing the module, students will be able to:

- evaluate sensitivity, exposure and vulnerability,
- identify the climate risk factors for investments,
- suggest adaptation options under climate change conditions.

To achieve this, the students will be qualified:

- to understand the differences between climate variability and climate change,
- to select the appropriate databases,
- to interpret the observed and expected tendency of climate extremes and impacts,
- to select the appropriate risk assessment method,
- to understand and interpret uncertainty.

3 Module contents

- Climate variability and climate change. Extreme events, observed and expected impacts.
- Sensitive and vulnerable regions and ecosystems, affected physical assets and infrastructure.
- Integration of climate change into Environmental impact assessments. Resilience, resistance, recovery, adaptation capacity.
- Risk assessment. Essential databases.
- Sensitivity analysis, evaluation of exposure to climate hazards, vulnerability assessment. Case studies.
- Risk identification, risk matrix. Case studies.
- Scoping of adaptation options, making investments climate resilient.
- Decision making under uncertainty.
- Monitoring networks, warning systems, decision support systems & related recent international research projects.

4 Teaching method

Lecture and Seminar

5 Participation requirements

Formal: fluent English (B2)

Substantial: Successful completion of the module Climate Change and Environmental Impacts is required

6 Forms of examination

	The module examination could be a project work or online oral exam in accordance with the general examination regulations. From a group size of 15 people, the examination form could be the written test.
7	**Requirements for the credits** Passed examination
8	**Usage of the module in other study programs**
9	**The weight of note in the final note** Weighting according to credits
10	**Module responsible** Dr. Borbála Pájer-Gálos
11	-

Climate Change and Environmental Impacts

Climate Change & Environmental Impacts (CLIM)					
CODE **MI-ES-CLIM**	**Workload** 90 h	**ECTS** 3 ECTS	**Frequency** Summer semester	**Duration** 1 semester	**Workload** 90 h

1	**Course** -Lectures -Seminar	**Contact hours** 30 h	**Self-study** 60 h	**group size** 20

2	**Learning outcomes / competencies** Upon completion of the module, students will have gathered a basic understanding of the weather, climate and climate change understand the interaction between climate and land use/cover have learned about the impacts of climate and climate change on biodiversity have an enhanced comprehension of climate change mitigation and adaption and a more detailed knowledge of sustainable management instruments
3	**Content** 1. Climate characteristics and climate zones, natural and anthropogenic reasons for climate changes, SRES Scenarios and Climate scenarios, effects of individual climate characteristics and their combinations on terrestrial ecosystems (with focus on forest and agricultural ecosystems). abiotic risks in forest and agricultural ecosystems. Possible feedbacks of landuse changes on regional climate. 2. Impacts on Biodiversity: fossil and pollen records of past climate change, impacts of recent climate change on biodiversity: phenology, community composition, terrestrial and aquatic ecosystem processes, species extinction and immigration, adaptation principles, conservation management and case studies
4	**Teaching and Didactics** Lecture (60 %), seminar (40 %)
5	**Prerequisites** **Formal:** - **others:** -
6	**Exam** Oral and written presentations
7	**Condition to award ECTS** passed examination
8	**Recognition of Module in other study program**
9	**Weighing factor of exam** according to credit points
10	**Lecturers** Prof. Dr. Oleg Panferov (Climate and Climate Change, Impacts on Ecosystems), Prof. Dr. Elke Hietel (Impacts on Biodiversity)
11	**Other information:** Language: English **Literature:** Climate Change 2013 - The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the IPCC, www.ipcc.ch

	Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, www.ipcc.ch Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, www.ipcc.ch IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. Lovejoy T.E., Hannah L.J. (eds.) (2005): Climate Change and Biodiversity. Yale University Press, New Haven & London.

Conflicts and Synergies in Climate and Environmental Protection

Conflicts and Synergies in Climate and Environmental Protection (COSY)					
CODE **MI-ES-COSY**	**Workload** 90 h	**Credits** 3	**Semester** 2. Semester	**Frequency** Winter semester	**Duration** 1 Semester

1	**Teaching method**	**Contact time**	**Self-study**	**Group size**
	Lecture	2 SWS 30 h	60 h	app. 20 students

2 Learning outcomes / competencies

After completing the module, students will be able to:

- Select, develop and plan the climate change mitigation and adaptation as well as environmental protection measures in a most optimal way so that the conflicts are as far as possible minimized and the synergies are created and efficiently used.

To achieve this, the students will be qualified:

- to estimate and evaluate the local or regional climate and land use change processes;
- to analyse the future climate projections;
- to recognize and evaluate the possible practical mitigation and climate change adaptation options, to identify and to link the affected fields of action, sectors and actors;
- to analyse the interactions and feedbacks between measures, to analyse the current scientific state-of-the-art on environmental consequences of possible climate change mitigation and adaptation measures;
- To derive measures to protect biodiversity and to assess the climate impact of environmental protection and nature conservation measures.

The students will be trained in the perception of their social skills and for social engagement.

3 Module contents

- Observed and projected climate change in Germany, local and regional peculiarities
- Region-specific vulnerabilities, need for adaptation and climate change mitigation potential,
- Climate change mitigation goals and German adaptation strategy,
- Analysis of the climate change adaptation measures and to reduce greenhouse gas emissions at different levels for different sectors (energy, industry, agriculture and forestry, waste),
- Effects, interactions and unexpected co-benefits and adverse side effects of climate mitigation and adaptation measures as well as of environmental protection measures, e.g. interactions / conflicts of bioenergy and biodiversity, between climate, biodiversity, agriculture, water, health, transport, infrastructure, etc.,
- Identification and linking of the actors: politics, administration, business and the public,
- Weighting of the goals, identification of trade-offs and selection of the optimal measures.

4 Teaching method

Lecture and Seminar

5 Participation requirements

Formal: none

Substantial: Environmental Law, Economics, Climatology and Climate change, Air pollution control and Greenhouse gas inventory, Climate change mitigation and adaptation, English for Engineers 1

6 Forms of examination

The module examination could be a paper (max. 10 pages) or project work or portfolio or an equivalent performance in accordance with the general examination regulations.

From a group size of 20 people, the examination form could be the written test.

7	**Condition to award ECTS** Passed examination
8	**Usage of the module** for other courses
9	**The weight of note in the final note** Weighting according to credits
10	**Module responsible** Prof. Dr. Oleg Panferov
11	**Other informations** **Language:** English **Literature:** - Lecture slides - UBA, 2017, Synergies and Conflicts between Climate Protection and Adaptation Measures in Countries of Different Development Levels. https://www.umweltbundesamt.de/en/publikationen/synergies-conflicts-between-climate-protection

Emission and Immission Lab. Air&Noise

Emission and Immission Lab. Air&Noise (ELAB)

CODE	Workload	ECTS	Semester	Frequency	Duration
MI-ES-ELAB	90 h	3	1,2	winter semester	1 semester

1	**Course** Laboratory	**Contact hours** 30 h	**Self-study** 60 h	**group size** 6

2 **Learning outcomes / competencies**

Upon completion of the module, students will

- understand noise measurements
- understand noise prediction in free space
- understand air pollution measurements
- understand air pollution prediction

3 **Content**

- Sound pressure measurement
- Sound power measurement
- binaural measurement of noise
- Environmental noise prediction according to Cnossos
- Measurement of basic figures for emissions
- Measurement of odors
- Calculation of air pollution control units

4 **Teaching and Didactics**
Laboratory

5 **Prerequisites**
Formal: -

others: - Air Resources and Environment Noise Control should be combined with this laboratory

6 **Exam**
Reports of Measurements and Calculations

7 **Condition to award ECTS**
completed Reports

8 **Recognition of Module in other study program**

9 **Weighing factor of exam**
according to credit points

10 **Lecturers**
Prof. Dr.-Ing. Dr. rer. nat. Sven Meyer, Prof. Dr. Frieder Kunz

11 **Other information:**

Language: English

Literature:
Will be provided during the course

Energetic Use of Renewable Materials

Energetic Use of Renewable Materials (EUOR)

Code	workload	credits	Semester	Frequency	Duration
MI-ES-EUOR	90 h	3	1 oder 2	winter semester	1 semester

	Course	Contact hours	Self-study	Group size
1	lecture	30 h	60 h	25 students

2 **Learning outcomes / competences**

- The students know the most important renewable energy carriers and their usage. They are able to discuss properties and challenges/problems along the chain of usage where agricultural questions as well as land surface availability, processing, allocation, technical usage as energy carrier up to the political and legislative boundaries are of importance. The students know about the borderline between material and energetic use including concepts of cascade usage and the area of conflict between food production and the energetic use of renewables.

3 **Content**

- Introduction: Climatic change, usage of fossile resources, sustainability
- Solid renewable energy carriers: wood and straw, composition of energy carriers, availabilities, boiler types, efficiencies, ash (composition, treatment), emissions/pollutants
- Liquid renewable energy carriers: plant oil, biodiesel, bioethanol, energy balance, life cycle assessment, political and legal questions and boundaries, land surface availability, prospects, fundamental reasonableness in distinction to electric mobility
- Gaseous renewable energy carriers: biogas, plant design, concepts and optimization, substrates, processes, fundamental reasonableness with regard to food usage for energy production
- Deepened consideration of land surface availabilities, life cycle assessment, consideration of distinction to other renewable energies: where is biomass useful and reasonable?
- Biobased hydrogen in distinction to renewable hydrogen from fluctuating renewable energies
- Outlook, future developments

4 **Teaching and didactics**

2 SWS lecture

5 **Prerequesites**

Fluent English recommended (writing and orally, B2/C1)

6 **Exam**

Homework / seminar paper

7 **Recognition of module in other study program**

According to study plans

8 **Weighting factor of exam**

Weighting factor according to credit points

9 **Lecturers**

Prof. Dr. Oliver Türk

10 **Other information**

Language: English

Literature:
Lecture notes, literature list will be given in the lecture

Environmental Controlling

Environmental Controlling (ENCO)					
CODE **MI-ES-ENCO**	**Workload** 180 h	**ECTS** 6	**Semester** 1 or 2	**Frequency** winter	**Duration** 1 Term
1	**Mode of teaching** Lectures, Practicals, Fieldwork, Group Work, Seminars	**Contact time** 4 SWS / 60 h	**Self-study** 120 h incl. Assessment	**Estimated Size of Cohort** approx. 20 students	
2	**Learning Outcomes (Expertise and Skills)** On successful completion of this module students will be able to: - Identify, name, handle and evaluate the key instruments of Environmental Assessment, Environmental Management and Environmental Controlling, - Define and describe the prerequisites for efficient Environmental Controlling and Environmental and other Quality Management disciplines, - Recognise and explain the important role of Environmental Controlling for - the communication with stakeholders - the management and shareholders - Integrate new developments in Environmental Management and Controlling in the context of previously used instruments - Realise and explain the important role of environmental disasters for the development of environmental awareness and environmental legislation throughout Europe and - Demonstrate a thorough understanding how the legislative process in Europe works.				
3	**Module Contents** Students will be introduced to: The relevant instruments for the use in a corporate environment of: - Env. Quality Management systems following EMAS and ISO 14001 - ISO 50001 Energy Management - Environmental Auditing - Environmental and carbon footprints - Corporate Social Responsibility (CSR) following ISO 26000 - Sustainability Reporting				
4	**Teaching mode** 60 hours lectures, seminars, excursions and guided learning towards the assessment task; digital learning environment where required and appropriate				
5	**Prerequisites** none				
6	**Exam** Coursework/ Presentation may be submitted in English or German:				
7	**Condition to award ECTS** Successful completion of assessment and Regular active participation in seminars (80%), which may be replaced by a colloquium if regular participation was not possible for good reasons. The module ENCO can only be credited if the student had not enrolled on the module ENCO or a similar module as part of a previous university degree.				
8	**Recognition of Module in other study program** MSc Landwirtschaft und Umwelt				

9	**Weighing factor of exam** According to the applicable assessment regulations (SG-PO):
10	**Lecturers** Prof. Rainer Hartmann
11	**Other relevant information** **Language: English**, Literature English and German **Literature:** An up-to-date literature list will be provided during the seminars.

Environmental Impact of Plastics

Environmental Impact of Plastics (EIOP)					
Code **MI-ES-EIOP**	**workload** 180 h	**ECTS** 6	**study semester** 1st – 3rd semester	**frequency** winter semester	**duration** 1 semester

1	**courses** lecture	**contact time** 60 h	**self-study** 120 h	**Group size** 25

2 Learning outcomes / Competencies

Upon completion of the module the students will:

- know the most important facts about the sustainability concept with regard to material use

- know the most important mass and special plastics, the raw material basis, production and applications

- know the environmental problems that are caused by the materials, their raw material and intermediates with regard to the production, use, and end of life

- know the most important environmental laws that are relevant in the context of plastics production, usage, and end of life with regard to the most important regions

- know approaches and initiatives for a “better plastics world”

- are able to discuss the environmental impact of plastics and are informed about the pros and cons of plastic materials in their respective typical applications

3 Contents

- Introduction: Material flows, fossile resources, climatic change, sustainability concepts

- Mass- and special plastics, materials, processes, applications, markets

- Raw materials, formulation, critical ingredients

- Recycling

- Legislation regarding plastics in the most important countries

- Initiatives against plastics or for a better plastics world and usage

- Outlook: The „better plastics world“ of the future

4 Teaching and didactics

4 SWS lecture

5 Prerequesites

Fluent English recommended (writing and orally, B2/C1)

6 Exam

seminar paper

7 Recognition of module in other study program

8 Weighting factor of exam

	Weighting factor according to credit points
9	**Lecturers** Prof. Dr. Oliver Türk
10	**Other information** **Language:** English **Literature:** Lecture notes, literature list will be given in the lecture Türk, O.; Plastics – The environmental issue, DeGruyter, Berlin, 2022 Türk, O.; Stoffliche Nutzung nachwachsender Rohstoffe, Springer Vieweg, Wiesbaden, 2014

Environmental Noise Control

Environmental Noise Control (ENC)					
CODE **MI-ES-ENC**	**Workload** 90 h	**ECTS** 3 ECTS	**study semester** winter	**Frequency** 1 -3 semester	**Duration** 1 semester

1	**Course** -Lectures -	**Contact hours** 30 h	**Self-study** 60 h	**group size** 20

2 **Learning outcomes / competencies**

Upon completion of the module, students

- will know basics of acoustics
- can read noise maps
- knows about noise abatement and noise action planning
- is able to apply the END 2002/49/EU on a community level

3 **Content**

Basics on airborne acoustics
- Sound pressure, Sound intensity, Sound power
- Levels in dB, dB(A), dB(C)
- Noise measurement techniques
- Noise calculation in free space with Cnossos

European Noise Directive (END) 2002/49/EU
- Noise mapping
- participation
- actions plans

Noise abatement measures

4 **Teaching and Didactics**

Lecture

5 **Prerequisites**

Formal: -

others: - Module ELAB contains laboratories on Noise and Air Pollution and should be taken in parallel

6 **Exam**

written or oral examination

7 **Condition to award ECTS**

passed examination

8 **Recognition of Module in other study program**

9 **Weighing factor of exam**

according to credit points

10 **Lecturers**

Prof. Dr. Frieder Kunz

11 **Other information:**

Language: English

Literature:

Will be provided during the course

European Environmental Law and Politics

European Environmental Law and Politics (EELP)					
CODE **MI-ES-EELP**	**Workload** 180 h	**ECTS** 6	**study semester** 1 and 2	**frequency** summer	**Duration** 1 semester

1	**Course** -Lectures	**Contact hours** 60 h	**Self-study** 120 h	**group size** 20

2 **Learning outcomes / competencies**

Upon completion of the module, students

- have gathered a better understanding of the functioning of the European Union
- understand the interaction between national and European law and politics
- gather an appreciation of the integration of environmental policy in general EU policy
- have an enhanced comprehension of the legal framework of European environmental politics and a more detailed knowledge of certain legal instruments
- have learned about the relevance of European case law
- be able to apply legal instruments in practical cases

3 **Content**

- Development of the EU
- Treaty of the European Union (TEU) and Treaty of the Functioning of the European Union (TFEU, former EC-Treaty)
- Competences of the relevant institutions
- Decision making procedures
- Principles of EU integration
- Legal Instruments
- Rights of Citizens
- Environmental law: legal impact on national legal orders, in depths analysis of waste law, air pollution law and energy law
- Excursion to Brussels (visits of EU institutions and Environmental organisations)

4 **Teaching and Didactics**

Seminar (25 %), individual preparation (30%) supervision in small groups or individually (5%), field trip (40%)

5 **Prerequisites**

Formal: -

others: -

6 **Exam**

Practical training report, oral or written presentation

7 **Condition to award ECTS**

passed examination

8 **Recognition of Module in other study program**

9 **Weighing factor of exam**

according to credit points

10 **Lecturers**

Prof. Dr. G. Roller (Environmental Law), Prof. R. Hartmann (Environmental Politics)

11 **Other information:**

Language: English

Literature:

Will be provided during the course

Fuel cells

Fuel Cells (FUCE)					
CODE **MI-ES-FUCE**	**work load** 90 h	**credits** 3	**study semester** 1 and 2	**frequency** winter semes-ter	**duration** 1 Semester

1	**courses** Lecture	**contact time** 2 SWS / 30 h	**self-study** 60 h	**group size** ~20 students
2	**learning outcomes / competencies** At the end of the module, the students will be able to choose suitable types of fuel cells depending on the area of application; understand fuel cell systems including balance-of-plant components; dimension fuel cell systems; formulate dynamic first principle models of fuel cell systems; assess pros and cons of different methods for hydrogen generation and hydrogen storage with respect to costs, application area, and environmental impact.			
3	**contents** physical and chemical fundamentals of fuel cells: equilibrium voltage, energetic and exergetic efficiency; Tafel equation; Butler-Volmer-kinetics types of fuel cells: PEMFC, DMFC, PAFC, MCFC, SOFC dynamic modeling of fuel cells: mass balance, charge balance, energy balance balance-of-plant (BOP) components systems of fuel cells and batteries; simple battery models methods of hydrogen generation and hydrogen storage			
4	**teaching** lecture			
5	**requirements for participation in form and content** **formal:** none **content:** introductory course in thermodynamics and / or physical chemistry			
6	**kind of examination** written examination			
7	**Condition to award ECTS** passed written exam			
8	**Recognition of Module in other study program**			
9	**Weighing factor of exam** weighting factor according to the course-specific examination regulations (SG-PO): 1			
10	**module coordinator and full time lecturer** Prof. Dr. Michael Mangold			
11	**further information** **language:** English **literature:** EG and G Technical services Inc, Fuel Cell Handbook, U.S. Department of Energy, 2016. Hoogers, G. (ed.), Fuel Cell Technology Handbook, CRC Press, 2002. Larminie, J. and Dicks, A., Fuel Cell Systems Explained, Wiley, 2003. Pukrushpan, J. et al., Control of Fuel Cell Power Systems, Springer, 2004.			

Geographic Information Systems

Geographic Information Systems (GIS)					
CODE	**Workload**	**ECTS**	**Semester**	**Frequency**	**Duration**
MI-ES-GIS	90 h	3	1st – 3rd semester	Summer semester	1 Semester

1	**Teaching method**	**Contact time**	**Self-study**	**Group size**
	Lecture, Lab	2 SWS 30 h	60 h	app. 20 students

2 Learning outcomes / competencies

The main objective of the course is to understand the GIS terms, data sources and the data processing algorithms. The first part of the course focuses on the basic GIS terms, the system components and geomodelling concept. In addition to the first part the understanding, the role and usage of the datum and projection systems are important. The second course part deals with the vector data model: the collection of vector data, storing vector and attribute data in files and databases, the creation and editing of vector data, the vector-based data query and analysis, and finally the thematic display of the vector data. A separate lecture explains the concept and the importance of topology, the relationship among spatial elements. The third chapter of the course concentrate on the raster model: the raster georeference, the raster data sources and storage, the several layers of raster analysis and the display of raster data. The objective of the last chapter is the understanding of surface modelling: both the grid and TIN based surface creation, the surface analysis and visualization. The labs follow the lectures, the students get to know and use the basic geoinformation software products and solve forestry, nature and environment protection related geospatial problems.

3 Content

- GIS terms, components, and methods
- Geomodelling, datum and projection systems
- Vector based modelling
- Vector data analysis
- Lab exam #1
- Raster based modelling
- Raster data analysis
- Lab exam #2
- Grid based surface modelling
- TIN based surface modelling
- Lab exam #3
- GIS applications in Forestry, Environmental Protection
- Case studies, practice

4 Teaching method

Lecture and Lab

5 Prerequisites

Formal: none

Substantial: Informatics

6 Exam

3 Lab Examinations on computers to solve 3 different GIS problems.

7 Condition to award ECTS

Passed the 3 examinations

8 Recognition of Module in other study program

9 Weighing factor of exam

Weighting according to credits

10 Lecturers

	Dr. Kornél Czimber, University of Sopron, Hungary
11	**Other information** **Language:** English **Literature:** - Lecture slides - online source: ocw.mit.edu

International Sales with Case Studies

International Sales with Case Studies (INSA)					
Code MI-ES-INSA	**Workload** 90 h	**ECTS** 3 ECTS	**study semester** 2 semester	**frequency** summer semes-ter	**duration** 1 semester

1	**Course** -Lectures -Exercises	**Contact hours** 30 h	**Self-study** 60 h	**Group size** 25

2 **Learning outcomes / competencies**

Upon completion of the module, students will
be able to develop marketing, sales and pricing strategies for products in international markets

- have an enhanced comprehension of options for market development and market activities as well as market analysis, messaging and product portfolio adjustments
- have learned about the relevance of different models of international sales activities, account management, composition of adequate sales channels, and sales supporting activities
- be able to apply the relevant tools which are shown, discussed and illustrated in the lecture by using case studies
-

3 **Content**

- - Global Marketing Research
- - Strategies for Global Markets
- - Sociocultural Environment, Cultural Aspects and Challenges in International Markets
- - International Pricing Politics, Terms and Conditions, Product Live Cycle
- - Export Modes
- - Support of International Sales Activities using CRM
- - Management of the International Sales Organization, Global Account Management
- - Management of the International Distribution System
- - International Sales Controlling, Sales Intelligence

4 **Teaching and Didactics**
Lectures (approx. 2/3) and exercises (approx. 1/3)

5 **Prerequisites**
Good command of English

6 **Exam**
Written exam

7 **Condition to award ECTS**
Presence in the lectures; passed exam

8 **Recognition of Module in other study program**
According to study plans

9 **Weighing factor of exam**
According to ECTS

10 **Lecturers**
Prof. Dr. Stefan Gabriel

11 **Other information:**

	Language: English **Literature:** Lecture presentation slides and handouts; Kotler, Philip: 'Marketing-Management', Pearson, international edition; Hollensen, Svend: 'Global Marketing – a decision oriented approach', Prentice Hall

International Water and Waste Management

International Water and Waste Management (IWWM)					
Code **MI-ES-IWWM**	**Workload** 180 h	**ECTS** 6	**Semester** 1 or 2	**frequency** Summer term	**Duration** 1 Term
1	**Mode of teaching** Lectures, Practicals, Fieldwork, Group Work, Seminars	**Contact time** 4 SWS / 60 h	**Self-study** 120 h incl. Assessment	**group size** approx. 20 students	
2	**Learning outcomes / Competencies** On successful completion of this module students will be able to: - Identify, name and evaluate the key aspects of water and waste management in an international context, - Undertake and present competent, self-directed research into these topic areas Waste Management - Analyse the requirements of a community and set waste management plans up for different communities in dependence of their environment, - Describe all major routes of re-use, recycling and waste treatment with their advantages and disadvantages, - Identify the most sustainable waste management options depending on requirements, - Design and set a local waste management strategy up. Water Management and Waste Water (WW) Treatment - Identify, analyse and evaluate the predominant water issues in different parts of the world, - Analyse and evaluate water issues in a variety of geographical, cultural and political settings - Analyse, describe and design appropriate water and waste water treatment technology				
3	**Content** Students will be introduced to Waste Management • Extended waste hierarchy • Waste management strategies depending on regional circumstances • Treatment, technology and destinations of waste and secondary raw materials • Effects and consequences of no, suboptimal or incorrect waste handling, • Waste management case studies from around der world Water Management • International water issues and their derivation • Geographical, climate and political reasons and consequences of/ for water issues • Water and WW technology and their appropriate application in various environments • Water quality analysis and assessment.				
4	**Teaching mode** 60 hours lectures, seminars, excursions and practicals; partially digital learning environment				
5	**Prerequisites** none				
6	**Exam** Coursework: Assignment, design study, research report; for large numbers exam				
7	**Condition to award ECTS** Successful completion of assessment, regular attendance				
8	**Recognition of Module in other study program**				

9	**Weighing factor of exam** According to the applicable assessment regulations (SG-PO):
10	**Lecturer** Prof. Rainer Hartmann, Prof. Mike Heath
11	**Other relevant information** **Language: English**, Literature English and German **Literature:** An up-to-date literature list will be provided during the seminars.

Life Cycle Assessment

Life Cycle Assessment (LCA)					
Code	**Workload**	**ECTS**	**Semester**	**Frequency**	**Duration**
MI-ES-LCA	90 h	3	1st semester	Winter semester	1 Semester

1	**Teaching method**	**Contact time**	**Self-study**	**group size**
	Online Lecture	30h	60 h	app. 25 students

2 Learning outcomes / competencies

After completing the module, students will be able to:

- do general tasks related to environmental life cycle analysis (LCA),
- know and adapt at the level of proficiency between types of environmental life cycle impact assessment,
- be informed at the level of knowledge a software and manual analysis methods.

To achieve this, the students will be qualified:

- to define the adequate system boundaries of an LCA
- to set up a life cycle inventory and an eco balance of a general product, activity, technology or service;
- to assess the environmental impacts of a general product, activity, technology or service with different assessment methodologies;
- to make an interpretation of the results of a life cycle assessment;
- to get familiar with the main life cycle assessment software.

The students will be trained in the perception of their social skills and for social engagement.

3 Content

- Environmental management. Life cycle approach. Circular economy.
- Life Cycle Assessment (LCA). Standards of LCA.
- Steps of the LCA
- Goal and scope definition, life cycle inventory
- Life cycle impact assessment, life cycle interpretation
- Impact assessment and management. Impact assessment methodologies.
- Case studies.
- Practical experience of executing a life cycle assessment using commercial software.

4 Teaching method

Lecture and Seminar

5 Prerequisites

Formal: Fluent English (writing and orally B2)

Substantial:

Own computer or notebook;

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6 Forms of examination

	The module examination could be a paper (max. 10 pages) or project work or portfolio or an equivalent performance in accordance with the general examination regulations. From a group size of 20 people, the examination form could be the written test.
7	**Condition to award ECTS** Passed examination
8	**Recognition of Module in other study program** According to study plans. Life Cycle Assessment – Case Studies
9	**The weight of note in the final note** Weighting according to credits
10	**Lecturers** Dr. habil. András POLGÁR
11	**Other information** **Language:** English **Literature:** - Lecture slides - ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework - ISO 14044:2006 Environmental management -- Life cycle assessment -- Requirements and guidelines - European Commission - Joint Research Centre - Institute for Environment and Sustainability (2010). International Reference Life Cycle Data System (ILCD) Handbook - General Guide for Life Cycle Assessment - Detailed Guidance. Publications Office of the European Union, Luxembourg. - Journals with discussions on LCA methodology and case studies

Life Cycle Assessment – Case Studies

Life Cycle Assessment - Case Study (LCAS)					
Code	**Workload**	**ECTS**	**Semester**	**Frequency**	**Duration**
MI-ES-LCAS	90 h	3	2nd Semester	Summer semester	1 Semester

1	**Course** Lectures	**Contact hours** 30 h	**Self-study** 60 h	**Group** approx. 10 Students

2 Learning outcomes / competencies

Upon completion of the module, students will be able to

- Describe an LCA according to ISO 14040
- Transfer the theory to a case study
- Describe and justify the own value choices for the subjective parts of an LCA
- Criticise an existing LCA on the case study subject

3 Content

Life Cycle Assessment according to ISO 14040

- Goal & scope
- Life cycle inventory
- Life cycle impact assessment
- Interpretation and use of the results

The theory of LCA is first introduced and then used on a case study. The subject of the study will be discussed and fixed in the course.

4 Teaching and Didactics

Lectures, work and discussion on the case study in groups and in the plenum

5 Prerequisites

Formal: Fluent English (writing and orally B2 or C1)

Content: None

6 Exam

Written exam (90 min)

7 Condition to award ECTS

Passed written examination

8 Recognition of Module in other study program

According to study plans

9 Weighing factor of exam

1

10 Lecturer

Prof. Dr.-Ing. Thilo Kupfer

11	**Other information** **Language:** English **Literature:** - Lecture notes - ISO 14040

Material Flow Management

Material Flow Management (MFMG)					
Code **MI-ES-MFMG**	**Workload** 90 h	**credits** 3	**semester** 1st – 3rd semester	**frequency** winter semester	**duration** 1 Semester

1	**Course** Lecture	**contact time** 30 h	**Self-study** 60 h	**Group size** 25

2 Learning outcomes / Competencies

Material flow management is the analysis and optimization of material and energy flows under consideration of the sustainability approach, i.e. under combination of ecologic, economic, and social aspects. Thus, material flow management is a very comprehensive and interdisciplinary approach.

Upon completion of the module the students will be able to understand the approach comprehensively and apply to material and energy flows under consideration of respective tools. The ability to consider legal aspects, the holistic view of the interplay of ecologic, economic, and social aspects, the structurization of the analysis, and the differentiation of systems and their boundaries will be communicated in the lecture.

A number of material examples will be discussed in the lecture.

3 Contents

- Basics of material flow management
- Spatial hierarchies (operational, local, regional, national, global)
- Material and energetic consideration
- Material circles („cradle-to-cradle product design), cascade use
- Material analysis, coupling with life cycle assessment, specific software, systems and boundaries
- legal aspects
- Material examples, boundaries of the approach

4 Teaching and didactics

2 SWS lecture

5 Prerequesites

Fluent English recommended (writing and orally, B2/C1)

6 Exam

Homework / seminar paper

7 Recognition of Module in other study program

According to study plans

8 Weighting factor of exam

Weighting factor according to credit points

9 Lecturer

Prof. Dr. Oliver Türk

10 Other information

Language: English

	Literature: Lecture notes, literature list will be given in the lecture

Professional English

Professional English (PrE)

Code MI-ES-PrE	Work-load 180 h	ECTS 6	scheduled 1.o.2. Sem.	frequency Summer Term	Duration 1 Semester

1	Course	Contact time	Self-study	Group size
	Lecture/ Tutorial	4 SWS / 60 h	120 h	20 students

2 Learning Outcomes / Competencies

Students
- communicate more effectively and fluently
- participate more confidently in meetings
- approach negotiations more diplomatically
- respond more spontaneously in different situations
- have expanded your range of professional vocabulary

are able to network with greater confidence

3 Content

Students
- communicate more effectively and fluently
- participate more confidently in meetings
- approach negotiations more diplomatically
- respond more spontaneously in different situations
- have expanded your range of professional vocabulary
- are able to network with greater confidence

4 Teaching mode

Interactive seminar and workshop

5 Prerequisites

Formal:
Content: More than sound B2 writing and speaking performance in English, C1 in comprehension of both written and oral English

6 Exam

a) Three brief presentations totalling 30 minutes or one five-page written contribution
b) One extended presentation of 30 minutes in total

7 Condition to award ECTS
passed exam
successful participation in classes

8 Recognition of Module in other study program
M-LU
M-UW

9 Weighing factor of exam according to ETCS

10 Lecturer

Mag. phil. Birgit Hoess.

11 Other information

Language of instruction: English
Literature: Appropriate state-of-the-art samples and sources

Restoration Ecology

Restoration Ecology (RECO)

Code	workload	credits	study semester	frequency	duration
MI-ES-RECO	90 h	3	1st – 3rd semester	winter semester	1 semester

1	**courses** lecture, excursion	**contact time** 2 SWS / 30 h	**self-study** 60 h	**Group size** no limitation

2 learning outcomes / competences

At the end of this module, the students will have basic knowledge of the restoration of ecosystems disturbed by humans.
There will be a detailed reading about:

- the limiting abiotic and biotic factors of restoration
- the restoration of open-cast mining areas
- the renaturation of lakes and lake shores, rivers and moors

3 content

lecture:

- Introduction to restoration ecology
- Ecological bases and limiting factors of the
- Basics of the renaturation of flowing and still waters, moors
- Lake shore renaturation, rehabilitation and renaturation of eutrophic lakes
- Revitalization of hydrogenetic bog types
- Renaturation and recultivation of mining sites
- Research network - the "Society for Ecological Renaturation (SER)"

excursion

- Excursion to the restored limestone quarry Mainz-Weisenau

4 teaching

lecture, excursion

5 requirements for participation in form and content

formal: no

content: basic knowledge in biology and ecology

6 Exam

written exam (90 min) or oral exam (30 min)

7 Condition to award ECTS

passed written exam, compulsory attendance at guest lectures

8 Recognition of Module in other study program

9 Weighing factor of exam

Weighting factor according to the course-specific examination regulations (SG-PO): 1

10 Lecturer:

Prof. Dr. Michael Rademacher

11 other information

language: English

Literature:

	- Clewell, A. & Aronson, J. (2013): Ecological Restoration, Second Edition: Principles, Values, and Structure of an Emerging Profession. - Society for Ecological Restoration (SER) - Rademacher, M. (2015): Biodiversity Management in quarries and gravel pits. – HeidelbergCement, ISBN 978-3-9815050-8-5 - Gann, G. (2019): International Principles And Standards For The Practice Of Ecological Restoration. - Society for Ecological Restoration (SER). - Zerbe, S. & G. Wiegleb (2009): Renaturierung von Ökosystemen in Mitteleuropa. – Springer. - Kollmann et a. (2019): Renaturierungsökologie. – Springer. - Zerbe, S. (2019): Renaturierung von Ökosystemen im Spannungsfeld von Mensch und Umwelt

Renewable Energies

Renewable Energies (REEN)					
course number **MI-ES-REEN**	**workload** 90 h	**credits** 3	**study semester** 1st – 3rd semester	**frequency** summer semester	**duration** 1 semester

1	**courses** lecture, excursion, seminar	**contact time** 2 SWS / 30 h	**self-study** 60 h	**group size** 25

2 **learning outcomes / competences**

Upon completion of the module, students will

- be conversant with criteria and issues related to sustainable energy sources.
- be able to identify relevant problems, collect and discuss relevant data and published information.
- be able to develop own solutions for a sustainable energy supply.

3 **content**

Background knowledge, calculation concept and planning basics for a self-sustaining building project including

- Energy - a history of growing demand and limited supply
- Energy, Exergy, Anergy - thermodynamically matching sources to tasks
- Definition: reserves / resources
- Solar and non-solar Renewables
- Geothermal energy, photovoltaics (PV), solar thermal energy, wind energy, biomass, evaluation of locations, invest and pay-back time / CO_2 balance

4 **teaching**

Lectures, case studies, seminar (group and individual work with short presentations) and excursions to agricultural enterprises and international organizations

5 **prerequisites**

formal: no

content: basic knowledge in physics and engineering

6 **Exam**

Presentation with discussion

7 **Condition to award ECTS**

passed examination

8 **Recognition of Module in other study program**

M-UW

9 **Weighting of the grade for the final grade**

Weighting factor according to credit points

10 **Lecturers**

Prof. Dr. Frieder Kunz

11	**other information** **language:** English **Literature:** Will be provided during the course

Renewable Materials, Lect&Lab

<table>
<tr><th colspan="7">Renewable Materials, Lect&Lab (REMA)</th></tr>
<tr><td colspan="2">Code

MI-ES-REMA</td><td>workload
180 h</td><td>credits
6</td><td>study semester
1st – 3rd semester</td><td>frequency
winter semester</td><td>duration
1 semester</td></tr>
<tr><td>1</td><td colspan="2">courses
lecture, (excursion)</td><td>contact time
50 h
(field 10 h)</td><td>self-study
120 h</td><td colspan="2">Group size
25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes / competencies
Upon completion of the module, students will
• distinguish renewable raw materials by their chemical nature, basic structures and resulting properties in processing and final use.
• suggest potential application fields for the materials according to their material profile.
• can judge about sustainability/ecological aspects of such materials by comparison with classical construction materials like metals and particularly petrochemical plastics.
• know about availability, economic aspects of renewable materials and future chances.
• be able to consider critically materials according to their profile and application.
• be able to provide an integrated consideration of material, energetical and cascade use of materials in connection with climatic change and limited petrochemical resources.
• be able to prepare biobased materials for measurement in the laboratory, can conduct measurements with the materials and relevant analytical instruments.</td></tr>
<tr><td>3</td><td colspan="6">content
• Material use of renewable materials / “biobased materials”
• Chemical families of renewable materials, structures, properties, availability
• Processing and fields of application
• Competitive materials, economical aspects of such materials
• Environmental/ecological aspects of such materials
• Material/energetical/cascade use
• Potential future development
• Connection with climatic change and limited resources
• Practical course as additional module</td></tr>
<tr><td>4</td><td colspan="6">teaching
2 SWS lecture, (field trip)</td></tr>
</table>

5	**Prerequisites** Fluent English recommended (writing and orally, B2/C1)
6	**Exam** Homework / seminar paper (participation in field trip)
7	**Recognition of module in other study program** According to study plans
8	**Weighting factor of exam** Weighting factor according to credit points
9	**Lecturer** Prof. Dr. Oliver Türk
10	**Other information** **Language:** English **Literature:** Lecture notes, literature list will be given in the lecture Türk, O.; Plastics – The environmental issue, DeGruyter, Berlin, 2023 Türk, O.; Stoffliche Nutzung nachwachsender Rohstoffe, Springer Vieweg, Wiesbaden, 2014

Renewable Materials – Practical Course

Renewable Materials – Practical Course (REMA P)					
Code **MI-ES-REMA P**	**workload** 180 h	**credits** 6	**study semester** 1st – 3rd semester	**frequency** summer semester	**duration** 1 semester
1 **courses** laboratory		**contact time** 60 h	**self-study** 120 h	**Group size** 25	
2	**Learning outcomes / competencies** Upon completion of the module, students will • Have “hands-on” experience with biobased materials in general and biobased plastics in particular in the laboratory • Be able to use several important analytical methods relevant for the development of materials • Complete the theoretical knowledge from the lecture REMA with practical experience in the real handling and analysis of the materials				
3	**content** Laboratory trials using several analytical methods for the analysis of biobased materials / plastics: • Differential Scanning Calorimetry (DSC) • Dynamical Mechanical Analysis (DMA) • Dielectric Analysis (DEA) • Thermogravimetric Analysis (TGA) • Rheometry • Tensiometry				
4	**teaching** 4 SWS laboratory				
5	**Prerequisites** Fluent English recommended (writing and orally, B2/C1)				
6	**Exam** seminar paper with the result of the laboratory trials				
7	**Recognition of module in other study program** According to study plans				
8	**Weighting factor of exam** Weighting factor according to credit points				
9	**Lecturer** Prof. Dr. Oliver Türk				

10	**Other information** **Language:** English **Literature:** Lecture notes, literature list will be given in the lecture Türk, O.; Plastics – The environmental issue, DeGruyter, Berlin, 2023 Türk, O.; Stoffliche Nutzung nachwachsender Rohstoffe, Springer Vieweg, Wiesbaden, 2014

Sustainable Business Administration and Simulation

Sustainable Business Administration and Simulation (SBAS)					
Code **MI-ES-SBAS**	**workload** 180 h	**credits** 6	**study semester** 1st – 3rd semester	**frequency** summer semester	**duration** 1 semester

1	**Course** - Lectures - Business Simulation - Group work	**Contact hours** 45 h	**Self-study** 135 h	**Group Size** 30

2 **Learning outcomes / competencies**

Upon completion of the module, students will

- provide basics in economics with focus on sustainability as well as on entrepreneurial thinking.
- are able to evaluate business data and to adequately adopt, read and interpret financial management reports.
- are able to recognize and consider internal and external conditions for business success in a dynamic competitive environment.
- acquire presentation skills for results, strategies and analysis.
- learn effective decision-making in a team including assessment of the implications of decision.

3 **Content**

This course is designed to introduce the students to the principles and functions of business with a focus on topics like ecology and sustainability as important part of the business environment. Within the module business will be studied as an important part of the total social, political and economic environment. The different areas of business will be covered and enhanced by application of a computer-based business simulation. Participants will represent the owners of up to six companies. They need to make strategic and operative decisions and try to lead their company successfully in a competitive environment. The course will be accompanied by relevant lectures providing basics in:

- Business ownership
- Financial information
- Planning
- Profit and loss account
- Financial accounting
- Financial reporting
- Strategy, Porter's Five Forces Analysis
- Sustainability from an entrepreneur’s point of view

4 **Teaching**

Lectures, exercises & group work with computer-based business simulation (→TOPSIM Mastering Management including comments, presentations, papers)

5 **Prerequisites**
Formal: Admission to the Master's programme

Content: Basics in economics

6 **Exam**

	Presentation including colloquium –50 % Outcome business simulation –50%
7	**Condition to award ECTS** Presence/ active participation in the simulation (min. 80 %) Successful presentation and successful participation in the business simulation
8	**Recognition of Module in other study program**
9	**Weighing factor of exam** Weighting factor according to credit points
10	**Lecturer** Prof. Dr. Martin Pudlik, Prof. Dr.-Ing. Christian Reichert
11	**Other information** **Language:** English Participation in business simulation requires equipment capable of online operation like laptop or tablet (alternative: participation via IT room at UAS Bingen) Organization: - The module will take place as a 5-day block seminar at the end of the semester. - Parts of the seminar will be held online via MS Teams. - A minimum number of eight participants is required. - Log-in data as well as composition of the teams will be announced one week before seminar start. - The number of participants for every seminar is limited. Registrations will be considered in the order of receipt and latest at the beginning of the respective semester. Literature: Participant's´ manual of the business simulation tool TOPSIM Mastering General Management Campbell McConnell, Stanley Brue, Sean Flynn McConnell: Economics. McGraw Hill, 21st edition (2017) Other relevant material handed by the lecturers

Ecological intensification of agricultural systems

Ecological intensification of agricultural systems (EIAS)					
code **MI-ES- EIAS**	**workload** 90 h	**credits** 3	**study semester**	**frequency** summer semester	**duration** 1 semester
1	**Course** Lecture / Tutorial	**Contact hours** 2 SWS / 30 h	**Self-study** 60 h	**Group size** 20-40 students	
2	**Learning outcomes / Cmpetencies** After successful completion of this course, students are expected to be able to: • Describe and evaluate different tools solutions and farming system approaches in respect to their sustainability and resilience • describe and apply general procedures of agro-ecological system analysis, • apply tools and solution for the design and redesign of sustainable agricultural systems • evaluate agricultural concepts and system approaches for potential trade-offs and synergies • apply frameworks and models that measure the domains of ecological intensification				
3	**Content** The course will focus on concepts that integrate ecological with agricultural principles to optimize resource conservation, productivity, societal benefit, and profitability- Major topics included are: • Major concepts and practices based on ecological intensification of farming and food systems (e.g. agroecology, agroforestry, organic farming, conservation agriculture, climate smart agriculture) • Categories of ecosystem services and their integration into agriculture • Types, causes and effects of soil degradation, loss of biodiversity, agricultural pollution. • Tools and solutions for increased soil fertility and soil health management; improved water and general resource use efficiencies; sustainable improvement of crop and livestock productivity; farm diversification. • Constraints and opportunities for social and economic development of local, regional and global agricultural systems. • Methods of environmental and social impact assessment.				
4	**Teaching** Lecture, tutorial, working groups				
5	**Prerequisites** None				
6	**Exam** Case study assessment reports, including poster presentation (70%) Peer review assessment (30%)				
7	**Condition to award ECTS** Passed examination (at least 50%, respectively)				
8	**Recognition of Module in other study program** Master Landwirtschaft und Umwelt (WP)				
9	**Weighting of the grade for the final grade** according to credit points				
10	**lecturer** Prof. Dr. Elmar Schulte-Geldermann				

11	**Other information** **Language:** English Literature: Study guide and list of relevant literature provided by the course lecturer(s)

Remote sensing of environmental changes

Remote sensing of environmental changes (RESE)					
Code **MI-ES-RESE**	**Workload** 180	**Credits** 6	**Semester** 1st – 3rd semester	**Frequency** Winter- semester	**Duration** 1 Semester

1	**Teaching method** Lecture (2 SWS), Labs (2 SWS)	**Contact time** 4 SWS 60 h	**Self-study** 120 h	**Group size** app. 10-20 students

2	**Learning outcomes / competencies** The course gives an insight into remote sensing and its application for detection and analysis of environmental changes. The course starts from introduction into the physical principles: electromagnetic spectrum, understanding of electromagnetic radiation and its interaction with the earth surface and atmosphere, interpretation of satellite measurements acquired in optical, thermal and microwave bands. Information on characteristics of historical and modern satellite platforms and instrument's used in environmental studies will help to understand advantages and limits of different techniques for solving specific tasks. The second part of the course is dedicated to the investigation and analysis of case studies grouped in two main domains: 1) changes of continental water cycle and its components and 2) changes in the cryosphere. Along the lectures, students learn about modern European satellite programs, products and services; become familiar with the processing of optical and microwave images using free software; learn how to find, extract/interpret an information/data from satellite data products; understand how to detect, attribute and analyse changes in environmental parameters; to explore a multi-satellite approach.
3	**Content** **1. Basics of remote sensing** Electromagnetic spectra and remote sensing: theory and applications, use in remote sensing. Visible / Near infra-red / Thermal infra-red / UV /Radar; Physics of measure; emission, capacities and limitations of active and passive sensors. Lab. Introduction to image treatment using free software **2. Environmental changes. Case studies.** 2.1 Continental water cycle and hydrology: satellite monitoring of soil moisture and draught conditions; water regime of rivers/lakes/wetlands from space (altimetry, radiometry, optics, gravimetry); water quality. Lab. Altimetry, radiometry and gravimetry data exploration 2.2. Detection and monitoring of changes in the cryosphere: operational remote sensing of the arctic sea ice retreat; changing Greenland (from ice sheet melt to water productivity increase); fate of lake and river ice (state-of-the-art and remote sensing contribution); space monitoring of permafrost degradation and its environmental and socio-economic effects. Lab. Multi-satellite approach implementation. **2.3** Investigation of an environmental change in one of the World regions using satellite observations. Methodological approach and realisation, Lab. Autonomous information search, data download, processing, analysis, preparation of resulting report.
4	**Teaching method** Lectures and Labs
5	**Participation requirements** **Formal:** none **Substantial:** Informatics, any programming language and/or statistical tools (e.g. R).
6	**Exam** Course paper (case study report)
7	**Condition to award ECTS** Passed examination
8	**Recognition of Module in other study program** M-UW
9	**Weighing factor of exam** Weighting according to credits
10	**Lecturers** Dr. Elena Zakharova, EOLA enterprise, France

11	**Other information** **Language:** English **Literature:** Lecture slides, scientific papers, satellite product descriptions (ATBD, Handbooks etc)