CONSTRUCTOR UNIVERSITY

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Study Program Handbook

Earth Sciences and Sustainable Management of Environmental Resources

Bachelor of Science

Subject-specific Examination Regulations for Earth Sciences and Sustainable Management of Environmental Resources (Fachspezifische Prufungsordnung)

The subject-specific examination regulations for Earth Sciences and Sustainable Management of Environmental Resources are defined by this program handbook and are valid only in combination with the General Examination Regulations for Undergraduate degree programs (General Examination Regulations = Rahmenprüfungsordnung). This handbook also contains the program-specific Study and Examination Plan (Chapter 6).

Upon graduation, students in this program will receive a Bachelor of Science (BSc) degree with a scope of 180 ECTS (for specifics see Chapter 4 of this handbook).

Current version	Valid as of	Decision	Details
Fall 2023 – V1.1	Sep 01, 2023	Aug 16, 2023	Editorial changes assessment types in ILO matrix by PSD
		Aug 02, 2023	Editorial change of all study schemes by Program Support and Development
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Fall 2023 – V1	Sep 01, 2023	Apr 26, 2023	Substantial change approved by the Academic Senate
		Jun 26, 2019	Originally approved by Academic Senate

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1 Program Overview

1.1 Concept

1.1.1 The Constructor University Educational Concept

Constructor University aims to educate students for both an academic and a professional career by emphasizing three core objectives: academic excellence, personal development, and employability to succeed in the working world. Constructor University offers an excellent research driven education experience across disciplines to prepare students for graduate education as well as career success by combining disciplinary depth and interdisciplinary breadth with supplemental skills education and extra-curricular elements. Through a multi-disciplinary, holistic approach and exposure to cutting-edge technologies and challenges, Constructor University develops and enables the academic excellence, intellectual competences, societal engagement, professional and scientific skills of tomorrows leaders for a sustainable and peaceful future.

In this context, it is Constructor University's aim to educate talented young people from all over the world, regardless of nationality, religion, and material circumstances, to become citizens of the world who can take responsible roles for the democratic, peaceful, and sustainable development of the societies in which they live. This is achieved through high-quality teaching, manageable study loads and supportive study conditions. Study programs and related study abroad programs convey academic knowledge as well as the ability to interact positively with other individuals and groups in culturally diverse environments. The ability to succeed in the working world is a core objective for all study programs at Constructor University, both in terms of actual disciplinary subject matter and social skills and intercultural competence. Study-program-specific modules and additional specializations provide the necessary depth, interdisciplinary offerings and the minor option provide breadth while the university-wide general foundation and methods modules, optional German language and Humanities modules, and an extended internship period strengthen the employability of students. The concept of living and learning together on an international campus with many cultural and social activities supplements students' education. In addition, Constructor University offers professional advising and counseling.

Constructor University's educational concept is highly regarded both nationally and internationally. While the university has consistently achieved top marks over the last decade in Germany's most comprehensive and detailed university ranking by the Center for Higher Education (CHE), it has also been listed by the renowned Times Higher Education (THE) magazine as one of the top 300 universities worldwide (ranking group 251-300) in 2019 as well as in 2021. Since 2022 Constructor University is considered to be among the top 30 percent out of more than 1600 universities worldwide and is ranked the most international university in Germany. The THE ranking is considered as one of the most widely observed university rankings. It is based on five major indicators: research, teaching, research impact, international orientation, and the volume of research income from industry.

1.1.2 Program Concept

The BSc program Earth Sciences and Sustainable Management of Environmental Resources (ESSMER) at Constructor University is an interdisciplinary science major with a strong focus on phenomena and processes encountered at or near the Earth's surface. Our students develop a holistic understanding of the Earth's surface environment with its interacting land masses, oceans, atmosphere, and biosphere, and of the human impact on this environment. The ESSMER program is based on a solid foundation in chemistry, mathematics, physics, and economics. It combines traditional geoscience disciplines such as geology, environmental science, and digital geoscience using key methodological tools and concepts from geochemistry, geodata analysis and data management as well as sustainability economics. The modular curriculum allows for an excellent integration of additional optional complementary courses from the social sciences, e.g., economics and management, and from the life sciences, e.g., biochemistry, cell biology and microbiology. This unique structure underlines the importance of a holistic understanding of environmental topics from different perspectives including chemistry, physics, and economics.

The ESSMER program imparts the knowledge and the skills that allow our graduates to address topical challenges and key research questions including the sustainable and responsible exploration of natural resources, the short- and long-term evolution of the Earth's climate and oceans, the scientific processing and analysis of large volumes of digital Earth data and pressing anthropogenic challenges to the natural environment. The ESSMER program is ideally suited for proactive and engaged students who are passionate about planet Earth and our natural environment, its dynamics, and the impact of human activities, who enjoy working outdoors, and who wish to contribute to finding solutions to pressing real-world problems, while being aware of the economic conseuences of their actions.

1.2 Specific Advantages of Earth Sciences and Sustainable Management of Environmental Resources at Constructor University

The ESSMER curriculum integrates a variety of course formats and educational elements ranging from lectures and seminars, field, and laboratory work to on-campus and off-campus teamwork in multidisciplinary and multicultural groups. Even at the introductory course level, theoretical concepts and important earth processes are demonstrated and illustrated using hands-on exercises, field work, and earth science data. In line with Constructor University's 4C concept, the ESSMER curriculum proceeds from introductory modules in the first year of study (CHOICE) to more advanced and disciplinary focused modules in the second study year (CORE). In the final year of study (CAREER), and in addition to the B.Sc. thesis project, a set of ESSMER capstone modules bring together different strands of the education at Constructor University in case studies and group projects, promoting social, intercultural understanding, and presentation skills as well as raising awareness of topical real-world challenges.

ESSMER instructors emphasize a global and interdisciplinary perspective that is firmly rooted in the natural sciences. We promote a process- and solution-oriented approach to real-world challenges and problem-solving skills that are highly sought by potential employers and graduate schools, thus opening a wide range of possible career paths in academia and industry. Students graduating from ESSMER, and its associated programs entered careers in professional areas as diverse as non-governmental organizations, mining and oil companies, international space agencies, media and press departments, publishing companies, consulting firms universities, and research institutions. The excellent quality of past earth sciences program at Constructor University has been independently and consistently acknowledged by top CHE Die Zeit rankings since 2009.

1.3 Program-Specific Educational Aims

1.3.1 Qualification Aims

The B.Sc. program Earth Sciences and Sustainable Management of Environmental Resources is fully committed to the mission of Constructor University. With planet Earth and global environment at the heart of the study program, internationality and interdisciplinary learning are key ingredients of the ESSMER program that benefit our graduates and supports them on their journey to become citizens of the world. The ESSMER program strongly emphasizes everyone's responsibility for the future sustainable development of our natural environment.

In field activities, data and chemistry laboratory courses, students are exposed to modern equipment and current research methods early in their career. ESSMER courses typically integrate theoretical concepts and processes with case studies and the application of practical and presentation skills, so that our graduates are well-prepared for a wide range of career paths in academia, business, consulting, government, and industry.

1.3.2 Intended Learning Outcomes

By the end of the study program, students will be able to

1. explain key concepts and processes in geology, environmental sciences, geochemistry, Earth data science and digital geosciences;
2. describe and discuss (near-)surface systems, identify and examine their components and interactions;
3. apply fundamental chemical and physical concepts and methods to solve real-world problems;
4. apply fundamental field skills, technologies, and concepts in Earth Sciences and Sustainable Management of Environmental Resources to address topical issues;
5. apply fundamental theories, approaches and methods for public policy analysis;
6. distinguish among the economic interests and activities of different stakeholders;
7. classify and analyze major anthropogenic disturbances of the natural (near-)surface system;
8. describe and appraise the interdependencies between resource exploration, responsible resource exploitation and environmental protection;
9. evaluate economic, political, and societal problems with regard to climate change using economics and management theories and scientific reasoning
10. cooperate and collaborate responsibly and ethically in international and culturally diverse teams and communities;
11. professionally communicate their own results in writing and in front of an audience, to both specialists and non-specialists;
12. select and apply key data processing and analysis techniques in applied and environmental geosciences;
13. perform quantitative analyses of materials, processes, and systems, and model their dynamics;
14. analyze scientific and technical questions, put them into context to what is known in the literature, and to solve the questions at hand;
15. evaluate, anticipate, and proactively communicate to society the human impact on the environment, and engage ethically as an environmentally responsible person;
16. apply research methods appropriate in ESSMER;

17. take responsibility for their own learning, personal and professional development, and role in society, evaluating critical feedback and self-analysis.

1.4 Career Options and Support

The Earth Sciences and Sustainable Management of Environmental Resources program provides a gateway to a wide range of different career paths that reflect the diversity of Earth and Environmental Sciences. The career prospects are excellent, as there is an increasing demand for graduates with a science-based background in Earth and Environmental Sciences, especially with a skill set that include practical field and lab work, numerical and analytical skills coupled with a sound knowledge in geochemistry, geology, and/or digital geosciences. An understanding and appreciation of the inherent interdisciplinary nature of the Earth Sciences and Sustainable Management of Environmental Resources is also greatly valued by both academia and industry.

Graduates of the Earth Sciences and Sustainable Management of Environmental Resources program at Constructor University can choose from a broad range of careers in academia and in industry, for example in the exploration and management of natural resources such as fresh water, fossil fuels and minerals on land and in the oceans, or green technologies in research at universities and various State-, NGO- or privately funded research facilities. Possible careers are also possible in environmental consulting and management as well as in start-ups or small and medium-sized companies in the steadily growing environmental and renewable energy sector. Furthermore, high-school and college teaching, work in science journalism and publishing or in the geo- and eco-tourism industry are possible. Since positions in industry and academia often require a M.Sc. degree, the modules and courses in the Earth Sciences and Sustainable Management of Environmental Resources program also aim to prepare students for further studies at graduate schools.

The Earth Sciences and Sustainable Management of Environmental Resources program profits from the excellent placement record held by previous earth sciences programs at Constructor University for its graduates in both, the international job market and highly ranked graduate programs in Germany and abroad (such as Berlin, Bremen, Munich and Tübingen in Germany, and, for example, MIT Boston, ETH Zurich, TU Delft and numerous other universities in the U.S., the Netherlands, the U.K., South Africa, Norway and Sweden). Earth Sciences alumni are currently employed by a variety of different companies such as Equinor, Wintershall, DuPont USA, Shell, Lürssen Werft GmbH, and McKinsey, universities, and research institutions such as the University of St. Andrews, UK, University of Colorado Boulder, USA, AWI Bremerhaven, MPI for Marine Microbiology, GFZ Potsdam, and Marum Bremen but also at NGOs and Federal and State departments and agencies.

Since Constructor University is an international residential campus university, all B.Sc. students live in shared housing facilities on Constructor University Campus. The experience of living, learning, and working together with students from more than 100 different countries ensures that all ESSMER graduates are well-prepared for working together in highly diverse multicultural teams and environments.

The Career Service Center (CSC) helps students in their career development. It provides students with high-quality training and coaching in CV creation, cover letter formulation, interview preparation, effective presenting, business etiquette, and employer research as well as in many other aspects, thus helping students identify and follow up on rewarding careers after graduating from Constructor University. Furthermore, the Alumni Office helps students establish a long-lasting and global network which is useful when exploring job options in academia, industry, and elsewhere.

1.5 Admission Requirements

Admission to Constructor University is selective and based on a candidate's school and/or university achievements, recommendations, self-presentation, and performance on standardized tests. Students admitted to Constructor University demonstrate exceptional academic achievements, intellectual creativity, and the desire and motivation to make a difference in the world.

The following documents need to be submitted with the application:

- Recommendation Letter (optional)
- Official or certified copies of high school/university transcripts
- Educational History Form
- Standardized test results (SAT/ACT) if applicable
- Motivation statement
- ZeeMee electronic resume (optional)
- Language proficiency test results (TOEFL Score: 90, IELTS: Level 6.5 or equivalent)

Formal admission requirements are subject to higher education law and are outlined in the Admission and Enrollment Policy of Constructor University.

For more detailed information about the admission visit:
https://constructor.university/admission-aid/application-information-undergraduate

1.6 More information and contacts

For more information on the study program please contact the Study Program Coordinator:

Prof. Dr. Andrea Koschinsky

Professor of Geosciences
Email: akoschinsky@constructor.university

or

Prof. Dr. Vikram Unnithan

Professor of Geosciences
Email: vunnithan@constructor.university

or visit our program website
https://constructor.university/programs/undergraduate-education/earth-sciences-and-sustainable-management-of-environmental-resources

For more information on Student Services please visit:

https://constructor.university/student-life/student-services

2 The Curricular Structure

2.1 General

The curricular structure provides multiple elements for enhancing employability, interdisciplinarity, and internationality. The unique CONSTRUCTOR Track, offered across all undergraduate study programs, provides comprehensive tailor-made modules designed to achieve and foster career competency. Additionally, a mandatory internship of at least two months after the second year of study and the possibility to study abroad for one semester give students opportunities to gain insight into the professional world, apply their intercultural competences and reflect on their roles and ambitions for employment and in a globalized society.

All undergraduate programs at Constructor University are based on a coherently modularized structure, which provides students with an extensive and flexible choice of study plans to meet the educational aims of their major as well as minor study interests and complete their studies within the regular period.

The framework policies and procedures regulating undergraduate study programs at Constructor University can be found on the website (https://constructor.university/student-life/student-services/university-policies)

2.2 The Constructor University 4C Model

Constructor University offers study programs that comply with the regulations of the European Higher Education Area. All study programs are structured according to the European Credit Transfer System (ECTS), which facilitates credit transfer between academic institutions. The three-year undergraduate programs involve six semesters of study with a total of 180 ECTS credit points (CP). The undergraduate curricular structure follows an innovative and student-centered modularization scheme, the 4C Model. It groups the disciplinary content of the study program in three overarching themes, CHOICE-CORE-CAREER according to the year of study, while the university-wide CONSTRUCTOR Track is dedicated to multidisciplinary content dedicated to methods as well as intellectual skills and is integrated across all three years of study. The default module size is 5 CP, with smaller 2.5 CP modules being possible as justified exceptions, e.g., if the learning goals are more suitable for 2.5 CP and the overall student workload is balanced.

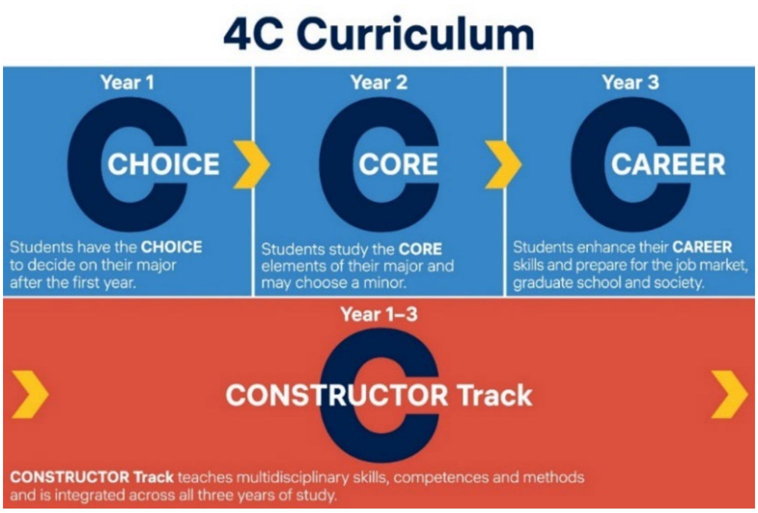

Figure 1: The Constructor University 4C-Model

2.2.1 Year 1 – CHOICE

The first study year is characterized by a university-specific offering of disciplinary education that builds on and expands upon the students' entrance qualifications. Students select introductory modules for a total of 45 CP from the CHOICE area of a variety of study programs, of which 15-45 CP will belong to their intended major. A unique feature of our curriculum structure allows students to select their major freely upon entering Constructor University. The team of Academic Advising Services offers curriculum counseling to all Bachelor students independently of their major, while Academic Advisors, in their capacity as contact persons from the faculty, support students individually in deciding on their major study program.

To pursue Earth Sciences and Sustainable Management of Environmental Resources as a major, the following CHOICE modules (30 CP) need to be taken as mandatory (m) modules:

- CHOICE Module: Fundamentals of Earth Sciences (m, 7.5 CP)
- CHOICE Module: Environmental Systems and Global Change (m, 7.5 CP)
- CHOICE Module: Microeconomics (m, 7.5 CP)
- CHOICE Module: Macroeconomics (m, 7.5 CP)

These CHOICE modules introduce the students in the first semester to the fundamentals of Earth Sciences and Sustainable Management of Environmental Resources (e.g., the structure of the Earth, its major compartments, plate tectonics, and geological timescales, and in the second semester provide more specific knowledge of geological phenomena, climate change and the human impact on the natural environment. At the same time a broad introduction in Economics is given in the first year. More advanced economics skills builds on this in the following years.

The remaining CHOICE modules (15 CP) can be selected in the first year of study according to interest and/or with the aim of allowing a change of major until the beginning of the second year, when the major choice becomes fixed.

Students can still change to another major at the beginning of their second year of studies, provided they have taken the corresponding mandatory CHOICE modules in their first year of studies. All students must participate in an entry advising session with their Academic Advisors to learn about their major change options and consult their Academic Advisor prior to changing their major.

Earth Sciences and Sustainable Management of Environmental Resources students that would like to retain an option for a major change are strongly recommended to register for the CHOICE modules of one of the following study programs in their first year. The module descriptions can be found in the respective Study Program Handbook.

- Global Economics and Management (GEM)
  CHOICE Module: Introduction to International Business (7.5 CP)
  CHOICE Module: Introduction to Finance and Accounting (7.5 CP)
  CHOICE Module: Introduction to International Business (m, 7.5 CP)
  CHOICE Module: Introduction to Finance and Accounting (m, 7.5 CP)

- International Business Administration (IBA)
  CHOICE Module: Introduction to International Business (7.5 CP)
  CHOICE Module: Introduction to Finance and Accounting (7.5 CP)

CHOICE Module: Introduction to International Business (m, 7.5 CP)
CHOICE Module: Introduction to Finance and Accounting (m, 7.5 CP)

- International Relations: Politics and History (IRPH)
  CHOICE Module: Introduction to International Relations Theory (7.5 CP)
  CHOICE Module: Introduction to Modern European History (7.5 CP)

2.2.2 Year 2 – CORE

In their second year, students take a total of 45 CP from a selection of in-depth, discipline-specific CORE modules. Building on the introductory CHOICE modules and applying the methods and skills acquired so far (see 2.3.1), these modules aim to expand the students' critical understanding of the key theories, principles, and methods in their major for the current state of knowledge and best practice.

To pursue Earth Sciences and Sustainable Management of Environmental Resources as a major, all the following mandatory CORE modules need to be taken:

- CORE Module: Geochemistry of Environmental Systems (m, 7.5 CP)
- CORE Module: Physics of Planet Earth (m, 7.5 CP)
- CORE Module: Natural Resources and Hazards (m, 7.5 CP)
- CORE Module: Advanced Field Laboratories (m, 7.5 CP)
- CORE Module: Finance and Sustainable Management of Natural Risks (m, 5 CP)
- CORE Module: Sustainability and Infrastructure Investments (m, 5 CP)
- CORE Module: Economics of Environmental Resources (m, 5 CP)

The CORE Modules are arranged as three sets of units, with each comprising one fall (F) and one spring (S) module. The student chooses the Fall (F) and Spring (S) semester modules Sustainability and Infrastructure Investments, Economics of Environmental Resources, and Finance and Sustainable Management of Natural Resources to focus on economics, finance and sustainable management. Additionally, Geochemistry of Environmental Systems and Natural Resources and Hazards to focus on Geochemistry and Resources and their impact on the environment, and module pair Physics of Planet Earth and Advanced Field Laboratories to focus on geophysics and extended field laboratories (for details see section 7 Module Descriptions). The contents of these paired CORE modules are structurally connected, and completion of both modules will be guaranteed by scheduling.

Earth Sciences and Sustainable Management of Environmental Resources students are required to take 45 CP credits of CORE modules to graduate in ESSMER. This does **not permit** the incorporation of a minor study track. However, Bachelor students majoring in other programs can pursue a minor in Earth Sciences (see below).

2.2.3 Year 3 – CAREER

During their third year, students prepare and make decisions for their career after graduation. To explore available choices fitting individual interests, and to gain professional experience, students take a mandatory summer internship (see 2.2.3.1). The third year of studies allows ESSMER students to further sharpen their profile with a selection of discipline-specific, research-oriented specialization modules that can be combined to enhance their individual competences in the natural sciences, strategy development for novel research approaches or managerial capabilities. Furthermore, the third year also focuses on the responsibility of students beyond their discipline (see CONSTRUCTOR Track).

The fifth semester also opens a mobility window for a diverse range of study abroad options. Finally, the sixth semester is dedicated to fostering the students' research experience by involving them in a Bachelor thesis project.

2.2.3.1 Internship / Start-up and Career Skills Module

As a core element of Constructor University's employability approach students are required to engage in a mandatory two-month internship of 15 CP that will usually be completed during the summer between the second and third years of study. This gives students the opportunity to gain first-hand practical experience in an external professional research environment, apply their knowledge and understanding in the context of an external institution, reflect on the relevance of their major to employment and society, reflect on their own personal role, and further develop their professional orientation. The internship can establish valuable contacts for the students' bachelor's thesis project, for the selection of a master program or graduate school, or for further employment after graduation. This module is complemented by career advising and several career skills workshops throughout all six semesters that prepare students for the transition from student life to professional life. As an alternative to the full-time internship, students interested in setting up their own company can apply for a start-up option to focus on developing their business plans.

For further information, please contact the Career Service Center (CSC) (https://constructor.university/student-life/career-services).

For organizational aspects consult with your Academic Advisor and the ESSMER SPC for reasonable choices to conduct a prosperous internship.

2.2.3.2 Specialization Modules

In the third year of their studies, students take 15 CP from major-specific or major-related, advanced Specialization Modules to consolidate their knowledge and to be exposed to state-of-the-art research in the areas of their interest. This curricular component is offered as a portfolio of modules, from which students can make free selections during their fifth and sixth semester. The default Specialization Module size is 5 CP, with smaller 2.5 CP modules being possible as justified exceptions.

To pursue Earth Sciences and Sustainable Management of Environmental Resources as a major, at least 15 CP from the following mandatory elective (me) Specialization Modules need to be taken:

- ESSMER Specialization: Digital Geosciences (me, 5 CP)
- ESSMER Specialization: Sustainability and Policy Evaluation (me, 5 CP)
- ESSMER Specialization: Advanced Environmental Science (me, 5 CP)
- ESSMER Specialization: Current Topics in ESSMER (me, 5 CP)

In addition to the advancement of disciplinary skills within ESSMER, these specialization modules are also meant to bring together different disciplinary threads developed in the CORE area in an interdisciplinary context, thus realizing the idea of capstone modules in the third year of study.

2.2.3.3 Study Abroad

Students have the opportunity to study abroad for a semester to extend their knowledge and abilities, broaden their horizons and reflect on their values and behavior in a different context as well as on their role in a global society. For a semester abroad (usually the fifth semester), modules related to the major with a workload equivalent to 22.5 CP must be completed. Modules recognized as study abroad CP need to be pre-approved according to Constructor University's study abroad procedures. Several exchange programs allow students to directly enroll at prestigious partner institutions worldwide. Constructor University's participation in Erasmus+, the European Union's exchange program, provides an exchange semester at a number of European universities that include Erasmus study abroad funding.

For further information, please contact the International Office (https://constructor.university/student-life/study-abroad/international-office)

ESSMER students that wish to pursue a study abroad in their fifth semester are required to select their modules at the study abroad partners such that they can be used to substitute between 10-15 CP of major-specific Specialization modules and between 5-15 CP of modules equivalent to the non-disciplinary New Skills modules (see CONSTRUCTOR Track). In their sixth semester, according to the study plan, returning study-abroad students complete the Bachelor Thesis/Seminar module (see next section), they take any missing Specialization modules to reach the required 15 CP in this area, and they take any missing New Skills modules to reach the required 15 CP in this area.

2.2.3.4 Bachelor Thesis/Seminar Module

This module is a mandatory graduation requirement for all undergraduate students. It consists of two module components in the major study program guided by a Constructor University faculty member: the Bachelor Thesis (12 CP) and a Seminar (3 CP). The title of the thesis will appear on the students' transcripts.

Within this module, students apply the knowledge skills, and methods they have acquired in their major discipline to become acquainted with actual research topics, ranging from the identification of suitable (short-term) research projects, preparatory literature searches, the realization of discipline-specific research, and the documentation, discussion, and interpretation of the results.

With their Bachelor Thesis students demonstrate understanding of the contents and methods of their major-specific research field. Furthermore, students show the ability to analyze and solve a well-defined problem with scientific approaches, a critical reflection of the status quo in scientific literature, and the original development of their own ideas. With the permission of a Constructor University Faculty Supervisor, the Bachelor Thesis can also have an interdisciplinary nature. In the seminar, students present and discuss their theses in a course environment and reflect on their theoretical or experimental approach and conduct. They learn to present their chosen research topics concisely and comprehensively in front of an audience and to explain their methods, solutions, and results to both specialists and non-specialists.

2.3 The CONSTRUCTOR Track

The CONSTRUCTOR Track is another important feature of Constructor University's educational model. The Constructor Track runs orthogonal to the disciplinary CHOICE, CORE, and CAREER modules across all study years and is an integral part of all undergraduate study programs. It provides an intellectual tool kit for lifelong learning and encourages the use of diverse methodologies to approach cross-disciplinary problems. The CONSTRUCTOR track contains Methods, New Skills and German Language and Humanities modules.

2.3.1 Methods and Skills Modules

Methods such as mathematics, statistics, programming, data handling, presentation skills, academic writing, and scientific and experimental skills are offered to all students as part of the Methods area in their curriculum. The modules that are specifically assigned to each study program to equip students with transferable academic skills. They convey and practice specific methods that are indispensable for each students' chosen study program. Students are required to take 20 CP in the Methods area. The size of all Methods modules is 5 CP.

To pursue ESSMER as a major, the following Methods and Skills modules (20 CP) need to be taken as mandatory modules:

- Methods Module: Mathematical Concepts (m, 5 CP)
- Methods Module: Statistics with R (m, 5 CP)
- Methods Module: Chemistry for Natural Scientists (m, 5 CP)
- Methods Module: Econometrics (m, 5 CP)

2.3.2 New Skills Modules

This part of the curriculum constitutes an intellectual and conceptual tool kit that cultivates the capacity for a particular set of intellectual dispositions including curiosity, imagination, critical thought, and transferability. It nurtures a range of individual and societal capacities, such as self-reflection, argumentation and communication. Finally, it introduces students to the normative aspects of inquiry and research, including the norms governing sourcing, sharing, withholding materials and research results as well as others governing the responsibilities of expertise as well as the professional point of view.

All students are required to take the following modules in their second year:

- New Skills Module: Logic (m, 2.5 CP)
- New Skills Module: Causation and Correlation (m, 2.5 CP)

These modules will be offered with two different perspectives of which the students can choose. The module perspectives are independent modules which examine the topic from different point of views. Please see the module description for more details.

In the third year, students take three 5 CP modules that build upon previous modules in the track and are partially constituted by modules that are more closely linked to each student's disciplinary field of study. The following module is mandatory for all students:

- New Skills Module: Argumentation, Data Visualization and Communication (m, 5 CP)

This module will also be offered with two different perspectives of which the students can choose.

In their fifth semester, students may choose between:

- New Skills Module: Linear Model/Matrices (me, 5 CP) and
- New Skills Module: Complex Problem Solving (me, 5 CP).

The sixth semester also contains the choice between two modules, namely:

- New Skills Module: Agency, Leadership and Accountability (me, 5 CP) and
- New Skills Module: Community Impact Project (me, 5 CP).

Students who study abroad during the fifth semester and are not substituting the mandatory Argumentation, Data Visualization and Communication module, are required to take this module during their sixth semester. Students who remain on campus are free to take the Argumentation, Data Visualization and Communication module in person in either the fifth or sixth semester as they prefer.

2.3.3 German Language and Humanities Modules

German language abilities foster students' intercultural awareness and enhance their employability in their host country. They are also beneficial for securing mandatory internships (between the 2nd and 3rd year) in German companies and academic institutions. Constructor University supports its students in acquiring basic as well as advanced German skills in the first year of the CONSTRUCTOR Track. Non-native speakers of German are encouraged to take two German modules (me, 2.5 CP each), but are not obliged to do so. Native speakers and other students not taking advantage of this offering take alternative modules in Humanities in each of the first two semesters:

- Humanities Module: Introduction to Philosophical Ethics (me, 2.5 CP)
- Humanities Module: Introduction to the Philosophy of Science (me, 2.5 CP)
- Humanities Module: Introduction to Visual Culture (me, 2.5 CP)

3 Earth Sciences as a Minor

The Earth Sciences and Sustainable Management of Environmental Resources program allows Bachelor students from other disciplines to pursue a Minor in Earth Sciences. A Minor in Earth Sciences is a valuable complementary study component for students with a strong general interest in environmental topics and/or for those who would like to pursue a career that requires interdisciplinary knowledge of the natural environment, the acquisition and processing of Earth (Big) data, and/or the natural resource sector on the one hand, and/or of computer science, economics, microbiology, biotechnology, chemistry or physics on the other.

3.1 Qualification Aims

The purpose of a Minor in Earth Sciences is to prepare students to deal with the pressing challenges of the next decades, such as Climate Change, scarcity of water and mineral resources, and responsible and sustainable interaction with the environment. A Minor in Earth Sciences enables them to understand, discuss, participate in and promote science-based approaches which address these issues.

3.1.1 Intended Learning Outcomes

With the default minor in Earth Sciences, students will be able to:

1. explain key concepts and processes in geology, and environmental sciences;
2. describe and discuss terrestrial (near-) surface systems, identify and examine their components and interactions;
3. apply fundamental field skills, technologies, and concepts in Earth and Environmental Sciences;
4. classify and analyze major anthropogenic disturbances of the natural system;
5. cooperate and collaborate responsibly and ethically in international and culturally diverse teams and communities.

3.2 Module Requirements

A Minor in Earth Sciences requires 30 CP. It includes the following mandatory CHOICE and CORE modules:

- CHOICE Module: Fundamentals of Earth Sciences (m, 7.5 CP)
- CHOICE Module: Environmental Systems and Global Change (m, 7.5 CP)
- CORE Module: Geochemistry of Environmental Systems (m, 7.5 CP)
- CORE Module: Natural Resources and Hazards (m, 7.5 CP)

3.3 Degree

After successful completion, the minor in Earth Sciences will be listed on the final transcript under PROGRAM OF STUDY and BA/BSc – [name of the major] as "(Minor: Earth Sciences (ES))".

4 Earth Sciences and Sustainable Management of Environmental Resources Undergraduate Program Regulations

4.1 Scope of these Regulations

The regulations in this handbook are valid for all students who entered the Earth Sciences and Sustainable Management of Environmental Resources undergraduate program at Constructor University in Fall 2023. In case of a conflict between the regulations in this handbook and the between the regulations in this handbook and the general Policies for Bachelor Studies, the latter apply (see https://constructor.university/student-life/student-services/university-policies).

In exceptional cases, certain necessary deviations from the regulations of this study handbook might occur during the course of study (e.g., change of the semester sequence, assessment type, or the teaching mode of courses).

In general, Constructor University reserves therefore the right to change or modify the regulations of the program handbook according to relevant policies and processes also after its publication at any time and in its sole discretion.

4.2 Degree

Upon successful completion of the study program, students are awarded a Bachelor of Science degree in Earth Sciences and Sustainable Management of Environmental Resources.

4.3 Graduation Requirements

To graduate, students need to obtain 180 CP. In addition, the following graduation requirements apply:

Students need to complete all mandatory components of the program as indicated in the Study and Examination Plan in Chapter 6 of this handbook.

5 Schematic Study Plan

Figure 2 shows schematically the sequence and types of modules required for the study program. A more detailed description, including the Assessment Types, is given in the Study and Examination Plans in the following section.

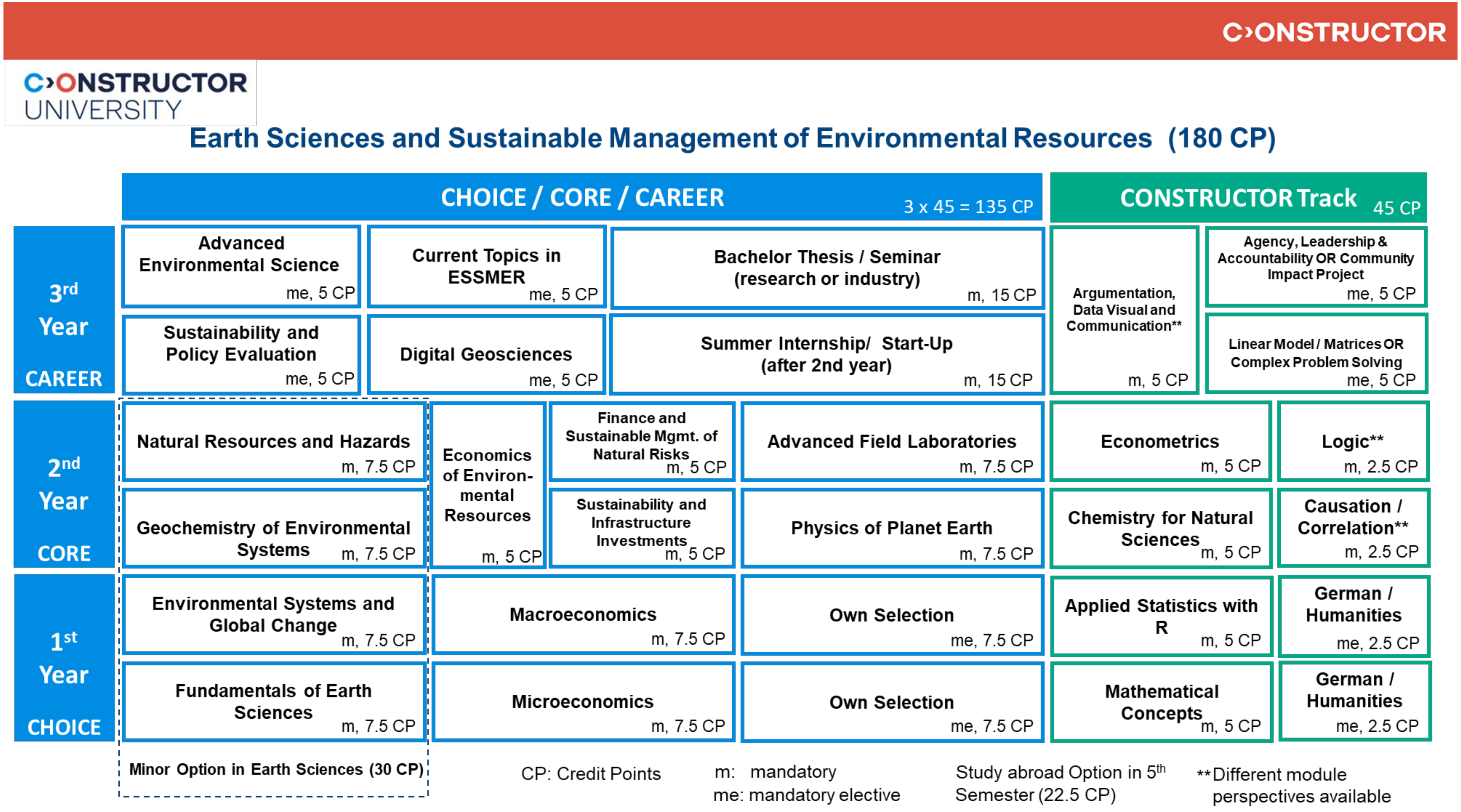

Figure 2: Schematic Study Plan for ESSMER

6 Study and Examination Plan

Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)

Matriculation Fall 2023

	Program-Specific Modules	**Type**	**Assessment**	**Period**	**Status[1]**	**Sem.**	**ECTS**
Year 1 - CHOICE							**45**
*Take the mandatory CHOICE unit **(s)** listed below, this is a requirement for the ESSMER program.*							
	Unit: Earth Sciences I - Default minor						**15**
CH-132	**Module: Fundamentals of Earth Sciences**				**m**	**1**	**7.5**
CH-132- A	Fundamentals of Earth Sciences	Lecture	Written Exam	Examination period			5
CH-132- B	Earth Sciences Lab	Lab					2.5
CH-133	**Module: Environmental Systems and Global Change**				**m**	**2**	**7.5**
CH-133- A	Environmental Systems and Global Change	Seminar	Written Exam	Examination period			5
CH-133- B	Environmental Systems Lab	Lab					2.5
	Unit: Sustainable Management of Environmental Resources 1						**15**
CH-310	**Module: Microeconomics**				**m**	**1**	**7.5**
CH-310-A	Microeconomics Theory and Policy	Lecture	Written Exam	Examination period			5
CH-310-B	Microeconomics - Tutorial	Tutorial					2.5
CH-311	**Module: Macroeconomics**				**m**	**2**	**7.5**
CH-311-A	Macroeconomics Theory and Policy	Lecture	Written Exam	Examination period			5
CH-311-B	Macroeconomics - Tutorial	Tutorial					2.5
	Unit: CHOICE (own selection)					**1/2**	**15**
Students take two further CHOICE modules from those offered for all other study programs.[2]							
Year 2 - CORE							**45**
Take all three units listed below							
	Unit: Earth Sciences II - Default minor						**15**
CO-466	**Module: Geochemistry of Environmental Systems**				**m**	**3**	**7,5**
CO-466-A	Geochemistry of Environmental Systems	Lecture	Written Exam	Examination period	m		7.5
CO-467	**Module: Natural Resources and Hazards**				**m**	**4**	**7,5**
CO-467-A	Natural Resources and Hazards	Lecture	Written Exam	Examination period	m		x
	Unit: Sustainable Management of Environmental Resources II						**15**
CO-468	**Module: Sustainability and Infrastructure Investments**				**m**	**3**	**5**
CO-468-A	Sustainability and Infrastructure Investments	Lecture	Written Exam	Examination period	m		5
CO-470	**Module: Economics of Environmental Resources**				**m**	**3-4**	**5**
CO-470-A	Economics of Environmental Resources	Lecture	Written Exam	Examination period	m		5
CO-469	**Module: Finance and Sustainable Management of Natural Risks**				**m**	**4**	**5**
CO-469-A	Finance and Sustainable Management of Natural Risks	Lecture	Written Exam	Examination period	m		5
	Unit: Earth Sciences III						**15**
CO-471	**Module: Physics of Planet Earth**				**m**	**3**	**7,5**
CO-471-A	Physical Concepts for Earth Sciences	Lecture	Written Exam	Examination period	m		2.5
CO-471-B	Introduction to Geophysics	Lecture					2.5
CO-471-C	Atmosphere and Climate Physics	Lecture					2.5
CO-472	**Module: Advanced Field Laboratories**				**m**	**4**	**7,5**
CCO-472-A	Advanced Field Lab A	Lab	Written report	during the sememster	m		2.5
CO-472-B	Advanced Field Lab B	Lab	Written report	during the sememster	m		5

	CONSTRUCTOR Track Modules	**Type**	**Assessment**	**Period**	**Status[1]**	**Sem.**	**ECTS**
Year 1							**15**
	Unit: Skills / Methods						**10**
CTMS-MAT-07	**Module: Mathematical Concepts**				**m**	**1**	**5**
CTMS-07	Mathematical Concepts	Lecture	Written Exam	Examination period			
CTMS-MET-03	**Module: Statistics with R**				**m**	**2**	**5**
CTMS-03	Statistics with R	Lecture	Written Exam	Examination period			
	Unit: Language						**5**
German is default language and open to Non-German speakers (on campus and online).[4]							
CTLA-	**Module: Language 1**				**me**	**1**	**2.5**
CTLA-	Language 1	Seminar	Various	Various	me		
CTLA-	**Module: Language 2**				**me**	**2**	**2.5**
CTLA-	Language 2	Seminar	Various	Various	me		
CTHU-HUM-001	**Humanities Module: Introduction into Philosophical Ethics**				**me**	**1**	**2.5**
CTHU-001	Introduction into Philosophical Ethics	Lecture	Written examin	Examination period	me		
CTHU-HUM-002	**Humanities Module: Introduction to the Philosophy of Science**				**me**	**2**	**2.5**
CTHU-002	Introduction to the Philosophy of Science	Lecture	Written examin	Examination period	me		
CTHU-HUM-003	**Introduction to Visual Culture**				**me**	**2**	**2.5**
CTHU-003	Introduction to Visual Culture	Lecture	Written examin	Examination period	me		
Year 2							**15**
	Unit: Skills / Methods						**10**
CTMS-SCI-15	**Module: Chemistry for Natural Sciences**				**m**	**3**	**5**
CTMS-15-A	Chemistry for Natural Sciences	Lecture	Written Exam	Examination period	m		2.5
CTMS-15-B	Chemistry for Natural Sciences Lab	Lab			m		2.5
CTMS-MET-05	**Module: Econometrics**				**m**	**4**	**5**
CTMS-05	Econometrics	Seminar	Written Exam	Examination period			5
	Unit: New Skills						**5**
Choose one of the two modules							
CTNS-NSK- 01	**Module: Logic (perspective I)**				**me**	**3**	**2.5**
CTNS-01	Logic (perspective I)	Lecture (	Written Examin	Examination period	me		2.5
CTNS-NSK-02	**Module: Logic (perspective II)**						
CTNS-02	Logic (perspective II)	Lecture (	Written Examin	Examination period	me		2.5
Choose one of the two modules							
CTNS-NSK	**Module: Causation and Correlation**				**me**	**4**	**2.5**
CTNS-03	Causation and Correlation (perspective I)	Lecture	Written examin	Examination period	me		2.5
CTNS-04	**Causation and Correlation (perspective II)**				me	4	2.5
CTNS-04	Causation and Correlation (perspective II)	Lecture	Written examin	Examination period	me		2.5

Year 3 - CAREER							45
CA-INT-900	**Module: Summer Internship**				m	4/5	15
CA-INT-900-0	Summer Internship						15
CA-EES-800	**Module: Seminar / Thesis ESSMER**				m	6	15
CA-EES-800-T	Seminar ESSMER	Seminar	Presentation				3
CA-EES-800-S	Thesis ESSMER	Thesis	Thesis				12
	Unit: Specialization				m		15
CA-S-ESSMER-801	**Module: Digital Geosciences**				me	5	5
CA-ESSMER-801	Digital Geosciences	Lecture	Term paper	during the semester			2,5
CA-S-ESSMER-802	**Module: Sustainability and Policy Evaluation**				me	5	5
CA-ESSMER-802	Sustainability and Policy Evaluation	Lecture	Written Exam	Examination period			5
CA-S-ESSMER-803	**Module: Advanced Environmental Science**				me	6	5
CA-ESSMER-803-A	Advanced Environmental Science	Lecture	Written Exam	Examination period			2,5
CA-ESSMER-803-B	Advanced Environmental Science Lab	Lab	Lab Report	during the semester			2,5
CA-S-EES-804	**Module: Current Topics in ESSMER**				me	6	5
CA-EES-804	Current Topics in ESSMER	Seminar	Term Paper	during the semester			5
	Total 15 ECTS of specialization modules				m	5/6	15

							15
	Unit: New Skills						10
Choose one of the two modules							
CTNS-NSK-05	**Module: Linear Model / Matrices**				me	5	5
CTNS-05	Linear Model/ Matrices	Seminar	Written Exam	Examination period			5
CTNS-NSK-06	**Module: Complex Problem Solving**				me	5	5
CTNS-06	Complex Problem Solving	Lecture	Written Exam	Examination period			5
Choose one of the two modules							5
CTNS-NSK-07	**Module: Argumentation, Data Visualization and Communication**				me	5/6	5
CTNS-07	Argumentation, Data Visualization and Communication (perspective I)	Lecture (o	Written exam	Examination period	me	5	5
CTNS-NSK-08	**Module: Argumentation, Data Visualization and Communication**				me	5/6	5
CTNS-08	Argumentation, Data Visualization and Communication (perspective II)	Lecture ((	Written exam	Examination period	me	6	5
Choose one of the two modules							
CTNS-NSK	**Module: Agency, Accountability & Leadership**				me	6	5
CTNS-09	Agency, Leadership, and Accountability	Lecture	Written Exam	Examination period			5
CTNC-CIP-10	**Module: Community Impact Project**				me	5/6	5
CTNC-10	Community Impact Project	Project	Project	Examination period			5
Total ECTS							**180**

¹ Status (m = mandatory, e = elective, me = mandatory elective)

² For a full listing of all CHOICE / CORE / CAREER / Constructor Track units / modules please consult the CampusNet online catalogue and /or the study program handbooks.

[3] German native speakers will have alternatives to the language courses (in the field of Humanities).

[4] Humanities I and II are optional to all students, except for German native speakers.

[5]Choose one of the perspectives

Figure 3: Study and Examination Plan ESSMER

7 ESSMER Modules

7.1 Fundamentals of Earth Sciences

<table>
<tr><td colspan="3">Module Name
Fundamentals of Earth Sciences</td><td>Module Code
CH-132</td><td>Level (type)
Year 1
Choice</td><td>CP
7.5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CH-132-A</td><td colspan="3">Fundamentals of Earth Sciences</td><td>Lectures</td><td>5</td></tr>
<tr><td>CH-132-B</td><td colspan="3">Fundamentals of Earth Sciences – Lab</td><td>Lab</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Vikram Unnithan,
Prof. Dr. Michael Bau</td><td colspan="3">Program Affiliation

• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)</td><td colspan="2">Mandatory Status

Mandatory for ESSMER and minor ES</td></tr>
<tr><td rowspan="2">Entry Requirements

Pre-requisites

☒ none</td><td rowspan="2">Co-requisites

☒ none</td><td rowspan="2">Knowledge, Abilities, or Skills</td><td>Frequency

Annually (Fall)</td><td colspan="2">Forms of Learning and Teaching

• Lectures (35 hours)
• Lab (17.5 hours)
• Self-Study (135 hours)</td></tr>
<tr><td>Duration

1 Semester</td><td colspan="2">Workload

187.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
Reading Material - Earth Science Literacy Principles http://www.earthscienceliteracy.org/esliteracy6may10_.pdf</td></tr>
<tr><td colspan="6">Content and Educational Aims
This module introduces earth sciences focussing on physical and historical geology. The module provides a basic understanding of how our planet works and has worked in the past. Students learn about the fundamental concepts of plate tectonics, the internal structure and evolution of the earth, identification of minerals and rocks and their role in the rock cycle. Elements from historical geology provide important concepts such as geological time and an understanding that geological, biological, and environmental processes are interrelated and interconnected but may have different timescales. Students are encouraged to think about the interconnectedness of the Earth as a system and its importance especially in the light of dwindling energy and mineral resources, climate change and growing population. Hands-on practical lab work forms an essential part of this module, whereby students will be introduced to geological methods and techniques such as working with rock samples, geological maps, and Earth data to explore concepts described during the lectures.</td></tr>
</table>

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. describe the general structure of the Earth, and the fundamental concepts of plate tectonics and geological structures
2. recognize, identify and categorize the major rock-forming minerals, indicating the causative geological processes
3. identify how Earth materials are transformed by rock cycle processes
4. appreciate the development of the geological time scale, the role of stratigraphy and absolute and relative time in the recognition of key events in the geological evolution of Earth, and their current relevance
5. discuss "the present is the key to the past" natural processes in the past and present and their implications for the future.

Indicative Literature

- Tarbuck, E.J. and Lutgens, F.K. (2015): Earth Science. London: Pearson Education.
- Johnson, C., Matthew, D., Affolter, P., Inkenbrandt, C. M. An Introduction to Geology (2019) Salt Lake City: Salt Lake Community College.

Usability and Relationship to other Modules

- CHOICE module, mandatory for ESSMER majors, usable by all

Examination Type: Module Examination

AssessmentType: Written Examination

Duration/Length: (180 minutes)

Weight: 100%

Scope: All intended learning outcomes

Module achievement: a minimum of 80% attendance in the Lab component is a prerequisite ("Studienbegleitleistung") for being admitted to the exam.

Completion: To pass this module, the examination has to be passed with at least 45%.

7.2 Microeconomics

<table>
<tr><td colspan="2">Module Name

Microeconomics</td><td>Module Code

CH-310</td><td>Level (type)

Year 1
(CHOICE)</td><td>CP

7.5</td></tr>
<tr><td colspan="5">Module Components</td></tr>
<tr><td>Number</td><td colspan="2">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CH-310-A</td><td colspan="2">Microeconomics Theory and Policy</td><td>Lecture</td><td>5</td></tr>
<tr><td>CH-310-B</td><td colspan="2">Microeconomics - Tutorial</td><td>Tutorial</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Colin Vance</td><td colspan="2">Program Affiliation

• Global Economics and Management (GEM)</td><td colspan="2">Mandatory Status

Mandatory for ESSMER, GEM, IBA and minor in GEM</td></tr>
<tr><td colspan="2" rowspan="2">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• Logical reasoning
• High school mathematics</td><td>Frequency

Annually

(Fall)</td><td colspan="2">Forms of Learning and Teaching

• Lecture (35 hours)
• Seminar (17.5 hours)
• Private Study (135 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

187.5 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

To prepare for this module, students are recommended to read the article “Research on teaching economics to undergraduates,” published in the Journal of Economic Literature in 2015. The article will allow students to get a first-hand look at the challenges of teaching economics from the viewpoint of those who teach it.</td></tr>
<tr><td colspan="5">Content and Educational Aims

The study of economics is concerned with the allocation of scarce resources and the associated implications for efficiency, equity, and human welfare. This module introduces the field of microeconomics, focusing on the role of markets in facilitating exchanges between different sectors of the economy such as workers, consumers, firms, and government institutions. Topics addressed include consumer theory, the cost structures and behavior of firms in various industries, competition, monopoly, and government regulation. The module applies theoretical concepts to contemporary policy questions, such as when government intervention is justified to correct market imperfections.

This module aims at transmitting fundamental knowledge of economics at the level of economic agents. A command of microeconomics constitutes the basis for undergraduate studies in the fields of economics and management and helps make sense of economic behaviors in many situations, including professional settings. With its focus on questions of welfare and the policy implications of microeconomic theories, this module also enables students to understand public affairs from an economic perspective at the micro level and promotes their capacity to differentiate among and explain the concepts taught in class. Textbook-based lectures ensure the transmission of the necessary knowledge. The accompanying, interactive tutorials further promote the students’ capacity to describe and give examples of the concepts taught in class.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. explain how economic concepts such as opportunity costs and the gains from trade can be applied to a range of themes of relevance to human welfare;
2. use graphical depictions to derive insights into how markets function;
3. distinguish between equity and efficiency when evaluating the outcomes of economic policies;
4. explain and differentiate among fundamental microeconomic models, such as that demonstrating the gains from trade, using graphs as visual aids;
5. explain the policy implications of microeconomic theories.

Indicative Literature

- Hayek, F. A. (1945). The use of knowledge in society. American Economic Review, 35(4): 519-530.
- King, M. L., Jr. (1963). Letter from a Birmingham jail.
- Thaler, R. H. (2016). Behavioral economics: Past, present, and future. American Economic Review, 106(7): 1577-1600.

Usability and Relationship to other Modules

- This module transmits fundamental knowledge of microeconomics that is necessary to the second-year modules "Development Economics", "Environmental and Resource Economics", "Comparing Economic Systems" and "International Economics". This module further benefits from the contents taught in its accompanying "Macroeconomics" as the combination of the two offers a comprehensive view of economic questions from the interaction of economic agents to the aggregated level.

Examination Type: Module Examination

Assessment Type: Written Examination

Duration/Length: (120 minutes)

Weight: 100%

Scope: All intended learning outcomes

Completion: To pass this module, the examination has to be passed with at least 45%.

7.3 Environmental Systems and Global Change

Module Name Environmental Systems and Global Change		**Module Code** CH-133	**Level (type)** Year 1 (CHOICE)	**CP** 7.5
Module Components				
Number	Name		Type	CP
CH-133-A	Environmental Systems and Global Change		Seminar	5
CH-133-B	Environmental Systems Lab		Lab	2.5
Module Coordinator Prof. Dr. Andrea Koschinsky	**Program Affiliation** • Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)		**Mandatory Status** Mandatory for ESSMER and minor ES	
Entry Requirements Pre-requisites ☒ Fundamentals of Earth Sciences	Co-requisites ☒ none	Knowledge, Abilities, or Skills	**Frequency** Annually (Spring)	**Forms of Learning and Teaching** Lecture (55 hours) Field Lab (25 hours) Private study (107.5 hours)
			Duration 1 Semester	**Workload** 187.5 hours
Recommendations for Preparation				
Content and Educational Aims				

The module is an introduction to how planet Earth works with a focus on the natural processes that affect and shape the surface of the Earth, and the environmental issues pertinent to society. Students are encouraged to think about the interconnectedness of the Earth as a system. The interdisciplinary nature of Earth and Environmental Science is emphasized throughout the course. Field components complement and extend the lecture material. The module aims to review the large-scale global processes that shape the terrestrial and marine systems with their specially adapted ecosystems. They illustrate how anthropogenic interactions such as resource extraction, energy consumption, and pollution interfere with these natural processes, which ecosystems respond to these changes and introduce concepts and strategies of remediation. The students will learn to distinguish between natural and anthropogenic environmental change and learn to read from the geological record to understand present changes and predict the impacts of future global change. The module will consider both terrestrial systems such as freshwater and soil systems, as well as marine systems, always in the context of their special environmental parameters and related environmental vulnerability or resilience.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. discuss natural processes that shape the Earth and the implications these processes have for the evolution of our planet and the environment;
2. connect environmental conditions to the development of specific adapted terrestrial and marine ecosystems;
3. appreciate and appraise the Earth as a complex and evolving dynamic system in the context of the long timescales and slow rates of geological processes and the short timescales and fast rates of human impact;
4. assess the extraction and use of various natural resources, land-use and climate change, and the impact these changes have on society.

5. critically assess the natural and human-driven systems and processes that provide resources, produce energy and affect the climate and our Earth surface environment;
6. apply sedimentological, chemical and biological data as proxies to reconstruct ancient environments and climate;
7. suggest mitigation strategies to remediate water, soil and air pollution, negative changes in the marine system, and global warming;
8. demonstrate awareness of the difficulties involved in the detection of any unusual environmental change signal above the background noise of natural variability.

Indicative Literature

United Nations Environmental Programme (2015). One Planet Many People. Retrieved from: https://na.unep.net/atlas/onePlanetManyPeople/book.php.

William F. Ruddiman: Earth's Climate – Past and Future. New York, W.H. Freeman and Company.

Usability and Relationship to other Modules

- Recommended for all ESSMER CHOICE and CORE modules.

Examination Type: Module Examination

Assessment Type: Written examination

Duration/Length: 120 min
Weight: 100%

Module achievement: The Field-Lab report is a prerequisite ("Studienbegleitleistung") for being admitted to the written examination.

Scope: All intended learning outcomes for the module

Completion: To pass this module, the examination has to be passed with at least 45%

7.4 Macroeconomics

Module Name			Module Code	Level (type)	CP
Macroeconomics			CH-311	Year 1 (CHOICE)	7.5
Module Components					
Number	Name			Type	CP
CH-311-A	Macroeconomics Theory and Policy			Lecture	5
CH-311-B	Macroeconomics -Tutorial			Tutorial	2.5
Module Coordinator Prof. Dr. Colin Vance	**Program Affiliation** • Global Economics and Management (GEM)			**Mandatory Status** Mandatory for ESSMER, GEM and IBA	
Entry Requirements			**Frequency**	**Forms of Learning and Teaching**	
Pre-requisites ☒ Microeconomics	Co-requisites ☒ None	Knowledge, Abilities, or Skills Logical reasoning High school mathematics	Annually (Spring)	• Lecture (35 hours) • Tutorial (17.5 hours) • Private Study (135 hours)	
			Duration 1 semester	**Workload** 187.5 hours	
Recommendations for Preparation None.					

Content and Educational Aims

The study of economics is concerned with the allocation of scarce resources and the associated implications for efficiency, equity, and human welfare. This module introduces the field of macroeconomics, focusing on different aspects of demand and supply-side policies. The module applies theoretical concepts to contemporary policy questions, such as when and why governments may want to intervene in the economy with the help of fiscal and monetary policies and what these government interventions mean for various markets and economic actors. The lectures cover the material students need to know to take and pass the module examination. In the tutorials, the students further integrate the material taught in the lectures via discussions of related concepts, policy problems, or scientific studies, and exercises.

This module aims at transmitting fundamental knowledge of economics at the aggregated level of whole economies. A command of macroeconomics constitutes the basis for undergraduate studies in the fields of economics and management and helps make sense of the economic conditions in which we behave, not least in professional settings. With its interest in questions of market regulation and policy implications of macroeconomics theories, this module also enables students to understand public affairs from the perspective of whole economies. Textbook-based lectures ensure the transmission of the necessary knowledge. The accompanying, interactive tutorials further promote the students' capacity to differentiate and explain the concepts taught in class.

Intended Learning Outcomes

By the end of this module, students will be able to

1. express and discuss ways to analyze the performance of national economies through key indicators such as GDP growth, unemployment, inflation, government deficit and trade imbalances
2. explain and differentiate the goals and effectiveness of government interventions to combat economic crises in the form of monetary and fiscal policies;
3. describe how supply side measures such as improvements in infrastructure, education, and research can improve long-term growth and the international competitiveness of companies;
4. demonstrate how economic development and economic policy decisions have a strong potential of producing winners and losers among economic actor;
5. explain the policy implications of macroeconomic theories.

Indicative Literature

- Snowdown, B., Vane, H. R. (2005). Modern macroeconomics. Its origins, development and current state. Cheltenham: Edward Elgar.
- Goodwin, N., Harris, J., Rajkarnikar, P. J., Roach, B. Torras, M. (2019). Macroeconomics in context. London: Routledge.

Usability and Relationship to other Modules

- This module transmits fundamental knowledge of macroeconomics that is necessary to the second-year modules “Development Economics”, “Environmental and Resource Economics”, “Comparing Economic Systems” and “International Economics”. This module further benefits from the contents taught in its accompanying module “Microeconomics” as the combination of the two offers a comprehensive view of economic questions from the interaction of economic agents to the aggregated level.

Examination Type: Module Examination

Assessment Type: Written Examination Duration/Length: (120 minutes)

Weight: 100%

Scope: All intended learning outcomes

Completion: To pass this module, the examination has to be passed with at least 45%.

7.5 Geochemistry of Environmental Systems

Module Name	Module Code	Level (type)	CP
Geochemistry of Environmental Systems	CO-466	Year 2 (CORE)	7.5

Module Components

Number	Name	Type	CP
CO-466-A	Geochemistry of Environmental Systems	Lectures + Tutorials	7.5

Module Coordinator	Program Affiliation	Mandatory Status
Prof. Dr. Michael Bau (Prof. Dr. Andrea Koschinsky)	• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)	Mandatory for ESSMER and ES Minor

Entry Requirements

Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills
☒Fundamentals of Earth Sciences ☒Environmental Systems and Global Change ☒Chemistry for Natural Sciences (Methods course)	☒ Chemistry for Natural Sciences (Methods)	none beyond formal pre-requisites

Frequency	Forms of Learning and Teaching
Annually (Fall)	• lectures (37.5 hours) • tutorials (15.0 hours) • homework, self-study (135hrs)

Duration	Workload
1 semester	187.5 hours

Recommendations for Preparation

Please review the content of the ESSMER CHOICE modules:

- Fundamentals of Earth Sciences
- Environmental Systems and Global Change

Content and Educational Aims

This module introduces the geochemistry of natural systems ranging from igneous and sedimentary rocks, aqueous systems (e.g., freshwater, groundwater, seawater and other natural waters) and soils with respect to major and trace elements, and organic compounds. Stable and radiogenic isotope geochemistry will be addressed and how the distribution and behaviour of elements and their isotopes are controlled by chemical processes in relation to environmental conditions. The theoretical framework will be provided by lectures that are complemented by tutorials and homework assignments in which students will apply trace element and isotope geochemical tools in a quantitative way to solve basic geochemical problems related to, for example, element behavior during water-rock interaction during weathering and changing climatic conditions. The module also provides the knowledge to assess the distribution and potential bioavailability of chemical compounds in the environment and hence their role as nutrients and/or contaminants. In addition to the study of natural systems, the anthropogenic change of natural elemental cycles as well as the introduction of industrial compounds into the environment and their fate will be addressed. Students learn to understand the implications of these anthropogenic interventions with organisms including humans and evaluate environmental mitigation and remediation techniques.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. classify elements according to their physico-chemical characteristics and behavior in natural systems;
2. characterize the fundamental parameters and processes that control the behavior of elements in aqueous natural systems;
3. predict and quantify the behavior of major and trace elements and organics in natural aqueous systems;
4. characterize and apply the radiogenic isotope systems commonly used in geochronology and as source proxies;
5. characterize and apply the stable isotope systems commonly used in biogeochemistry;
6. assess the potential environmental impact of different elements based on their specific geochemical behavior
7. assess the risk and possible mitigation and remediation strategies of contamination with anthropogenic chemical compounds

Indicative Literature

- Hugh R. Rollinson (1993). Using Geochemical Data: Evaluation, Presentation, Interpretation. Abingdon: Routledge
- Langmuir, D. (1997). Aqueous Environmental Geochemistry. New Jersey: Prentice Hall
- White, W.M. (2013). Geochemistry Chapter 6: Aquatic Chemistry, Chapter 14: Organic Geochemistry; Chapter 15: The Ocean as a Chemical System. Hoboken: Wiley-Blackwell
- Faure, G. and Mensing, T.M. (2005). Isotopes. Principles and applications. 3rd Ed. Hoboken: John Wiley and Sons.
- Hoefs, J. (1997). Stable Isotope Geochemistry. Berlin: Springer-Verlag.
- Schwedt, G. (2001). The Essential Guide to Environmental Chemistry. Wiley.

Usability and Relationship to other Modules

• This module builds on the ESSMER CHOICE modules "Fundamentals of Earth Sciences" and "Environmental Systems and Global Change"

Examination Type: Module Examination

Assessment Type: Written examination — Duration: 180 min, Weight: 100 %

Scope: All indented learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

7.6 Sustainability and Infrastructure Investments

Module Name	Module Code	Level (type)	CP
Sustainability and Infrastructure Investments	CO-468	Year 2 (CORE)	5

Module Components

Number	Name	Type	CP
CO-468-A	Sustainability and Infrastructure Investments	Lecture	5

Module Coordinator	Program Affiliation	Mandatory Status
Prof. Dr. Andrea Koschinsky, Prof. Dr. Vikram Unnithan	• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)	Mandatory for ESSMER

Entry Requirements			Frequency	Forms of Learning and Teaching
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring/Fall)	• Lecture (35 hours) • Private study (90 hours)
☒ Microeconomics and Macroeconomic	☒ none	• Students should be familiar with the main impacts of climate change	**Duration**	**Workload**
			1 semester	125 hours

Recommendations for Preparation

To follow the debate on the measures and policies to address environmental issues and the sustainability transition.

Content and Educational Aims

The first part of the course will deal with Public Economics concepts. In particular, the course will provide students with basic general theoretical and empirical tools associated with public economics. Students will study the main market failures and contexts of direct government intervention, instruments of government revenues (taxation) and areas of government expenditures (education, healthcare, pension, infrastructures).

The second part of the course will deal with the finance and management of infrastructure investments. Students will be provided with basic concepts of project finance and financial modelling to assess the economic and financial feasibility and profitability of infrastructure projects. Cost benefits analysis taking into account also environmental and social impacts associated with the analysed investments will be introduced. The course will cover also the basics of contracts such as Public Private Partnership for managing infrastructure projects.

Finally, the course presents climate change policy under its multiple economic facets. Alternative economic scenarios in which climate change and climate policy play a crucial role are compared with different business as usual scenarios, analysing the impact of climate change on social and economic variables. Furthermore, based on a game-theoretic framework that carefully describes international climate negotiations, it will then be possible to identify the main properties of an effective international agreement on climate change control.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. Identify the main pros and cons of Government intervention in the economy;
2. Understanding the reasons and the role of Government expenditure;
3. Discuss the impact of major public interventions;
4. Apply the theoretical knowledge to practical analysis of simple infrastructure projects;
5. Calculate economic and financial indicators for the evaluation of infrastructure project performances;
6. Compare alternative financial solutions for infrastructure projects based on the usage of different financial instruments and approaches;
7. Assess impacts of climate change;
8. Apply economic instruments to mitigate climate change;
9. Identify solutions to reduce obstacles towards international climate agreements.

Indicative Literature

- J. GRUBER, Public Finance and Public Policy, Freeman and Worth, 2016 (ISBN/EAN: 9781319154165).
- Delmon, Jeffrey, Private Sector Investment in Infrastructure: Project Finance, PPP Projects and PPP Frameworks, Editore: Kluwer Law International, Anno edizione: 2021.
- Scott Barrett, Carlo Carraro, Jim De Melo, Towards a Workable and Effective Climate Regine, CEPR Press 2015, free downloadable at www.cepr.org (anche in francese per la casa editrice Economica).
- Nicholas Stern, Why Are We Waiting? The Logic, Urgency and Promise of Tackling Climate Change, MIT Press, 2014.
- Gernot Wagner and Martin L. Weitzman, Climate Shock: The Economic Consequences of a Hotter Planet , Princeton University Press, 2014.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination

Duration: 120 min
Weight: 100 %

Scope: All indented learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

7.7 Physics of Planet Earth

Module Name		**Module Code**	**Level (type)**	**CP**
Physics of Planet Earth		CO-471	Year 2 (CORE)	7.5
Module Components				
Number	Name		Type	CP
CO-471-A	Physical Concepts for Earth Sciences		Lecture	2.5
CO-471-B	Introduction to Geophysics		Lecture	2.5
CO-471-C	Atmosphere and Climate Physics		Lecture	2.5
Module Coordinator Prof. Dr. Joachim Vogt	**Program Affiliation** • Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)		**Mandatory Status** Mandatory for ESSMER	
Entry Requirements Pre-requisites ☒ none	Co-requisites ☒ none	Knowledge, Abilities, or Skills	**Frequency** Annually (Fall)	**Forms of Learning and Teaching** • Lecture (52.5 hours) • Private study (135 hours)
			Duration 1 semester	**Workload** 187.5 hours
Recommendations for Preparation Introductory courses on Earth Sciences, Mathematical Concepts, basic physics				
Content and Educational Aims The module introduces the physics of fundamental Earth structures and processes. The course Physical Concepts for Earth Sciences reviews and summarizes relevant descriptions and methods from different physical disciplines, most notably classical mechanics, fluid dynamics, thermodynamics, electromagnetism, and radiation physics. The course Introduction to Geophysics is concerned with the physics of Earth as a planet, including physical principles governing the structure of the interior and the atmosphere, Earth's gravity, and the geomagnetic field. The course Atmosphere and Climate Physics discusses atmosphere formation and stability, the vertical structure of the atmosphere, heat transfer processes, global circulation and winds, and the physics of the climate system, with an introduction to climate modeling.				

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. explain key physical processes that are relevant for Earth Sciences,
2. apply selected physical concepts and methods to problems in Earth Sciences,
3. identify basic physical principles governing important planetary processes,
4. understand global geophysical fields and their variability,
5. describe the structure and the global dynamics of the atmosphere,
6. characterize the climate system and the physics of climate change.

Indicative Literature

- E. J. Tarbuck et al.: Earth Science, Pearson Education.
- H. Goose et al.: Introduction to Climate Dynamics and Climate Modeling, online textbook available at http://www.climate.be/textbook
- M. Salby: Fundamentals of Atmospheric Physics, Elsevier.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination

Duration: 180 min
Weight: 100 %

Scope: All indented learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

7.8 Natural Resources and Hazards

<table>
<tr><td colspan="2">Module Name
Natural Resources and Hazards</td><td>Module Code
CO-467</td><td>Level (type)
Year 2 (CORE)</td><td>CP
7.5</td></tr>
<tr><td colspan="5">Module Components</td></tr>
<tr><td>Number</td><td colspan="2">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CO-467-A</td><td colspan="2">Natural Resources and Hazards</td><td>Lectures + Tutorials</td><td>7.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Michael Bau (Prof. Dr. Vikram Unnithan)</td><td colspan="2">Program Affiliation

• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)</td><td colspan="2">Mandatory Status

Mandatory for ESSMER and minor ES</td></tr>
<tr><td>Entry Requirements

Pre-requisites

☒Fundamentals of Earth Sciences

☒Environmental Systems and Global Change

☒Chemistry for Natural Sciences (Methods course)

☒Geochemistry of Environmental Systems</td><td>

Co-requisites

☒ none</td><td>

Knowledge, Abilities, or Skills

none beyond formal pre-requisites</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• lectures (37.5 hours)
• tutorials (15.0 hours)
• homework, self-study (135hrs)

Workload

187.5 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation
Please review the content of the ESSMER CHOICE and CORE modules:
• Fundamentals of Earth Sciences
• Environmental Systems and Global Change
• Geochemistry of Environmental Systems</td></tr>
<tr><td colspan="5">Content and Educational Aims

This module provides an introduction to the field of natural resources (i.e. environmental and mineral resources, the latter with special emphasis on resources of critical high-technology metals for enabling technologies, such as rare earth elements, gallium, or lithium), to the processes that affect the environmental impact of resource exploitation and on the recognition and appreciation of environmental resources such as soil and freshwater as essential and hence precious natural resources. The risks and hazards related to the exploitation of both environmental and mineral resources will be addressed and will be discussed in relation to other natural risks such as earthquakes, volcanic eruptions, droughts and floods.</td></tr>
</table>

Intended Learning Outcomes By the end of this module, students will be able to 1. recognize and characterize the major different types of environmental and mineral resources; 2. relate specific geological processes and environmental conditions to the formation and preservation of environmental and mineral resources; 3. appraise and apply the concept of "criticality" in the context of environmental and mineral resource; 4. understand and critically assess the potential role of risks and hazards to sustainable use of environmental and mineral resources.
Indicative Literature • H Robb, L. (2005). Introduction to Ore-Forming Processes. Hoboken: Blackwell. and others (to be defined)
Usability and Relationship to other Modules • This module builds the ESSMER CHOICE modules “Fundamentals of Earth Sciences” and “Environmental Systems and Global Change” and on the CORE module “Geochemistry of Environmental Systems”
Examination Type: Module Examination Assessment: Written examination — Duration: 180 min; Weight: 100 % Scope: All indented learning outcomes of the module Completion: To pass this module, the examination has to be passed with at least 45%

7.9 Finance and Sustainable Management of Natural Risks

Module Name		Module-Code	Level (type)	CP
Finance and Sustainable Management of Natural Risks		CO-469	YEAR 2 (CORE)	5
Module Components				
Number	Name		Type	CP
CO-469-A	Finance and Sustainable Management of Natural Risks		Lecture	5

Module Coordinator	**Program Affiliation**	**Mandatory Status**
Prof. Dr. Andrea Koschinsky, Prof. Dr. Vikram Unnithan	• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)	Mandatory for ESSMER

Entry Requirements			**Frequency**	**Forms of Learning and Teaching**
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring/Fall)	Lecture (35 hours) Private study (90 hours)
☒ none	☒ none		**Duration** 1 semester	**Workload** 125 hours

Recommendations for Preparation

Basic concepts of finance and statistics.

Content and Educational Aims

This module aims to provide a general overview of the different impacts of natural risks. Furthermore, it provides students with a set of techniques to deal with their effects (financing, risk transfer, risk mitigation). Through the application of disaster risk financing and management concepts and instruments, students will be able to combine different tools for a comprehensive assessment of the efficacy and effectiveness of alternative management strategies.

More in detail, the following concepts will be presented during the course:

- Introduction to hazard and risk. Definition of exposure, vulnerability, loss;
- Presentation of regulatory frameworks for environmental risk assessment and management related to natural disasters;
- Approaches and methodologies (ex-ante risk assessment, data requirements, high risk correlation analysis, catastrophe modelling, insurance and disaster risk financing) for environmental risk assessment
- Management of issues related to natural disaster to assess their effects on economies and societies (long-/short-run, direct/indirect);
- Decision Support Systems for evaluation and management of environmental impacts of natural disasters, accounting for the role of the complexity and systemic features of natural risks on socio-economic dimensions;
- Assessment and management tools applied to case studies.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. know the basic linguistic terminology in the field of natural disasters risk management;
2. knowing how to formulate and argue simple hypotheses, also developing a critical approach to the evaluation of alternative scenarios in natural disasters risk management;
3. understand which the geographical, demographic and socio-economic characteristics are impacting on the level of risk of a certain area;
4. understand and analyze disaster risk financing and management solutions;
5. identify and evaluate ex-ante and post-disaster funding interventions.

Indicative Literature

- Mitchell-Wallace K., Jones M., Hillier J., Foote M., Natural Catastrophe Risk Management and Modelling: A Practitioner's Guide, Editore: Wiley, Anno edizione: 2017, ISBN: 978-1-118-90604-0.
- World Bank, Financial Protection Against Natural Disasters. An Operational Framework for Disaster Risk Financing and Insurance, Editore: World Bank, Anno edizione: 2014.
- Grossi P., Kunreuther H., Catastrophe Modeling: A New Approach to Managing Risk, Editore: Springer, Anno edizione: 2005, ISBN: 978-0-387-23082-5.
- Romieu E.,Welle T., Schneiderbauer S., Pelling M., Vinchon C., 2010. Vulnerability assessment within climate change and natural hazard contexts: revealing gaps and synergies through coastal applications. Sustainability Science:159–170.
- Parry M, Carter T, 1998. Climate Impact and Adaptation assessment: the IPCC Method. Earthscan.
- Willows, R.I., and R.K. Connell (eds.) 2003. Climate adaptation: Risk, uncertainty and decision-making. UKCIP Technical Report. UKCIP. Oxford, UK.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination

Duration: 120 min
Weight: 100 %

Scope: All indented learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

7.10 Economics of Environmental Resources

Module Name	**Module Code**	**Level (type)**	**CP**
Economics of Environmental Resources	CO-470	YEAR 2 (CORE)	5

Module Components

Number	Name	Type	CP
CO-470-A	Economics of Environmental Resources	Lecture	5

Module Coordinator	**Program Affiliation**	**Mandatory Status**
Prof. Dr. Andrea Koschinsky. Prof. Dr. Vikram Unnithan	• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)	Mandatory for ESSMER

Entry Requirements			**Frequency**	**Forms of Learning and Teaching**
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring/Fall)	• Lecture (35 hours) • Private study (90 hours)
☒ none	☒ none		**Duration** 2 semester	**Workload** 125 hours

Recommendations for Preparation

Basic knowledge of microeconomic models to analyze environmental and resource economic issues.

Content and Educational Aims

This course explores the proper role of government in the regulation of the environment. It will help students to develop the tools to estimate the costs and benefits of environmental regulations.

Furthermore, the course covers economic analysis and methods for environmental accounting, the theory on optimal management and use of renewable and non-renewable natural resources, valuation of the environment, and international environmental problems and agreements.

Furthermore, the course will cover the following topics:

- Economics of sustainable development (including the measurement of sustainable development and the effect of economic growth on the environment);
- Valuation of environmental resources (including cost-benefit analysis);
- Economics of international environmental problems (including the impact of trade and investment liberalization on the environment);
- Economics of climate change (including the analytical controversy among environmental economists).

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. to understand the root causes of environmental problems and to be able to recommend efficient solutions to them;
2. to appreciate why the environmental issues of non-renewable resources (e.g., oil) are very different from the issues of renewable resources (e.g., fishing) and to be able to recommend policies for addressing these issues;
3. to analyze climate change and global warming as an economic problem and to understand the promise but also limitations of what economics can offer to solve this hugely challenging problem;
4. design simple models of the relationship between economic activity and the environment;
5. determine the optimal level of pollution and the optimal use of a natural resource from an economic point of view;
6. understand how various policies, such as taxes, subsidies, and quotas, can be used to realize the optimal solution when markets fail;
7. discuss policies related to exhaustion of non-renewable resources and overutilization of renewable resources, common pool problems and sustainability concepts.

Indicative Literature

- B. C. Field and M. K. Field, Environmental Economics: An Introduction, (8th edition), McGraw-Hill.(2020).
- Kolstad, Charles. Environmental Economics. 2nd ed. Oxford University Press, 2010. ISBN: 9780199732647.
- Stavins, Rober, ed. Economics of the Environment: Selected Readings. 4th ed. W. W. Norton Co., 2000. ISBN: 9780393975239.
- Oates, Wallace, ed. The RFF Reader in Environmental and Resource Management. Resources for the Future, 1999. ISBN: 9780915707966.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination

Duration: 120 min
Weight: 100 %

Scope: All indented learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

7.11 Advanced Field Laboratories

Module Name	**Module Code**	**Level (type)**	**CP**
Advanced Field Laboratories	CO-472	Year 2 (CORE)	7.5

Module Components

Number	Name	Type	CP
CO-472-A	Applying Geoscientific Methods in the Field I: Eifel, GER	Field Camp + Lectures	2.5
CO-472-B	Applying Geoscientific Methods in the Field II: Dingle, IRL	Field Camp + Lectures	5

Module Coordinator	**Program Affiliation**	**Mandatory Status**
Prof. Dr. Michael Bau (Prof. Dr. Vikram Unnithan)	• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)	Mandatory for ESSMER

Entry Requirements

Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills
☒Fundamentals of Earth Sciences ☒Environmental Systems and Global Change ☒Chemistry for Natural Sciences (Methods course) ☒Geochemistry of Environmental Systems	☒ Natural Resources and Hazards	• none beyond formal pre-requisites

Frequency	**Forms of Learning and Teaching**
Annually (Spring)	• Field Lab (4 days and 12 days, resp.) • Lectures (4.5 hours)

Duration	**Workload**
16 days (in April & June, resp)	187.5 hours

Recommendations for Preparation
Please review the content of the ESSMER CHOICE and CORE modules:

- Fundamentals of Earth Sciences
- Environmental Systems and Global Change
- Geochemistry of Environmental Systems

Content and Educational Aims

This module consists of two components, both of which focus on the application of methods and techniques used in resource and environmental geology, geochemistry, geophysics and oceanography. While the first module component (I) introduces the basic geoscientific methods and techniques used in the real-life environment, the extended field laboratory (II) builds upon and expands and complements component I. Students will be made familiar with geological features at various scales and with techniques applied in geological, geochemical, geophysical and oceanographic field work. The module focuses on geological sequences that illustrate the chemical evolution of and the interconnections within the Earth's lithosphere, hydrosphere and atmosphere. A mapping project complements the FieldCamp.

Intended Learning Outcomes

By the end of this module, students will be able to

1. review, research and discuss relevant literature on the field topic;
2. apply concepts, methods and analyses to real world problems including anthropogenic impact;
3. perform and actively contribute to geological and oceanographic field studies;
4. prepare a scientific report using relevant terminology and illustrations;
5. demonstrate the ability to work individually but also as part of a group in a field situation.

Indicative Literature

R.R. Compton (2016). Geology in the Field. Earthspun Books.

Usability and Relationship to other Modules

• This module builds the ESSMER CHOICE modules "Fundamentals of Earth Sciences" and "Environmental Systems and Global Change" and on the CORE modules "Geochemistry of Environmental Systems" and "Natural Resources and risks"

Examination Type: Module Component Examination

Module Component 1: Field Camp + Lectures 1

Assessment Type: Written Report — Length: minimum 5 pages

Weight: 25%

Scope: Intended learning outcomes of the module

Module Component 2: Field Camp + Lectures 2

Assessment Type: Written Report — Length: minimum 15 pages

Weight: 75%

Scope: Intended learning outcomes of the module

Completion: To pass this module, the written report of each module component has to be passed with at least 45%. Please note that there is a mandatory attendance for the Labs.

7.12 Digital Geosciences

Module Name	Module Code	Level (type)	CP
Digital Geosciences	CA-S-ESSMER-801	Year 3 (Specialization)	5

Module Components

Number	Name	Type	CP
CA-ESSMER-801	Digital Geosciences	Lecture	5

Module Coordinator	Program Affiliation	Mandatory Status
Prof. Dr. Joachim Vogt	• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)	Mandator elective for ESSMER

Entry Requirements

Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills
Physics of Planet Earth	☒ none	

Frequency	Forms of Learning and Teaching
Annually (Fall)	•Lecture (35 hours) •Private study (90 hours)

Duration	Workload
1 semester	125 hours

Recommendations for Preparation

Content and Educational Aims

This module is concerned with digital aspects of Earth Sciences such as processing and analysis of geophysical data, remote sensing applications, and computational modeling of environmental systems. Starting with a general introduction to datasets, models, and tools in Earth Sciences (ES), students learn to find, access, and display ES data and models of different types and formats, and to perform basic processing and visualization operations. In the remote sensing part of the module, students are introduced to space-borne observations of the surface, the oceans, and the atmosphere. The module is concluded with a discussion of computational modeling approaches in the Earth Sciences.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. identify and select digital tools, data repositories, and computational models to answer topical questions in the Earth sciences (ES);
2. perform basic processing and analysis of ES datasets and models;
3. distinguish and explain different measurement principles in remote-sensing and in-situ instrumentation;
4. access, process, and display satellite observations of the Earth's surface, oceans, and atmosphere;
5. analyze and interpret satellite observations of the Earth's surface, oceans, and atmosphere;
6. differentiate and explain computational modeling approaches in ES.

Indicative Literature

- J. B. Campbell: Introduction to Remote Sensing, 5New York: The Guilford Press.
- Jake VanderPlas: Python Data Science Handbook. Newton: O'Reilly.
- K. Tempfli, N. Kerle, G. C. Huurneman, L. L. F. Janssen (eds.): Principles of Remote Sensing (free PDF), International Institute for Geo-Information Science & EO (ITC), Enschede, 2009.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment: Term Paper

Length: 15 pages
Weight: 100 %

Scope: All indented learning outcomes of the module

Completion: To pass this module, the grade for the written report has to be at least 45%

7.13 Sustainability and Policy Evaluation

Module Name	Module Code	Level (type)	CP
Sustainability and Policy Evaluation	CA-S-ESSMER-802	Year 3 (Specialization)	5

Module Components

Number	Name	Type	CP
CA-ESSMER-802	Sustainability and Policy Evaluation	Lecture	5

Module Coordinator	Program Affiliation	Mandatory Status
Prof. Dr. Andrea Koschinsky, Prof. Dr. Vikram Unnithan	• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)	Mandatory elective for ESSMER

Entry Requirements			Frequency	Forms of Learning and Teaching
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring/Fall)	• Lecture (35 hours) • Private study (90 hours)
☒ none	☒ none		**Duration**	**Workload**
			1 semester	125 hours

Recommendations for Preparation

Basic knowledge of quantitative methods for social sciences. Furthermore, the course assumes students to have already had some familiarity with the basic concepts and terminology of public policy and administration.

Content and Educational Aims

The course is designed to give students a comprehensive introduction to theories, approaches, and methods for public policy analysis. The course examines how politics and institutions shape public policy, the processes of public policy change, and the challenges of public sector management.

Furthermore, students are provided with a set of quantitative tools used for data analysis and applied empirical research, focusing on the estimation of causal relationships between policy interventions and the observed outcome.

In particular, the course will introduce the following econometric techniques, particularly suitable for policy evaluation:

- Natural experiments;
- Randomized controlled trials;
- Observational Data and Instrumental Variable;
- Regression discontinuity designs;
- Exploiting variation over time: Panel, difference-in-differences, and synthetic control methods.

Intended Learning Outcomes

Upon completion of this module, students will be able to:

1. Understand fundamental theories, approaches and methods for public policy analysis;
2. Evaluate how and why public policies emerge, and the processes involved in policy making;
3. Understand how policy impact is evaluated at local and international levels;
4. Analyse the effectiveness of policy reforms that aim to improve government efficiency and representation, accelerate transitions to sustainability, and govern rapidly emerging technologies using real-world examples;
5. Recognize interesting research questions associated with the impact of policy intervention;
6. Reproduce empirical analyses choosing the most appropriate quantitative econometric technique, motivating the choice.

Indicative Literature

- Weimer, David L., and Aidan R. Vining. 2017. Policy Analysis: Concepts and Practice. 6th edition. Routledge.
- Kingdon, John. 2010. Agendas, Alternatives, and Public Policy. 2nd edition. Pearson.
- Cairney, Paul. 2011. Understanding Public Policy: Theories and Issues. MacMillan.
- J. ANGRIST, J.S. PISCHKE, Mastering Metrics, Princeton University Press, 2014.
- J.H. STOCK, M.W. WATSON, Introduction to Econometrics, Pearson, 2015.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination

Duration: 120 min
Weight: 100 %

Scope: All indented learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

7.14 Current Topics in ESSMER

<table>
<tr><td colspan="3">Module Name
Current Topics in ESSMER</td><td>Module Code
CA-S-EES-804</td><td>Level (type)
Year 3 (Specialization)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CA-EES-804</td><td colspan="3">Current Topics in ESSMER</td><td>Seminar</td><td>5</td></tr>
<tr><td>Module Coordinator
Prof. Dr. Vikram Unnithan</td><td colspan="3">Program Affiliation
• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)</td><td colspan="2">Mandatory Status
Mandatory elective for ESSMER</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements
Pre-requisites: ☒ Fundamentals of Earth Sciences, Environmental Systems and Global Change, and two ESSMER CORE modules
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: • None beyond formal pre-requisites</td><td>Frequency
Annually (Fall)</td><td colspan="2">Forms of Learning and Teaching
• Lectures and seminars (35 hours)
• Private study (90 hours)</td></tr>
<tr><td>Duration
1 semester</td><td colspan="2">Workload
125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
Review all previous ESSMER modules.</td></tr>
<tr><td colspan="6">Content and Educational Aims
In this module, topics currently (controversially) discussed in ESSMER will be presented, discussed, and analyzed. The underlying scientific background will be explained to allow students to understand the controversy and/or importance and relevance of the debated issues for the ESSMER community. The students will also be made familiar with important unsolved problems, key current issues, and researchers in the field, allowing them to better critically read, and evaluate high-impact scientific papers and presentations.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes
By the end of this module, students will be able to
1. critically assess scientific literature on a wide range of topical research in ESSMER;
2. familiarize themselves with current much-debated topics in selected ESSMER disciplines and subject areas;
3. summarize and describe topical research questions in selected ESSMER disciplines and subject areas;
4. synthesize a body of knowledge on a given ESSMER subject;
5. participate in scientific discussions on topical and possibly controversial ESSMER subjects.</td></tr>
</table>

Indicative Literature Not specified- topical literature, varies from year to year.
Usability and Relationship to other Modules • CAREER module of the EES program, depending on the topic, it draws on knowledge and skills acquired in all prior modules.
Examination Type: Module Examination Assessment Type: Term paper Length: 20 pages Weight: 100% Scope: All intended learning outcomes of the module Completion: To pass this module, the term paper has to be passed with at least 45%.

7.15 Advanced Environmental Science

<table>
<tr><td colspan="2">Module Name
Advanced Environmental Science</td><td>Module Code
CA-S-ESSMER-803</td><td>Level (type)
Year 3
Specialization</td><td>CP
5.0</td></tr>
<tr><td colspan="5">Module Components</td></tr>
<tr><td>Number</td><td colspan="2">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CA-ESSMER-803-A</td><td colspan="2">Advanced Environmental Science</td><td>Lecture</td><td>2.5</td></tr>
<tr><td>CA-ESSMER-803-B</td><td colspan="2">Advanced Environmental Science Lab</td><td>Lab</td><td>2.5</td></tr>
<tr><td>Module Coordinator
Prof. Dr. Vikram Unnithan, Prof. Dr. Michael Bau</td><td colspan="2">Program Affiliation
• Earth Sciences and Sustainable Management of Environmental Resources (ESSMER)</td><td colspan="2">Mandatory Status
Mandatory elective for ESSMER</td></tr>
<tr><td colspan="2" rowspan="2">Entry Requirements
Pre-requisites: ☒Fundamentals of Earth Sciences; Advanced field lab
Co-requisites: ☒ none
Knowledge, Abilities, or Skills</td><td>Frequency
Annually (Spring)</td><td colspan="2">Forms of Learning and Teaching
• Lectures (17.5 hours)
• Lab (40 hours)
• Self-Study (67.5 hours)</td></tr>
<tr><td>Duration
1 Semester</td><td colspan="2">Workload
125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation</td></tr>
</table>

Content and Educational Aims

This module engages students to further their understanding of Environmental Sciences by exploring the largest and least explored habitat on our planet: the ocean. They are introduced to marine geophysical exploration methods, major oceanographic processes, and the effects of global climate change on conditions that sustain marine life, ecosystems, and humans. Students are challenged to think about the interconnectedness of Earth's systems and how altering the atmosphere, biosphere, and geosphere impacts oceans (hydrosphere). The goal is for students to appreciate the complexity of ocean processes and the need for systems thinking to comprehend such complex interactions both in space and time. Some key concepts from systems thinking such as positive and negative feedback loops, emergence, and resilience with also be discussed in the context of oceans. An emphasis on practical field and lab work, dealing with real-world data is an important theme for this module and functions as a capstone unit allowing students to employ interdisciplinary knowledge to discuss management decisions or evaluate strategies for environmental protection or climate change mitigation. Overall, this module will make students aware of our dependence on and responsibility for the preservation and protection of the largest habitat on Earth - the oceans

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. understand and apply fundamental practical skills and concepts in biological, geological, geochemical, and environmental fields of ocean research
2. apply basic marine data acquisition, analysis and interpretation techniques
3. apply chemical and physical concepts and methods to real-world problems in marine environmental sciences.

Indicative Literature

Marine and Coastal Resource Management: Principles and Practice by David R. Green, Jeffrey L. Payne (2017); Essentials of Oceanography by Trujillo, Thurman (2019)

Usability and Relationship to other Modules

ESSMER Majors

Examination Type: Module Component Examination

Module Component 1: Advanced Environmental Science
Assessment Type: Written examination — Duration/length: 60 min
Weight: 50%

Scope: All indented learning outcomes of the module

Module Component 2: Advanced Environmental Lab
Assessment Type: Practical assessment (Lab Report)
Weight: 50%

Scope: All indented learning outcomes of the module

Completion: To pass this module, the examination of each module component has to be passed with at least 45%, and attendance for the Lab part is mandatory.

7.16 Internship / Startup and Career Skills

<table>
<tr><td colspan="3">Module Name
Internship / Startup and Career Skills</td><td>Module Code
CA-INT-900</td><td>Level (type)
Year 3
(CAREER)</td><td>CP
15</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CA-INT-900-0</td><td colspan="3">Internship</td><td>Internship</td><td>15</td></tr>
<tr><td>Module Coordinator

Sinah Vogel & Dr. Tanja Woebs (CSC Organization); SPC / Faculty Startup Coordinator (Academic responsibility)</td><td colspan="3">Program Affiliation

• CAREER module for undergraduate study programs</td><td colspan="2">Mandatory Status

Mandatory for all undergraduate study programs except IEM</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites: ☒ at least 15 CP from CORE modules in the major
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• Information provided on CSC pages (see below)
• Major specific knowledge and skills</td><td>Frequency

Annually
(Spring/Fall)</td><td colspan="2">Forms of Learning and Teaching

• Internship/Start-up
• Internship event
• Seminars, info-sessions, workshops and career events
• Self-study, readings, online tutorials</td></tr>
<tr><td>Duration
1 semester</td><td colspan="2">Workload

375 Hours consisting of:
Internship (308 hours)
Workshops (33 hours)
Internship Event (2 hours)
Self-study (32 hours)</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Please see the section “Knowledge Center” at JobTeaser Career Center for information on Career Skills seminar and workshop offers and for online tutorials on the job market preparation and the application process. For more information, please see https://constructor.university/student-life/career-services
Participating in the internship events of earlier classes</td></tr>
<tr><td colspan="6">Content and Educational Aims

The aims of the internship module are reflection, application, orientation, and development: for students to reflect on their interests, knowledge, skills, their role in society, the relevance of their major subject to society, to apply these skills and this knowledge in real life whilst getting practical experience, to find a professional orientation, and to develop their personality and in their career. This module supports the programs’ aims of preparing students for gainful, qualified employment and the development of their personality.

The full-time internship must be related to the students’ major area of study and extends lasts a minimum of two consecutive months, normally scheduled just before the 5th semester, with the internship event and submission of the internship report in the 5th semester. Upon approval by the SPC and CSC, the internship may take place at other</td></tr>
</table>

times, such as before teaching starts in the 3rd semester or after teaching finishes in the 6th semester. The Study Program Coordinator or their faculty delegate approves the intended internship a priori by reviewing the tasks in either the Internship Contract or Internship Confirmation from the respective internship institution or company. Further regulations as set out in the Policies for Bachelor Studies apply.

Students will be gradually prepared for the internship in semesters 1 to 4 through a series of mandatory information sessions, seminars, and career events.
The purpose of the Career Services Information Sessions is to provide all students with basic facts about the job market in general, and especially in Germany and the EU, and services provided by the Student Career Support.
In the Career Skills Seminars, students will learn how to engage in the internship/job search, how to create a competitive application (CV, Cover Letter, etc.), and how to successfully conduct themselves at job interviews and/or assessment centers. In addition to these mandatory sections, students can customize their skill set regarding application challenges and their intended career path in elective seminars.
Finally, during the Career Events organized by the Career Service Center (e.g. the annual Constructor Career Fair and single employer events on and off campus), students will have the opportunity to apply their acquired job market skills in an actual internship/job search situation and to gain their desired internship in a high-quality environment and with excellent employers.

As an alternative to the full-time internship, students can apply for the StartUp Option. Following the same schedule as the full-time internship, the StartUp Option allows students who are particularly interested in founding their own company to focus on the development of their business plan over a period of two consecutive months. Participation in the StartUp Option depends on a successful presentation of the student's initial StartUp idea. This presentation will be held at the beginning of the 4th semester. A jury of faculty members will judge the student's potential to realize their idea and approve the participation of the students. The StartUp Option is supervised by the Faculty StartUp Coordinator. At the end of StartUp Option, students submit their business plan. Further regulations as outlined in the Policies for Bachelor Studies apply.

The concluding Internship Event will be conducted within each study program (or a cluster of related study programs) and will formally conclude the module by providing students the opportunity to present on their internships and reflect on the lessons learned within their major area of study. The purpose of this event is not only to self-reflect on the whole internship process, but also to create a professional network within the academic community, especially by entering the Alumni Network after graduation. It is recommended that all three classes (years) of the same major are present at this event to enable networking between older and younger students and to create an educational environment for younger students to observe the "lessons learned" from the diverse internships of their elder fellow students.

Intended Learning Outcomes

By the end of this module, students will be able to

1. describe the scope and the functions of the employment market and personal career development;
2. apply professional, personal, and career-related skills for the modern labor market, including self-organization, initiative and responsibility, communication, intercultural sensitivity, team and leadership skills, etc.;
3. independently manage their own career orientation processes by identifying personal interests, selecting appropriate internship locations or start-up opportunities, conducting interviews, succeeding at pitches or assessment centers, negotiating related employment, managing their funding or support conditions (such as salary, contract, funding, supplies, work space, etc.);
4. apply specialist skills and knowledge acquired during their studies to solve problems in a professional environment and reflect on their relevance in employment and society;
5. justify professional decisions based on theoretical knowledge and academic methods;
6. reflect on their professional conduct in the context of the expectations of and consequences for employers and their society;
7. reflect on and set their own targets for the further development of their knowledge, skills, interests, and values;
8. establish and expand their contacts with potential employers or business partners, and possibly other students and alumni, to build their own professional network to create employment opportunities in the future;
9. discuss observations and reflections in a professional network.

Indicative Literature

Not specified

Usability and Relationship to other Modules This module applies skills and knowledge acquired in previous modules to a professional environment and provides an opportunity to reflect on their relevance in employment and society. It may lead to thesis topics.
Examination Type: Module Examination Assessment Type: Internship Report or Business Plan and Reflection Length: approx. 3.500 words Scope: All intended learning outcomes Weight: 100%

7.17 Bachelor Thesis and Seminar

Module Name	Module Code	Level (type)	CP
Bachelor Thesis and Seminar	CA-EES-800	Year 3 (CAREER)	15

Module Components

Number	Name	Type	CP
CA-EES-800-T	Bachelor Thesis ESSMER	Thesis	12
CA-EES-800-S	Thesis Seminar ESSMER	Seminar	3

Module Coordinator	Program Affiliation	Mandatory Status
Study Program Chair	• All undergraduate programs	Mandatory for all undergraduate programs

Entry Requirements			Frequency	Forms of Learning and Teaching
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	annually	• Self-study/lab work (350 hours) • Seminars (25 hours)
☒ Students must have taken and successfully passed a total of at least 30 CP from advanced modules, and of those, at least 20 CP from advanced modules in the major.	☒ None	• Comprehensive knowledge of the subject and deeper insight into the chosen topic; • ability to plan and undertake work independently; • skills to identify and critically review literature.	**Duration** 14-week lecture period	**Workload** 375 hours

Recommendations for Preparation

- Identify an area or a topic of interest and discuss this with your prospective supervisor in good time.
- Create a research proposal including a research plan to ensure timely submission.
- Ensure you possess all required technical research skills or are able to acquire them on time.
- Review the University's Code of Academic Integrity and Guidelines to Ensure Good Academic Practice.

Content and Educational Aims

This module is a mandatory graduation requirement for all undergraduate students to demonstrate their ability to deal with a problem from their respective major subject independently by means of academic/scientific methods within a set period. Although supervised, the module requires students to be able to work independently and regularly and set their own goals in exchange for the opportunity to explore a topic that excites and interests them personally and which a faculty member is interested to supervise. Within this module, students apply their acquired knowledge about the major discipline, skills, and methods to conduct research, ranging from the identification of suitable (short-term) research projects, preparatory literature searches, the realization of discipline-specific research, and the documentation, discussion, interpretation and communication of the results.

This module consists of two components, an independent thesis and an accompanying seminar. The thesis component must be supervised by a Constructor University faculty member and requires short-term research work, the results of which must be documented in a comprehensive written thesis including an introduction, a justification of the methods, results, a discussion of the results, and conclusions. The seminar provides students with the opportunity to present, discuss and justify their and other students' approaches, methods and results at various stages of their research to practice these skills to improve their academic writing, receive and reflect on formative feedback, thereby growing personally and professionally.

Intended Learning Outcomes

On completion of this module, students will be able to

1. independently plan and organize advanced learning processes;
2. design and implement appropriate research methods taking full account of the range of alternative techniques and approaches;
3. collect, assess and interpret relevant information;
4. draw scientifically founded conclusions that consider social, scientific and ethical insights;
5. apply their knowledge and understanding to a context of their choice;
6. develop, formulate and advance solutions to problems and arguments in their subject area, and defend these through argument;
7. discuss information, ideas, problems and solutions with specialists and non-specialists.

Usability and Relationship to other Modules

- This module builds on all previous modules of the program. Students apply the knowledge, skills and competencies they acquired and practiced during their studies, including research methods and the ability to acquire additional skills independently as and if required.

Examination Type: Module Component Examinations

Module Component 1: Thesis
Assessment Type: Thesis

Length: approx. 6.000 – 8.000 words (15 – 25 pages), excluding front and back matter.
Weight: 80%

Scope: All intended learning outcomes, mainly 1-6.

Module Component 2: Seminar
Assessment Type: Presentation

Duration: approx. 15 to 30 minutes
Weight: 20%

Scope: The presentation focuses mainly on ILOs 6 and 7, but by nature of these ILOs it also touches on the others.

Completion: To pass this module, both module component examinations have to be passed with at least 45%.

Two separate assessments are justified by the size of this module and the fact that the justification of solutions to problems and arguments (ILO 6) and discussion (ILO 7) should at least have verbal elements. The weights of the types of assessments are commensurate with the sizes of the respective module components.

8 CONSTRUCTOR Track Modules

8.1 Methods

8.1.1 Mathematical Concepts for the Sciences

Module Name	**Module Code**	**Level (type)**	**CP**
Mathematical Concepts for the Sciences	CTMS-MAT-07	Year 1 (Methods)	5

Module Components

Number	Name	Type	CP
CTMS-07	Mathematical Concepts for the Sciences	Lecture	5

Module Coordinator(s)	**Program Affiliation**	**Mandatory Status**
Dr. Keivan Mallahi Karai	• CONSTRUCTOR Track Area	Mandatory for BCCB, CBT, ESSMER and MCCB

Entry Requirements			**Frequency**	**Forms of Learning and Teaching**
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Fall)	• Lectures (35 hours) • Private study (90 hours)
☒ None	☒ None	• none	**Duration**	**Workload**
			1 semester	125 hours

Recommendations for Preparation

Review basic mathematical concepts and tools.

Content and Educational Aims

In this module, students develop and strengthen quantitative problem-solving skills that are important in the natural sciences. Hands-on exercises and group work are integrated in the lectures to maximize feedback between the students and the instructor. The module starts with a review of elementary mathematical concepts such as functions and their graphs, units and dimensions, and series and convergence. Vectors and matrices are introduced using linear equations, and then motivated further in the context of basic analytical geometry. An extended section on calculus proceeds from basic differentiation and integration to the solution of differential equations, always guided by applications in the natural sciences. The module is concluded by a data-oriented introduction to descriptive statistics and basic statistical modeling applied to laboratory measurements and observations of natural systems.

Intended Learning Outcomes

By the end of this module, students will be able to

1. identify important types of quantitative problems in the natural sciences;
2. select and use key solution strategies, methods, and tools;
3. explain and apply linear algebra concepts and techniques;
4. analyze models and observations of natural systems using derivatives and integrals;
5. classify differential equations, find equilibria, and apply standard solution methods;
6. process data by means of descriptive statistics and basic regression techniques.

Indicative Literature

E. N. Bodine, S. Lenhart, and L. J. Gross (2014). Mathematics for the Life Sciences. Princeton: Princeton University Press.

D. Cherney, T. Denton, A. Waldron (2013, June). Linear Algebra. Retrieved from: https://www.math.ucdavis.edu/~linear/.

K.F. Riley, M.P. Hobson, and S.J. Bence (2002). Mathematical methods for physics and engineering, Cambridge: Cambridge University Press.

M. Corral. Vector Calculus (2008). Retrieved from: http://www.mecmath.net/calc3book.pdf.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment type: Written examination

Duration: 120 min
Weight: 100%

Scope: All intended learning outcomes of this module.

Completion: To pass this module, the examination has to be passed with at least 45%.

8.1.2 Applied Statistics with R

<table>
<tr><td colspan="3">Module Name
Applied Statistics with R</td><td>Module Code
CTMS-MET-03</td><td>Level (type)
Year 1 (Methods)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTMS-03</td><td colspan="3">Applied Statistics with R</td><td>Lecture & Lab</td><td>5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Adalbert F.X. Wilhelm</td><td colspan="3">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory for ESSMER, GEM, IEM, ISCP and MDDA
Mandatory elective for IBA and IRPH</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• none</td><td>Frequency

Annually (Spring)</td><td colspan="2">Forms of Learning and Teaching

• Lecture (17.5 hours)
• Lab (17.5 hours)
• Homework and self-study (90 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
Get acquainted with statistical thinking by watching online videos for introductory probability and statistics as well as paying attention whenever arguments are backed up by empirical data.</td></tr>
<tr><td colspan="6">Content and Educational Aims

We live in a world full of data and more and more decisions are taken based on a comprehensive analysis of data. A central method of data analysis is the use of models describing the relationship between a set of predictor variables and a response. This module provides a thorough introduction to quantitative data analysis covering graphical representations, numerical summary statistics, correlation, and regression models. The module also introduces the fundamental concepts of statistical inference. Students learn about the different data types, how to best visualize them and how to draw conclusions from the graphical representations. Students will learn in this module the ideas and techniques of regression models within the generalized linear model framework involving multiple predictors and co-variates. Students will learn how to become an intelligent user of statistical techniques from a prosumers perspective to assess the quality of presented statistical results and to produce high-quality analyses by themselves. By using illustrative examples from economics, engineering, and the natural and social sciences students will gain the relevant background knowledge for their specific major as well as an interdisciplinary glimpse of other research fields. The general objective of the module is to enable students to become skilled statistical modelers who are well versed in the various assumptions, limitations, and controversies of statistical models and their application. Regular exercises and practical sessions will corroborate the students' proficiency with the statistical software R.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students should be able to:
1. apply basic techniques in statistical modeling and quantitative research methods
2. describe fundamental statistical concepts, procedures, their assumptions and statistical fallacies
3. explain the potential of using quantitative methods in all fields of applications;
4. express informed skepticism of the limitations of statistical reasoning;
5. interpret statistical modeling results in scientific publications;</td></tr>
</table>

6. perform basic and intermediate-level statistical analyses of data, using R.

Indicative Literature

- Michael J. Crawley (2013). The R Book, Second Edition. Hoboken: John Wiley & Sons.
- Peter Daalgard (2008). Introductory Statistics with R. Berlin: Springer.
- John Maindonald, W. John Braun (2010). Data Analysis and Graphics Using R – an Example-Based Approach, Third Edition, Cambridge Series. In Statistical and Probabilistic Mathematics. Cambridge: Cambridge University Press.
- Christopher Gandrud (2015). Reproducible Research with R and RStudio, Second Edition. The R Series, Chapman & Hall/CRC Press.
- Randall E. Schumacker (2014). Learning Statistics Using R. Thousand Oaks: Sage.

Charles Wheelan (2013). Naked Statistics: Stripping Dread from The Data. New York: W.W. Norton & Company.

Usability and Relationship to other Modules

- Quantitative analytical skills are used and needed in many modules of all study programs.
- This module introduces students to R in preparation for the 2nd year mandatory method module on econometrics

Examination Type: Module Examination

Assessment Type: Written examination Duration: 120 min
Weight: 100%

During the examination students use software "R" as an auxiliary resource approved by the Instructor of Record.

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

8.1.3 Chemistry for Natural Sciences

<table>
<tr><td colspan="2">Module Name
Chemistry for Natural Sciences</td><td>Module Code
CTMS-SCI-15</td><td>Level (type)
Year 2</td><td>CP
5.0</td></tr>
<tr><td colspan="5">Module Components</td></tr>
<tr><td>Number</td><td colspan="2">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTMS-15-A</td><td colspan="2">Chemistry for Natural Sciences</td><td>Lectures</td><td>2.5</td></tr>
<tr><td>CTMS-15-B</td><td colspan="2">Chemistry for Natural Sciences Lab</td><td>Lab</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Andrea Koschinsky</td><td colspan="2">Program Affiliation

• CONSTRUCTOR Track area</td><td colspan="2">Mandatory Status

Mandatory for ESSMER</td></tr>
<tr><td colspan="2" rowspan="2">Entry Requirements

Pre-requisites
☒ none

Co-requisites
☒ none

Knowledge, Abilities, or Skills
Methods track</td><td>Frequency

Annually (Fall)</td><td colspan="2">Forms of Learning and Teaching

• Lectures (17.5 hours)
• Lab sessions (17.5 hours)
• Private study (90 hours)</td></tr>
<tr><td>Duration

1 Semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation</td></tr>
<tr><td colspan="5">Content and Educational Aims

This module is comprised of general, inorganic and organic chemistry at an introductory level, with a focus on inorganic chemistry. The module objectives are to provide a basic understanding of the fundamental principles and theories of chemistry. This includes an introduction to matter, molecules, atomic theory, stoichiometry, intermolecular forces and solids, as well as chemical thermodynamics and kinetics, redox chemistry, electrochemistry and equilibrium chemistry. The organic chemistry component incorporates a systematic examination of the physical properties and reactivity of simple organic compounds. Subsequently, these theories and principles are applied to chemical concepts in natural systems. It will demonstrate how chemical reactions and equilibria interact with changes in the environment. Furthermore, the module introduces compartments, components, and chemical processes including interactions with the biosphere in natural systems.

The module also introduces students to basic safety requirements and techniques used in a chemistry laboratory as well as sampling methods of natural materials to be analyzed. The material covered in the lecture is reinforced in the laboratory practical sessions.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes
Upon completion of this module, students will be able to

1. describe the basis of atomic theory and explain the structure of an atom, ions and electronic configuration;
2. describe periodic trends for groups and periods;
3. calculate molecules, molar mass, moles and molarity;
4. identify the types of chemical reactions in natural systems;
5. relate bonding and intermolecular forces to the structure of solids and molecules;</td></tr>
</table>

6. apply the principles of pH, acids and bases as well as the action of buffers;
7. balance chemical reactions;
8. explain and calculate equilibrium constants for different types of reactions;
9. name simple organic compounds and identify common functional groups;
10. describe the chemical reactions and physical properties of hydrocarbons;
11. apply their knowledge of common organic functional groups to predict simple reaction products.
12. participate effectively in group work and problem solving through participation in lab practical sessions;
13. work safely in the laboratory under supervision;
14. carry out simple sample preparation techniques including grinding, weighing, drying, filtration, and performing dilutions;
15. determine pH, redox potential and conductivity in water samples;
16. analyze key components such as nutrients in natural water samples using photometry and other simple analytical tools;
17. identify the aims of a laboratory experiment, record procedures and results accurately, interpret them, and draw conclusions;
18. critically assess accuracy and errors in lab techniques.

Indicative Literature

- Schwedt, G., & Haderlie, B. (1997). The essential guide to analytical chemistry. New York: Wiley.
- Timberlake, K. C. (2016). Basic chemistry. Global Edition, 5th edition: Pearson Education.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment type: Written examination

Duration: 120 min
Weight: 100%

Module achievement: participation in the lab sessions is a prerequisite ("Studienbegleitleistung") for being admitted to the exam

Scope: All intended learning outcomes for the module

Completion: To pass this module, the examination has to be passed with at least 45%

8.1.4 Econometrics

<table>
<tr><td colspan="2">Module Name

Econometrics</td><td>Module Code

CTMS-MET-05</td><td>Level (type)

Year 2 (Methods)</td><td>CP

5</td></tr>
<tr><td colspan="5">Module Components</td></tr>
<tr><td>Number</td><td colspan="2">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTMS-05</td><td colspan="2">Econometrics</td><td>Seminar</td><td>5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Colin Vance</td><td colspan="2">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory for ESSMER and GEM Mandatory elective for IBA and IEM</td></tr>
<tr><td colspan="2" rowspan="2">Entry Requirements

Pre-requisites

☒ Applied statistics with R

Co-requisites

☒ None

Knowledge, Abilities, or Skills
• Knowledge of the ordinary least-squares regression model.
• Ability to estimate regression models using R software.
• Skills in conducting statistical inference tests.</td><td>Frequency

Annually

(Spring)</td><td colspan="2">Forms of Learning and Teaching

• Seminar (35 hours)
• Private study (90 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

An accessible overview of regression analysis can be found in Sykes, A.O. (1993). An Introduction to Regression Analysis. Coase-Sandor Institute for Law & Economics, Univ. of Chicago Working Paper No. 20. https://chicagounbound.uchicago.edu/law_and_economics/51/. Students are also encouraged to read: Ziliak, Stephen T. (2008). Retrospectives: Guinnessometrics: The Economic Foundation of “Student’s” t. Journal of Economic Perspectives 22(4): 199-216.</td></tr>
</table>

Content and Educational Aims

This module focuses on the application of econometric methods to the analysis of secondary data. Specifically, the goal is to expose students to some of the issues and challenges typically confronted by econometricians when analyzing empirical data in the realms of social science research, business and finance. Emphasis will be placed on the intuition underlying various commonly applied econometric techniques and on the steps needed to implement them. The module expands on the knowledge acquired in statistics and intensifies discussions of multiple regression analysis. The general objective is to become familiar with contemporary methods that are used in econometric and business analyses and to become a critical reader of case studies. In this regard, a clear distinction will be drawn along two dimensions: between questions of statistical significance versus those of economic or social significance; and between correlation and causation. The module takes a practical approach that covers how to estimate econometric models using R software. Sessions will often include computer applications to foster understanding of the discussed topics.

Intended Learning Outcomes

By the end of this module, students will be able to

1. explain the mechanics and assumptions underpinning the Ordinary Least Squares (OLS) regression model;
2. estimate an OLS model on secondary data using R-software;
3. interpret the coefficient estimates from an OLS model with respect to their sign and magnitude;
4. conduct one- and two-sided tests of the statistical significance of coefficients.

Indicative Literature

Abadie, A. & Cattaneo, M.D. (2018). Econometric methods for program evaluation. Annual Review of Economics, 10, 465-503.

Angrist, J.D. & Pischke, J.S. (2014). Mastering'metrics: The path from cause to effect. Princeton University Press.

Kabacoff, R. (2015). R in action: Data analysis and graphics with R. Chapter 8. Manning Publications Co.

Wooldridge, J. M. (2015). Introductory econometrics: A modern approach. 6th edition. Cambridge Learning.

Ziliak, Stephen T. (2008). Guinnessometrics: The economic foundation of “student’s”. Journal of Economic Perspectives 22(4), 199-216.

Usability and Relationship to other Modules

- The module is a mandatory / mandatory elective module of the Methods area that is part of the Constructor Track (Methods and New Skills modules; Language and Humanities modules).
- This module builds on models and topics from the first-year modules “Microeconomics” and “Macroeconomics” and from the second-year modules “Environmental and Resource Economics” and “Development Economics”
- This module introduces students to R in preparation for the 2nd year mandatory method module on econometrics and 3rd year GEM module on advanced econometrics; the statistics skills prepare students for all 2nd and 3rd year GEM modules and the thesis
- This module prepares students in IBA for the analysis of data in the 2nd year modules International Strategic Management and Marketing and the 3rd year module Contemporary Topics in Marketing and the thesis
- Mandatory for a major in GEM.
- Mandatory elective for a major in IBA
- Elective for all other study programs.

Examination Type: Module Examination

Assessment Type: Written examination — Duration: 120 min — Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: To pass this module, the examination has to be passed with at least 45%

8.2 New Skills

8.2.1 Logic (perspective I)

<table>
<tr><td colspan="3">Module Name
Logic (perspective I)</td><td>Module Code
CTNS-NSK-01</td><td>Level (type)
Year 2
(New Skills)</td><td>CP
2.5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTNS-01</td><td colspan="3">Logic (perspective I)</td><td>Lecture (online)</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Jules Coleman</td><td colspan="3">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory elective for all UG students (one perspective must be chosen)</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills</td><td>Frequency

Annually
(Fall)</td><td colspan="2">Forms of Learning and Teaching

• Online lecture (17.5h)
• Private study (45h)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation</td></tr>
<tr><td colspan="6">Content and Educational Aims</td></tr>
</table>

Suppose a friend asks you to help solve a complicated problem? Where do you begin? Arguably, the first and most difficult task you face is to figure out what the heart of the problem actually is. In doing that you will look for structural similarities between the problem posed and other problems that arise in different fields that others may have addressed successfully. Those similarities may point you to a pathway for resolving the problem you have been asked to solve. But it is not enough to look for structural similarities. Sometimes relying on similarities may even be misleading. Once you've settled tentatively on what you take to be the heart of the matter, you will naturally look for materials, whether evidence or arguments, that you believe is relevant to its potential solution. But the evidence you investigate of course depends on your formulation of the problem, and your formulation of the problem likely depends on the tools you have available – including potential sources of evidence and argumentation. You cannot ignore this interactivity, but you can't allow yourself to be hamstrung entirely by it. But there is more. The problem itself may be too big to be manageable all at once, so you will have to explore whether it can be broken into manageable parts and if the information you have bears on all or only some of those parts. And later you will face the problem of whether the solutions to the particular sub problems can be put together coherently to solve the entire problem taken as a whole.

What you are doing is what we call engaging in computational thinking. There are several elements of computational thinking illustrated above. These include: Decomposition (breaking the larger problem down into smaller ones); Pattern recognition (identifying structural similarities); Abstraction (ignoring irrelevant particulars of the problem): and Creating Algorithms), problem-solving formulas.

But even more basic to what you are doing is the process of drawing inferences from the material you have. After all, how else are you going to create a problem-solving formula, if you draw incorrect inferences about what information has shown and what, if anything follows logically from it. What you must do is apply the rules of logic to the information to draw inferences that are warranted.

We distinguish between informal and formal systems of logic, both of which are designed to indicate fallacies as well as warranted inferences. If I argue for a conclusion by appealing to my physical ability to coerce you, I prove nothing about the truth of what I claim. If anything, by doing so I display my lack of confidence in my argument. Or if the best I can do is berate you for your skepticism, I have done little more than offer an ad hominem instead of an argument. Our focus will be on formal systems of logic, since they are at the heart of both scientific argumentation and computer developed algorithms. There are in fact many different kinds of logic and all figure to varying degrees in scientific inquiry. There are inductive types of logic, which purport to formalize the relationship between premises that if true offer evidence on behalf of a conclusion and the conclusion and are represented as claims about the extent to which the conclusion is confirmed by the premises. There are deductive types of logic, which introduce a different relationship between premise and conclusion. These variations of logic consist in rules that if followed entail that if the premises are true then the conclusion too must be true.

There are also modal types of logic which are applied specifically to the concepts of necessity and possibility, and thus to the relationship among sentences that include either or both those terms. And there is also what are called deontic logic, a modification of logic that purport to show that there are rules of inference that allow us to infer what we ought to do from facts about the circumstances in which we find ourselves. In the natural and social sciences most of the emphasis has been placed on inductive logic, whereas in math it is placed on deductive logic, and in modern physics there is an increasing interest in the concepts of possibility and necessity and thus in modal logic. The humanities, especially normative discussions in philosophy and literature are the province of deontic logic.

This module will also take students through the central aspects of computational thinking, as it is related to logic; it will introduce the central concepts in each, their relationship to one another and begin to provide the conceptual apparatus and practical skills for scientific inquiry and research.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to

1. apply the various principles of logic and expand them to computational thinking.
2. understand the way in which logical processes in humans and in computers are similar and different at the same time.
3. apply the basic rules of first-order deductive logic and employ them rules in the context of creating a scientific or social scientific study and argument.
4. employ those rules in the context of creating a scientific or social scientific study and argument.

Indicative Literature

- Frege, Gottlob (1879), Begriffsschrift, eine der arithmetischen nachgebildete Formelsprache des reinen Denkens [Translation: A Formal Language for Pure Thought Modeled on that of Arithmetic],Halle an der Salle: Verlag von Louis Nebert.
- Gödel, Kurt (1986), Russels mathematische Logik. In: Alfred North Whitehead, Bertrand Russell: Principia Mathematica. Vorwort, S. V–XXXIV. Suhrkamp.
- Leeds, Stephen. "George Boolos and Richard Jeffrey. Computability and logic. Cambridge University Press, New York and London1974, x+ 262 pp." The Journal of Symbolic Logic 42.4 (1977): 585-586.
- Kubica, Jeremy. Computational fairy tales. Jeremy Kubica, 2012.
- McCarthy, Timothy. "Richard Jeffrey. Formal logic: Its scope and limits. of XXXVIII 646. McGraw-Hill Book Company, New York etc. 1981, xvi+ 198 pp." The Journal of Symbolic Logic 49.4 (1984): 1408-1409.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written Examination — Duration: 60 min, Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

8.2.3 Logic (perspective II)

Module Name	Module Code	Level (type)	CP
Logic (perspective II)	CTNS-NSK-02	Year 2 (New Skills)	2.5

Module Components

Number	Name	Type	CP
CTNS-02	Logic (perspective II)	Lecture (online)	2.5

Module Coordinator	Program Affiliation	Mandatory Status
NN	• CONSTRUCTOR Track Area	Mandatory elective for all UG students (one perspective must be chosen)

Entry Requirements			Frequency	Forms of Learning and Teaching
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Fall)	• Online lecture (17.5h) • Private study (45h)
☒ none	☒ none		**Duration**	**Workload**
			1 semester	62.5 hours

Recommendations for Preparation

Content and Educational Aims

The focus of this module is on formal systems of logic, since they are at the heart of both scientific argumentation and computer developed algorithms. There are in fact many kinds of logic and all figure to varying degrees in scientific inquiry. There are inductive types of logic, which purport to formalize the relationship between premises that if true offer evidence on behalf of a conclusion and the conclusion and are represented as claims about the extent to which the conclusion is confirmed by the premises. There are deductive types of logic, which introduce a different relationship between premise and conclusion. These variations of logic consist in rules that if followed entail that if the premises are true then the conclusion too must be true.

This module introduces logics that go beyond traditional deductive propositional logic and predicate logic and as such it is aimed at students who are already familiar with basics of traditional formal logic. The aim of the module is to provide an overview of alternative logics and to develop a sensitivity that there are many different logics that can provide effective tools for solving problems in specific application domains.

The module first reviews the principles of a traditional logic and then introduces many-valued logics that distinguish more than two truth values, for example true, false, and unknown. Fuzzy logic extends traditional logic by replacing truth values with real numbers in the range 0 to 1 that are expressing how strong the believe into a proposition is. Modal logics introduce modal operators expressing whether a proposition is necessary or possible. Temporal logics deal with propositions that are qualified by time. Once can view temporal logics as a form of modal logics where propositions are qualified by time constraints. Interval temporal logic provides a way to reason about time intervals in which propositions are true.

The module will also investigate the application of logic frameworks to specific classes of problems. For example, a special subset of predicate logic, based on so-called Horn clauses, forms the basis of logic programming languages such as Prolog. Description logics, which are usually decidable logics, are used to model relationships and they have applications in the semantic web, which enables search engines to reason about resources present on the Internet.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to

1. apply the various principles of logic
2. explain practical relevance of non-standard logic
3. describe how many-valued logic extends basic predicate logic

4. apply basic rules of fuzzy logic to calculate partial truth values 5. sketch basic rules of temporal logic 6. implement predicates in a logic programming language 7. prove some simple non-standard logic theorems
Indicative Literature • Bergmann, Merry. “An Introduction to Many-Valued and Fuzzy Logic: Semantics, Algebras, and Derivation Systems”, Cambridge University Press, April 2008. • Sterling, Leon S., Ehud Y. Shapiro, Ehud Y. "The Art of Prolog", 2nd edition, MIT Press, March 1994. • Fisher, Michael. “An Introduction to Practical Formal Methods Using Temporal Logic”, Wiley, Juli 2011. • Baader, Franz. "The Description Logic Handbook: Theory Implementation and Applications", Cambridge University Press, 2nd edition, May 2010.
Usability and Relationship to other Modules
Examination Type: Module Examination Assessment Type: Written Examination — Duration: 60 min, Weight: 100% Scope: All intended learning outcomes of the module. Completion: To pass this module, the examination has to be passed with at least 45%

8.2.4 Causation and Correlation (perspective I)

<table>
<tr><td colspan="2">Module Name
Causation and Correlation (perspective I)</td><td>Module Code
CTNS-NSK-03</td><td>Level (type)
Year 2
(New Skills)</td><td>CP
2.5</td></tr>
<tr><td colspan="5">Module Components</td></tr>
<tr><td>Number</td><td colspan="2">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTNS-03</td><td colspan="2">Causation and Correlation</td><td>Lecture (online)</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Jules Coleman</td><td colspan="2">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory elective for all UG students (one perspective must be chosen)</td></tr>
<tr><td colspan="2" rowspan="2">Entry Requirements

Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills:</td><td>Frequency

Annually (Spring)</td><td colspan="2">Forms of Learning and Teaching

• Online lecture (17.5h)
• Private study (45h)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

62.5 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation</td></tr>
</table>

Content and Educational Aims

In many ways, life is a journey. And also, as in other journeys, our success or failure depends not only on our personal traits and character, our physical and mental health, but also on the accuracy of our map. We need to know what the world we are navigating is actually like, the how, why and the what of what makes it work the way it does. The natural sciences provide the most important tool we have developed to learn how the world works and why it works the way it does. The social sciences provide the most advanced tools we have to learn how we and other human beings, similar in most ways, different in many others, act and react and what makes them do what they do. In order for our maps to be useful, they must be accurate and correctly reflect the way the natural and social worlds work and why they work as they do.

The natural sciences and social sciences are blessed with enormous amounts of data. In this way, history and the present are gifts to us. To understand how and why the world works the way it does requires that we are able to offer an explanation of it. The data supports a number of possible explanations of it. How are we to choose among potential explanations? Explanations, if sound, will enable us to make reliable predictions about what the future will be like, and also to identify many possibilities that may unfold in the future. But there are differences not just in the degree of confidence we have in our predictions, but in whether some of them are necessary future states or whether all of them are merely possibilities? Thus, there are three related activities at the core of scientific inquiry: understanding where we are now and how we got here (historical); knowing what to expect going forward (prediction); and exploring how we can change the paths we are on (creativity).

At the heart of these activities are certain fundamental concepts, all of which are related to the scientific quest to uncover immutable and unchanging laws of nature. Laws of nature are thought to reflect a causal nexus between a previous event and a future one. There are also true statements that reflect universal or nearly universal connections between events past and present that are not laws of nature because the relationship they express is that of a correlation between events. A working thermostat accurately allows us to determine or even to predict the temperature in the room in which it is located, but it does not explain why the room has the temperature it has. What then is the core difference between causal relationships and correlations? At the same time, we all recognize that given where we are now there are many possible futures for each of us, and even had our lives gone just the slightest bit differently than they have, our present state could well have been very different than it is. The relationship between possible pathways between events that have not materialized but could have is expressed through the idea of counterfactual.

Creating accurate roadmaps, forming expectations we can rely on, making the world a more verdant and attractive place requires us to understand the concepts of causation, correlation, counterfactual explanation, prediction, necessity, possibility, law of nature and universal generalization. This course is designed precisely to provide the conceptual tools and intellectual skills to implement those concepts in our future readings and research and ultimately in our experimental investigations, and to employ those tools in various disciplines.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to

1. formulate testable hypotheses that are designed to reveal causal connections and those designed to reveal interesting, important and useful correlations.
2. distinguish scientifically interesting correlations from unimportant ones.
3. apply critical thinking skills to evaluate information.
4. understand when and why inquiry into unrealized possibility is important and relevant.

Indicative Literature

- Thomas S. Kuhn: The Structure of Scientific Revolutions, Nelson, fourth edition 2012;
- Goodman, Nelson. Fact, fiction, and forecast. Harvard University Press, 1983;
- Quine, Willard Van Orman, and Joseph Silbert Ullian. The web of belief. Vol. 2. New York: Random house, 1978.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written Examination

Duration/Length: 60 min
Weight: 100%

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

8.2.5 Causation and Correlation (perspective II)

<table>
<tr><td colspan="3">Module Name

Causation and Correlation (perspective II)</td><td>Module Code

CTNS-NSK-04</td><td>Level (type)

Year 2
(New Skills)</td><td>CP

2.5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTNS-04</td><td colspan="3">Causation and Correlations (perspective II)</td><td>Lecture
(online)</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Dr. Keivan Mallahi-Karai
Dr. Eoin Ryan
Dr. Irina Chiaburu</td><td colspan="3">Program Affiliation

• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status

Mandatory elective for all UG students (one perspective must be chosen)</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills:
• Basic probability theory</td><td>Frequency

Annually
(Spring)</td><td colspan="2">Forms of Learning and Teaching

• Online lecture (17.5h)
• Private study (45h)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation</td></tr>
<tr><td colspan="6">Content and Educational Aims

Causality or causation is a surprisingly difficult concept to understand. David Hume famously noted that causality is a concept that our science and philosophy cannot do without, but it is equally a concept that our science and philosophy cannot describe. Since Hume, the problem of cause has not gone away, and sometimes seems to get even worse (e.g., quantum mechanics confusing previous notions of causality). Yet, ways of doing science that lessen our need to explicitly use causality have become very effective (e.g., huge developments in statistics). Nevertheless, it still seems that the concept of causality is at the core of explaining how the world works, across fields as diverse as physics, medicine, logistics, the law, sociology, and history – and ordinary daily life – through all of which, explanations and predictions in terms of cause and effect remain intuitively central.

Causality remains a thorny problem but, in recent decades, significant progress has occurred, particularly in work by or inspired by Judea Pearl. This work incorporates many 20th century developments, including statistical methods – but with a reemphasis on finding the why, or the cause, behind statistical correlations –, progress in understanding the logic, semantics and metaphysics of conditionals and counterfactuals, developments based on insights from the likes of philosopher Hans Reichenbach or biological statistician Sewall Wright into causal precedence and path analysis, and much more. The result is a new toolkit to identify causes and build causal explanations. Yet even as we get better at identifying causes, this raises new (or old) questions about causality, including metaphysical questions about the nature of causes (and effects, events, objects, etc), but also questions about what we really use causality for (understanding the world as it is or just to glean predictive control of specific outcomes), about how causality is used differently in different fields and activities (is cause in physics the same</td></tr>
</table>

as that in history?), and about how other crucial concepts relate to our concept of cause (space and time seem to be related to causality, but so do concepts of legal and moral responsibility).

This course will introduce students to the mathematical formalism derived from Pearl's work, based on directed acyclic graphs and probability theory. Building upon previous work by Reichenbach and Wright, Pearl defines a "a calculus of interventions" of "do-calculus" for talking about interventions and their relation to causation and counterfactuals. This model has been applied in various areas ranging from econometrics to statistics, where acquiring knowledge about causality is of great importance.

At the same time, the course will not forget some of the metaphysical and epistemological issues around cause, so that students can better critically evaluate putative causal explanations in their full context. Abstractly, such issues involve some of the same philosophical questions Hume already asked, but more practically, it is important to see how metaphysical and epistemological debates surrounding the notion of cause affect scientific practice, and equally if not more importantly, how scientific practice pushes the limits of theory. This course will look at various ways in which empirical data can be transformed into explanations and theories, including the variance approach to causality (characteristic of the positivistic quantitative paradigm), and the process theory of causality (associated with qualitative methodology). Examples and case studies will be relevant for students of the social sciences but also students of the natural/physical world as well.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to

1. have a clear understanding of the history of causal thinking.
2. be able to form a critical understanding of the key debates and controversies surrounding the idea of causality.
3. be able to recognize and apply probabilistic causal models.
4. be able to explain how understanding of causality differs among different disciplines.
5. be able demonstrate how theoretical thinking about causality has shaped scientific practices.

Indicative Literature

Paul, L. A. and Ned Hall. Causation: A User's Guide. Oxford University Press 2013.

Pearl, Judea. Causality: Models, Reasoning and Inference. Cambridge University Press 2009

Pearl, Judea, Glymour Madelyn and Jewell, Nicolas. Causal Inference in Statistics: A Primer. Wiley 2016

Ilari, Phyllis McKay and Federica Russo. Causality: Philosophical Theory Meets Scientific Practice. Oxford University Press 2014.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment: Written examination

Duration/Length: 60 min

Weight: 100 %

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

8.2.6 Linear Model and Matrices

Module Name	Module Code	Level (type)	CP
Linear Model and Matrices	CTNS-NSK-05	Year 3 (New Skills)	5

Module Components

Number	Name	Type	CP
CTNS-05	Linear model and matrices	Seminar (online)	5

Module Coordinator	Program Affiliation	Mandatory Status
Prof. Dr. Marc-Thorsten Hütt	• CONSTRUCTOR Track Area	Mandatory elective

Entry Requirements			Frequency	Forms of Learning and Teaching
Pre-requisites ☒ Logic ☒ Causation & Correlation	Co-requisites ☒ none	Knowledge, Abilities, or Skills	Annually (Fall)	• Online lecture (35h) • Private Study (90h)
			Duration 1 Semester	**Workload** 125 hours

Recommendations for Preparation

Content and Educational Aims

There are no universal 'right skills'. But the notion of linear models and the avenue to matrices and their properties can be useful in diverse disciplines to implement a quantitative, computational approach. Some of the most popular data and systems analysis strategies are built upon this framework. Examples include principal component analysis (PCA), the optimization techniques used in Operations Research (OR), the assessment of stable and unstable states in nonlinear dynamical systems, as well as aspects of machine learning.

Here we introduce the toolbox of linear models and matrix-based methods embedded in a wide range of transdisciplinary applications (part 1). We describe its foundation in linear algebra (part 2) and the range of tools and methods derived from this conceptual framework (part 3). At the end of the course, we outline applications to graph theory and machine learning (part 4). Matrices can be useful representations of networks and of system of linear equations. They are also the core object of linear stability analysis, an approach used in nonlinear dynamics. Throughout the course, examples from neuroscience, social sciences, medicine, biology, physics, chemistry, and other fields are used to illustrate these methods.

A strong emphasis of the course is on the sensible usage of linear approaches in a nonlinear world. We will critically reflect the advantages as well as the disadvantages and limitations of this method. Guiding questions are: How appropriate is a linear approximation of a nonlinear system? What do you really learn from PCA? How reliable are the optimal states obtained via linear programming (LP) techniques?

This debate is embedded in a broader context: How does the choice of a mathematical technique confine your view on the system at hand? How, on the other hand, does it increase your capabilities of analyzing the system (due to software available for this technique, the ability to compare with findings from other fields built upon the same technique and the volume of knowledge about this technique)?

In the end, students will have a clearer understanding of linear models and matrix approaches in their own discipline, but they will also see the full transdisciplinarity of this topic. They will make better decisions in their choice of data analysis methods and become mindful of the challenges when going from a linear to a nonlinear thinking.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. apply the concept of linear modeling in their own discipline
2. distinguish between linear and nonlinear interpretation strategies and understand the range of applicability of linear models
3. make use of data analysis / data interpretation strategies from other disciplines, which are derived from linear algebra
4. be aware of the ties that linear models have to machine learning and network theory

   Note that these four ILOs can be loosely associated with the four parts of the course indicated above

Indicative Literature

Part 1:

- material from Linear Algebra for Everyone, Gilbert Strang, Wellesley-Cambridge Press, 2020

Part 2:

- material from Introduction to Linear Algebra (5th Edition), Gilbert Strang, Cambridge University Press, 2021

Part 3:

- Mainzer, Klaus. "Introduction: from linear to nonlinear thinking." Thinking in Complexity: The Computational Dynamics of Matter, Mind and Mankind (2007): 1-16.
- material from Mathematics of Big Data: Spreadsheets, Databases, Matrices, and Graphs, Jeremy Kepner, Hayden Jananthan, The MIT Press, 2018
- material from Introduction to Linear Algebra (5th Edition), Gilbert Strang, Cambridge University Press, 2021

Part 4:

- material from Linear Algebra and Learning from Data, Gilbert Strang, Wellesley-Cambridge Press, 2019

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment: Written examination — Duration/Length: 120 min

Weight: 100 %

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%

8.2.7 Complex Problem Solving

Module Name		**Module Code**	**Level (type)**	**CP**
Complex Problem Solving		CTNS-NSK-06	Year 3 (New Skills)	5
Module Components				
Number	Name		Type	CP
CTNS-06	Complex Problem Solving		Lecture (online)	5
Module Coordinator Prof. Dr. Marco Verweij	**Program Affiliation** • CONSTRUCTOR Track Area		**Mandatory Status** Mandatory elective	
Entry Requirements Pre-requisites ☒ Logic ☒ Causation & Correlation	Co-requisites ☒ none	Knowledge, Abilities, or Skills • Being able to read primary academic literature • Willingness to engage in teamwork	**Frequency** Annually (Fall) **Duration** 1 semester	**Forms of Learning and Teaching** • Online Lectures (35h) • Private Study (90h) **Workload** 125 hours

Recommendations for Preparation

Please read: Camillus, J. (2008). Strategy as a wicked problem. Harvard Business Review 86: 99-106; Rogers, P. J. (2008). Using programme theory to evaluate complicated and complex aspects of interventions. Evaluation, 14, 29–48.

Content and Educational Aims

Complex problems are, by definition, non-linear and/or emergent. Some fifty years ago, scholars such as Herbert Simon began to argue that societies around the world had developed an impressive array of tools with which to solve simple and even complicated problems, but still needed to develop methods with which to address the rapidly increasing number of complex issues. Since then, a variety of such methods has emerged. These include 'serious games' developed in computer science, 'multisector systems analysis' applied in civil and environmental engineering, 'robust decision-making' proposed by the RAND Corporation, 'design thinking' developed in engineering and business studies, 'structured problem solving' used by McKinsey & Co., 'real-time technology assessment' advocated in science and technology studies, and 'deliberative decision-making' emanating from political science.

In this course, students first learn to distinguish between simple, complicated and complex problems. They also become familiar with the ways in which a particular issue can sometimes shift from one category into another. In addition, the participants learn to apply several tools for resolving complex problems. Finally, the students are introduced to the various ways in which natural and social scientists can help stakeholders resolve complex problems. Throughout the course examples and applications will be used. When possible, guest lectures will be offered by experts on a particular tool for tackling complex issues. For the written, take-home exam, students will have to select a specific complex problem, analyse it and come up with a recommendation – in addition to answering several questions about the material learned.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. identify a complex problem;
2. develop an acceptable recommendation for resolving complex problems.
3. understand the roles that natural and social scientists can play in helping stakeholders resolve complex problems;

Indicative Literature

- Chia, A. (2019). Distilling the essence of the McKinsey way: The problem-solving cycle. Management Teaching Review 4(4): 350-377.
- Den Haan, J., van der Voort, M.C., Baart, F., Berends, K.D., van den Berg, M.C., Straatsma, M.W., Geenen, A.J.P., & Hulscher, S.J.M.H. (2020). The virtual river game: Gaming using models to collaboratively explore river management complexity, Environmental Modelling & Software 134, 104855,
- Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C.S., & Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. AMBIO: A Journal of the Human Environment 31(5): 437-440.
- Ostrom, E. (2010). Beyond markets and states: Polycentric governance of complex economic systems. American Economic Review 100(3): 641-72.
- Pielke, R. Jr. (2007). The honest broker: Making sense of science in policy and politics. Cambridge: Cambridge University Press.
- Project Management Institute (2021). A guide to the project management body of knowledge (PMBOK® guide).
- Schon, D. A., & Rein, M. (1994). Frame reflection: Toward the resolution of intractable policy controversies. New York: Basic Books.
- Simon, H. A. (1973). The structure of ill structured problems. Artificial Intelligence 4(3-4): 181-201.
- Verweij, M. & Thompson, M. (Eds.) (2006). Clumsy solutions for a complex world. London: Palgrave Macmillan.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination — Duration: 120 min

Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%

8.2.8 Argumentation, Data Visualization and Communication (perspective I)

<table>
<tr><td colspan="2">Module Name
Argumentation, Data Visualization and Communication (perspective I)</td><td>Module Code
CTNS-NSK-07</td><td>Level (type)
Year 3
(New Skills)</td><td>CP
5</td></tr>
<tr><td colspan="5">Module Components</td></tr>
<tr><td>Number</td><td colspan="2">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTNS-07</td><td colspan="2">Argumentation, Data Visualization and Communication (perspective I)</td><td>Lecture (online)</td><td>5</td></tr>
<tr><td>Module Coordinator
Prof. Dr. Jules Coleman,
Prof Dr. Arvid Kappas</td><td colspan="2">Program Affiliation
• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status
Mandatory elective for all UG students (one perspective must be chosen)</td></tr>
<tr><td colspan="2" rowspan="2">Entry Requirements
Pre-requisites: ☒ Logic
☒ Causation & Correlation
Co-requisites: ☒ none
Knowledge, Abilities, or Skills:</td><td>Frequency
Annually
(Fall)</td><td colspan="2">Forms of Learning and Teaching
• Online Lectures (35h)
• Private Study (90h)</td></tr>
<tr><td>Duration
1 semester</td><td colspan="2">Workload
125h</td></tr>
<tr><td colspan="5">Recommendations for Preparation</td></tr>
</table>

One must be careful not to confuse argumentation with being argumentative. The latter is an unattractive personal attribute, whereas the former is a requirement of publicly holding a belief, asserting the truth of a proposition, the plausibility of a hypothesis, or a judgment of the value of a person or an asset. It is an essential component of public discourse. Public discourse is governed by norms and one of those norms is that those who assert the truth of a proposition or the validity of an argument or the responsibility of another for wrongdoing open themselves up to good faith requests to defend their claims. In its most general meaning, argumentation is the requirement that one offer evidence in support of the claims they make, as well as in defense of the judgments and assessments they reach. There are different modalities of argumentation associated with different contexts and disciplines. Legal arguments have a structure of their own as do assessments of medical conditions and moral character. In each case, there are differences in the kind of evidence that is thought relevant and, more importantly, in the standards of assessment for whether a case has been successfully made. Different modalities of argumentation require can call for different modes of reasoning. We not only offer reasons in defense of or in support of beliefs we have, judgments we make and hypotheses we offer, but we reason from evidence we collect to conclusions that are warranted by them.

Reasoning can be informal and sometimes even appear unstructured. When we recognize some reasoning as unstructured yet appropriate what we usually have in mind is that it is not linear. Most reasoning we are familiar with is linear in character. From A we infer B, and from A and B we infer C, which all together support our commitment to D. The same form of reasoning applies whether the evidence for A, B or C is direct or circumstantial. What changes in these cases is perhaps the weight we give to the evidence and thus the confidence we have in drawing inferences from it.

Especially in cases where reasoning can be supported by quantitative data, wherever quantitative data can be obtained either directly or by linear or nonlinear models, the visualization of the corresponding data can become key in both, reasoning and argumentation. A graphical representation can reduce the complexity of argumentation and is considered a must in effective scientific communication. Consequently, the course will also focus on smart and compelling ways for data visualization - in ways that go beyond what is typically taught in statistics or mathematics lectures. These tools are constantly developing, as a reflection of new software and changes in state of the presentation art. Which graph or bar chart to use best for which data, the use of colors to underline messages and arguments, but also the pitfalls when presenting data in a poor or even misleading manner. This will also help in readily identifying intentional mis-representation of data by others, the simplest to recognize being truncating the ordinate of a graph in order to exaggerate trends. This frequently leads to false arguments, which can then be readily countered.

There are other modalities of reasoning that are not linear however. Instead they are coherentist. We argue for the plausibility of a claim sometimes by showing that it fits in with a set of other claims for which we have independent support. The fit is itself the reason that is supposed to provide confidence or grounds for believing the contested claim.

Other times, the nature of reasoning involves establishing not just the fit but the mutual support individual items in the evidentiary set provide for one another. This is the familiar idea of a web of interconnected, mutually supportive beliefs. In some cases, the support is in all instances strong; in others it is uniformly weak, but the set is very large; in other cases, the support provided each bit of evidence for the other is mixed: sometimes strong, sometimes weak, and so on.

There are three fundamental ideas that we want to extract from this segment of the course. These are (1) that argumentation is itself a requirement of being a researcher who claims to have made findings of one sort or another; (2) that there are different forms of appropriate argumentation for different domains and circumstances; and (3) that there are different forms of reasoning on behalf of various claims or from various bits of evidence to conclusions: whether those conclusions are value judgments, political beliefs, or scientific conclusions. Our goal is to familiarize you with all three of these deep ideas and to help you gain facility with each.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to

1. distinguish among different modalities of argument, e.g. legal arguments, vs. scientific ones.
2. construct arguments using tools of data visualization.
3. communicate conclusions and arguments concisely, clearly and convincingly.

Indicative Literature

- Tufte, E.R. (1985). The visual display of quantitative information. The Journal for Healthcare Quality (JHQ), 7(3), 15.
- Cairo, A (2012). The Functional Art: An introduction to information graphics and visualization. New Ridders.
- Knaflic, C.N. (2015). Storytelling with data: A data visualization guide for business professionals. John Wiley & Sons.

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written Examination

Duration/Length: 120 (min)
Weight: 100%

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%.

8.2.9 Argumentation, Data Visualization and Communication (perspective II)

Module Name	**Module Code**	**Level (type)**	**CP**
Argumentation, Data Visualization and Communication (perspective II)	CTNS-NSK-08	Year 3 (New Skills)	5

Module Components

Number	Name	Type	CP
CTNS-08	Argumentation, Data Visualization and Communication (perspective II)	Lecture (online)	5

Module Coordinator	**Program Affiliation**	**Mandatory Status**
Prof. Dr. Jules Coleman, Prof Dr. Arvid Kappas	• CONSTRUCTOR Track Area	Mandatory elective for all UG students (one perspective must be chosen)

Entry Requirements			**Frequency**	**Forms of Learning and Teaching**
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring)	• Online Lecture (35 hours) • Tutorial of the lecture (10 hours) • Private study for the lecture (80 hours)
☒ Logic ☒ Causation & Correlation	☒ none	• ability and openness to engage in interactions • media literacy, critical thinking and a proficient handling of data sources • own research in academic literature	**Duration** 1 semester	**Workload** 125 hours

Recommendations for Preparation

Content and Educational Aims

Humans are a social species and interaction is crucial throughout the entire life span. While much of human communication involves language, there is a complex multichannel system of nonverbal communication that enriches linguistic content, provides context, and is also involved in structuring dynamic interaction. Interactants achieve goals by encoding information that is interpreted in the light of current context in transactions with others. This complexity implies also that there are frequent misunderstandings as a sender's intention is not fulfilled. Students in this course will learn to understand the structure of communication processes in a variety of formal and informal contexts. They will learn what constitutes challenges to achieving successful communication and to how to communicate effectively, taking the context and specific requirements for a target audience into consideration. These aspects will be discussed also in the scientific context, as well as business, and special cases, such as legal context – particularly with view to argumentation theory.

Communication is a truly transdisciplinary concept that involves knowledge from diverse fields such as biology, psychology, neuroscience, linguistics, sociology, philosophy, communication and information science. Students will learn what these different disciplines contribute to an understanding of communication and how theories from these fields can be applied in the real world. In the context of scientific communication, there will also be a focus on visual communication of data in different disciplines. Good practice examples will be contrasted with typical errors to facilitate successful communication also with view to the Bachelor's thesis.

Intended Learning Outcomes Upon completion of this module, students will be able to 1. analyze communication processes in formal and informal contexts. 2. identify challenges and failures in communication. 3. design communications to achieve specified goals to specific target groups. 4. understand the principles of argumentation theory. 5. use data visualization in scientific communications.
Indicative Literature • Joseph A. DeVito: The Interpersonal Communication Book (Global edition, 16th edition), 2022 • Steven L. Franconeri, Lace M. Padilla, Priti Shah, Jeffrey M. Zacks, and Jessica Hullman: The Science of Visual Data Communication: What Works Psychological Science in the Public Interest, 22(3), 110–161, 2022 • Douglas Walton: Argumentation Theory – A Very Short Introduction. In: Simari, G., Rahwan, I. (eds) Argumentation in Artificial Intelligence. Springer, Boston, MA, 2009
Examination Type: Module Examination Assessment Type: Digital submission of asynchronous presentation, including reflection Duration/Length: Asynchronous/Digital submission Weight: 100% Scope: All intended learning outcomes of the module Module achievement: Asynchronous presentation on a topic relating to the major of the student, including a reflection including concept outlining the rationale for how arguments are selected and presented based on a particular target group for a particular purpose. The presentation shall be multimedial and include the presentation of data The module achievement ensures sufficient knowledge about key concepts of effective communication including a reflection on the presentation itself Completion: To pass this module, the examination has to be passed with at least 45%%.

8.2.10 Agency, Leadership, and Accountability

Module Name Agency, Leadership, and Accountability			**Module Code** CTNS-NSK-09	**Level (type)** Year 3 (New Skills)	**CP** 5
Module Components					
Number	Name			Type	CP
CTNS-09	Agency, Leadership, and Accountability			Lecture	5
Module Coordinator Prof. Dr. Jules Coleman	**Program Affiliation** • CONSTRUCTOR Track Area			**Mandatory Status** Mandatory for ACS Mandatory elective for all other UG study programs	
Entry Requirements			**Frequency** Annually (Spring)	**Forms of Learning and Teaching** • Online Lectures (35h) • Private Study (90h)	
Pre-requisites ☒ none	Co-requisites ☒ none	Knowledge, Abilities, or Skills	**Duration** 1 semester	**Workload** 125 hours	
Recommendations for Preparation					

Content and Educational Aims

Each of us is judged by the actions we undertake and held to account for the consequences of them. Sometimes we may be lucky and our bad acts don't have harmful effects on others. Other times we may be unlucky and reasonable decisions can lead to unexpected or unforeseen adverse consequences for others. We are therefore held accountable both for choices and for outcomes. In either case, accountability expresses the judgment that we bear responsibility for what we do and what happens as a result. But our responsibility and our accountability in these cases is closely connected to the idea that we have agency.

Agency presumes that we are the source of the choices we make and the actions that result from those choices. For some, this may entail the idea that we have free will. But there is scientific world view that holds that all actions are determined by the causes that explain them, which is the idea that if we knew the causes of your decisions in advance, we would know the decision you would make even before you made it. If that is so, how can your choice be free? And if it is not free, how can you be responsible for it? And if you cannot be responsible, how can we justifiably hold you to account for it?

These questions express the centuries old questions about the relationship between free will and a determinist world view: for some, the conflict between a scientific world view and a moral world view.

But we do not always act as individuals. In society we organize ourselves into groups: e.g. tightly organized social groups, loosely organized market economies, political societies, companies, and more. These groups have structure. Some individuals are given the responsibility of leading the group and of exercising authority. But one can exercise authority over others in a group merely by giving orders and threatening punishment for non-compliance.

Exercising authority is not the same thing as being a leader? For one can lead by example or by encouraging others to exercise personal judgment and authority. What then is the essence of leadership?

The module has several educational goals. The first is for students to understand the difference between actions that we undertake for which we can reasonably held accountable and things that we do but which we are not responsible for. For example, a twitch is an example of the latter, but so too may be a car accident we cause as a result of a heart attack we had no way of anticipating or controlling. This suggests the importance of control to responsibility. At the heart of personal agency is the idea of control. The second goal is for students to understand what having control means. Some think that the scientific view is that the world is deterministic, and if it is then we cannot have any personal control over what happens, including what we do. Others think that the quantum scientific view entails a degree of indeterminacy and that free will and control are possible, but only in the sense of being unpredictable or random. But then random outcomes are not ones we control either. So, we will devote most attention to trying to understand the relationships between control, causation and predictability.

But we do not only exercise agency in isolation. Sometimes we act as part of groups and organizations. The law often recognizes ways in which groups and organizations can have rights, but is there a way in which we can understand how groups have responsibility for outcomes that they should be accountable for. We need to figure out then whether there is a notion of group agency that does not simply boil down to the sum of individual actions. We will explore the ways in which individual actions lead to collective agency.

Finally we will explore the ways in which occupying a leadership role can make one accountable for the actions of others over which one has authority.

Intended Learning Outcomes

Students acquire transferable and key skills in this module.

By the end of this module, the students will be able to

1. understand and reflect how the social and moral world views that rely on agency and responsibility are compatible, if they are, with current scientific world views.
2. understand how science is an economic sector, populated by large powerful organizations that set norms and fund research agendas.
3. identify the difference between being a leader of others or of a group – whether a research group or a lab or a company – and being in charge of the group.
4. learn to be a leader of others and groups. Understand that when one graduates one will enter not just a field of work but a heavily structured set of institutions and that one's agency and responsibility for what happens, what work gets done, its quality and value, will be affected accordingly.

Indicative Literature

- Hull, David L. "Science as a Process." Science as a Process. University of Chicago Press, 2010;
- Feinberg, Joel. "Doing & deserving; essays in the theory of responsibility." (1970).

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written examination

Duration/Length: 120 min
Weight: 100%

Scope: All intended learning outcomes of the module

Completion: To pass this module, the examination has to be passed with at least 45%.

8.2.11 Community Impact Project

Module Name	Module Code	Level (type)	CP
Community Impact Project	CTNC-CIP-10	Year 3 (New Skills)	5

Module Components

Number	Name	Type	CP
CTNC-10	Community Impact Project	Project	5

Module Coordinator	Program Affiliation	Mandatory Status
CIP Faculty Coordinator	• CONSTRUCTOR Track Area	Mandatory elective

Entry Requirements			Frequency	Forms of Learning and Teaching
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Fall / Spring)	- Introductory, accompanying, and final events: 10 hours - Self-organized teamwork and/or practical work in the community: 115 hours
☒ at least 15 CP from CORE modules in the major	☒ None	• Basic knowledge of the main concepts and methodological instruments of the respective disciplines	**Duration** 1 semester	**Workload** 125 hours

Recommendations for Preparation

Develop or join a community impact project before the 5th or 6th semester based on the introductory events during the 4th semester by using the database of projects, communicating with fellow students and faculty, and finding potential companies, organizations, or communities to target.

Content and Educational Aims

CIPs are self-organized, major-related, and problem-centered applications of students' acquired knowledge and skills. These activities will ideally be connected to their majors so that they will challenge the students' sense of practical relevance and social responsibility within the field of their studies. Projects will tackle real issues in their direct and/or broader social environment. These projects ideally connect the campus community to other communities, companies, or organizations in a mutually beneficial way.
Students are encouraged to create their own projects and find partners (e.g., companies, schools, NGOs), but will get help from the CIP faculty coordinator team and faculty mentors to do so. They can join and collaborate in interdisciplinary groups that attack a given issue from different disciplinary perspectives.
Student activities are self-organized but can draw on the support and guidance of both faculty and the CIP faculty coordinator team.

Intended Learning Outcomes

The Community Impact Project is designed to convey the required personal and social competencies for enabling students to finish their studies at Constructor University as socially conscious and responsible graduates (part of the Constructor University's mission) and to convey social and personal abilities to the students, including a practical awareness of the societal context and relevance of their academic discipline.

By the end of this project, students will be able to

- understand the real-life issues of communities, organizations, and industries and relate them to concepts in their own discipline;
- enhance problem-solving skills and develop critical faculty, create solutions to problems, and communicate these solutions appropriately to their audience;
- apply media and communication skills in diverse and non-peer social contexts;

- develop an awareness of the societal relevance of their own scientific actions and a sense of social responsibility for their social surroundings;
- reflect on their own behavior critically in relation to social expectations and consequences;
- work in a team and deal with diversity, develop cooperation and conflict skills, and strengthen their empathy and tolerance for ambiguity.

Indicative Literature

Not specified

Usability and Relationship to other Modules

- Students who have accomplished their CIP (6th semester) are encouraged to support their fellow students during the development phase of the next year's projects (4th semester).

Examination Type: Module Examination

Project, not numerically graded (pass/fail)
Scope: All intended learning outcomes of the module

8.3 Language and Humanities Modules

8.3.1 Languages

The descriptions of the language modules are provided in a separate document, the “Language Module Handbook” that can be accessed from the Constructor University’s Language & Community Center internet sites (https://constructor.university/student-life/language-community-center/learning-languages).

8.3.2 Humanities

8.3.2.1 Introduction to Philosophical Ethics

<table>
<tr><td colspan="3">Module Name
Introduction to Philosophical Ethics</td><td>Module Code
CTHU-HUM-001</td><td>Level (type)
Year 1</td><td>CP
2.5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>CTHU-001</td><td colspan="3">Introduction to Philosophical Ethics</td><td>Lecture (online)</td><td>2.5</td></tr>
<tr><td>Module Coordinator
Dr. Eoin Ryan</td><td colspan="3">Program Affiliation
• CONSTRUCTOR Track Area</td><td colspan="2">Mandatory Status
Mandatory elective</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements
Pre-requisites: ☒ none
Co-requisites: ☒ none
Knowledge, Abilities, or Skills</td><td>Frequency
Annually (Fall)</td><td colspan="2">Forms of Learning and Teaching
• Online lectures (17.5 h)
• Private Study (45h)</td></tr>
<tr><td>Duration
1 semester</td><td colspan="2">Workload
62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation</td></tr>
<tr><td colspan="6">Content and Educational Aims
The nature of morality – how to lead a life that is good for yourself, and how to be good towards others – has been a central debate in philosophy since the time of Socrates, and it is a topic that continues to be vigorously discussed. This course will introduce students to some of the key aspects of philosophical ethics, including leading normative theories of ethics (e.g. consequentialism or utilitarianism, deontology, virtue ethics, natural law ethics, egoism) as well as some important questions from metaethics (are useful and generalizable ethical claims even possible; what do ethical speech and ethical judgements actually do or explain) and moral psychology (how do abstract ethical principles do when realized by human psychologies). The course will describe ideas that are key factors in ethics (free will, happiness, responsibility, good, evil, religion, rights) and indicate various routes to progress in understanding ethics, as well as some of their difficulties.</td></tr>
</table>

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. describe normative ethical theories such as consequentialism, deontology and virtue ethics.
2. discuss some metaethical concerns.
3. analyze ethical language.
4. highlight complexities and contradictions in typical ethical commitments.
5. indicate common parameters for ethical discussions at individual and social levels.
6. analyze notions such as objectivity, subjectivity, universality, pluralism, value.

Indicative Literature

- Simon Blackburn, Being Good (2009)
- Russ Shafer-Landay, A Concise Introduction to Ethics (2019)
- Mark van Roojen, Metaethicas: A Contemporary Introduction (2015)

Usability and Relationship to other Modules

Examination Type: Module Examination

Assessment Type: Written Examination

Duration/Length: 60 min
Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

8.3.2.2 Introduction to the Philosophy of Science

Module Name		Module Code	Level (type)	CP
Introduction to the Philosophy of Science		CTHU-HUM-002	Year 1	2.5
Module Components				
Number	Name		Type	CP
CTHU-002	Introduction to the Philosophy of Science		Lecture (online)	2.5
Module Coordinator Dr. Eoin Ryan	**Program Affiliation** • CONSTRUCTOR Track Area		**Mandatory Status** Mandatory elective	
Entry Requirements Pre-requisites ☒ none	Co-requisites ☒ none	Knowledge, Abilities, or Skills	**Frequency** Annually (Spring)	**Forms of Learning and Teaching** • Online lectures (17.5h) • Private Study (45h)
			Duration 1 semester	**Workload** 62.5 hours
Recommendations for Preparation				
Content and Educational Aims This humanities module will introduce students to some of the central ideas in philosophy of science. Topics will include distinguishing science from pseudo-science, types of inference and the problem of induction, the pros and cons of realism and anti-realism, the role of explanation, the nature of scientific change, the difference between natural and social sciences, scientism and the values of science, as well as some examples from philosophy of the special sciences (e.g., physics, biology). The course aims to give students an understanding of how science produces knowledge, and some of the various contexts and issues which mean this process is never entirely transparent, neutral, or unproblematic. Students will gain a critical understanding of science as a human practice and technology; this will enable them both to better understand the importance and success of science, but also how to properly critique science when appropriate.				
Intended Learning Outcomes Upon completion of this module, students will be able to 1. understand key ideas from the philosophy of science. 2. discuss different types of inference and rational processes. 3. describe differences between how the natural sciences, social sciences and humanities discover knowledge. 4. identify ways in which science can be more and less value-laden. 5. illustrate some important conceptual leaps in the history of science.				
Indicative Literature • Peter Godfrey-Smith, Theory and Reality (2021) • James Ladyman, Understanding Philosophy of Science (2002) • Paul Song, Philosophy of Science: Perspectives from Scientists (2022)				
Usability and Relationship to other Modules				

Examination Type: Module Examination

Assessment Type: Written Examination

Duration/Length: 60 min

Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination must be passed with at least 45%.

8.3.2.3 Introduction to Visual Culture

Module Name	Module Code	Level (type)	CP
Introduction to Visual Culture	CTHU-HUM-003	Year 1	2.5

Module Components

Number	Name	Type	CP
CTHU-003	Introduction to Visual Culture	Lecture (online)	2.5

Module Coordinator	Program Affiliation	Mandatory Status
Dr. Irina Chiaburu	• CONSTRUCTOR Track Area	Mandatory elective

Entry Requirements

Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills
☒ none	☒ none	

Frequency	Forms of Learning and Teaching
Annually (Spring/Fall)	• Online lectures (17.5h) • Private Study (45h)

Duration	Workload
1 semester	62.5 h

Recommendations for Preparation

Content and Educational Aims

Of the five senses, the sense of sight has for a long time occupied the central position in human cultures. As John Berger has suggested this could be because we can see and recognize the world around us before we learn how to speak. Images have been with us since the earliest days of the human history. In fact, the earliest records of human history are images found on cave walls across the world. We use images to capture abstract ideas, to catalogue and organize the world, to represent the world, to capture specific moments, to trace time and change, to tell stories, to express feelings, to better understand, to provide evidence and more. At the same time, images exert their power on us, seducing us into believing in their 'innocence', that is into forgetting that as representations they are also interpretations, i.e., a particular version of the world.

The purpose of this course is to explore multiple ways in which images and the visual in general mediate and structure human experiences and practices from more specialized discourses, e.g., scientific discourses, to more informal and personal day-to-day practices, such as self-fashioning in cyberspace. We will look at how social and historical contexts affect how we see, as well as what is visible and what is not. We will explore the centrality of the visual to the intellectual activity, from early genres of scientific drawing to visualizations of big data. We will examine whether one can speak of visual culture of protest, look at the relationship between looking and subjectivity and, most importantly, ponder the relationship between the visual and the real.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. Understand a range of key concepts pertaining to visual culture, art theory and cultural analysis
2. Understand the role visuality plays in development and maintenance of political, social, and intellectual discourses
3. Think critically about images and their contexts
4. Reflect critically on the connection between seeing and knowing

Indicative Literature

- Berger, J., Blomberg, S., Fox, C., Dibb, M., & Hollis, R. (1973). Ways of seeing.
- Foucault, M. (2002). The order of things: an archaeology of the human sciences (Ser. Routledge classics). Routledge.
- Hunt, L. (2004). Politics, culture, and class in the French revolution: twentieth anniversary edition, with a new preface (Ser. Studies on the history of society and culture, 1). University of California Press.

• Miller, V. (2020). Understanding digital culture (Second). SAGE. • Thomas, N. (1994). Colonialism's culture: anthropology, travel and government. Polity Press.
Usability and Relationship to other Modules
Examination Type: Module Examination Assessment: Written examination — Duration/Length: 60 min. Weight: 100% Scope: all intended learning outcomes Completion: To pass this module, the examination has to be passed with at least 45%.

9 Appendix

9.1 Intended Learning Outcomes Assessment-Matrix

ESSMER					Fundamentals in Earth Sciences	Environmental Systems and Global Change	Microeconomics	Macroeconomics	Geochemistry of Environmental Systems	Natural Resources and Hazards	Sustainability and Infrastructure Investments	Economics of Environmental Resources	Finance and Sustainable Management of Natural Risks	Physics of Planet Earth	Advanced Field Laboratories	Digital Geoscience	Sustainability and Policy Evaluation	Advanced Environmental Science	Current Topics in ESSMER	Bachelor Thesis	CT Methods/Skills	CT New Skills	CT Language/Humanities
Semester					1	2	1	2	3	4	3	3-4	4	3	4	5	5	6	6	6	1-4	3-6	1-2
mandatory/mandatory elective					m	m	m	m	m	m	m	m	m	m	m	me	me	me	me	m	m	m	me
Credits					7,5	7,5	7,5	7,5	7,5	7,5	5	5	5	7,5	7,5	5	5	5	5	12	20	20	5
	Competencies*																						
Program Learning Outcomes	A	E	P	S																			
explain key concepts and processes in geology, oceanography, environmental sciences, geochemistry, Earth data science and digital geosciences	x	x			x	x			x	x				x	x	x		x	x				
describe and discuss (near-)surface systems, identify and examine their components and interactions	x	x			x	x			x	x				x	x	x		x	x				
apply fundamental chemical and physical concepts and methods to real-world problems	x	x		x	x	x			x	x				x	x	x		x	x				
apply fundamental theories, approaches and methods for public policy analysis	x	x					x	x			x	x	x				x						
apply fundamental field skills, technologies, and concepts in ESSMER;		x		x	x	x									x	x		x					
classify and analyze major anthropogenic disturbances of the natural (near-)surface system;	x	x		x		x			x	x						x		x	x				
describe and appraise the interdependencies between resource exploration, responsible resource exploitation and environmental protection;	x	x	x	x	x	x			x	x				x	x			x	x				
select and apply key data processing and analysis techniques in applied and environmental geosciences;	x	x			x	x								x	x	x		x			x		
perform quantitative analyses of materials, processes and systems, and model their dynamics;	x	x							x	x				x		x		x					
analyze scientific and technical questions, put them into relationship to what is known in the literature, and suggest avenues to solve the questions at hand;	x	x	x	x		x			x	x				x	x	x		x	x				
cooperate and collaborate responsibly and ethically in international and culturally diverse teams and communities;		x	x	x	x	x				x		x	x	x	x	x		x	x				
professionally communicate their own results in writing and in front of an audience, to both specialists and non-specialists;	x	x	x	x	x	x				x		x	x	x	x			x	x				
evaluate, anticipate, and proactively communicate to society the human impact on the environment, and engage ethically as an environmentally responsible person;	x	x	x	x	x									x		x		x	x				
apply research methods appropriate in ESSMER;	x	x					x	x		x	x	x	x	x	x						x		
take responsibility for their own learning, personal and professional development and role in society, evaluating critical feedback and self-analysis;	x	x	x	x		x	x	x	x	x	x	x	x	x	x							x	
distinguish among the economic interests and activities of different stakeholders	x	x	x	x			x	x			x	x	x				x						
evaluate economic, political, and societal problems with regard to climate change using economics and management theories and scientific reasoning	x	x		x			x	x			x	x	x				x						
Assessment Type																							
Oral examination																							x
Written examination					x	x	x	x	x	x	x	x	x	x			x	x			x	x	x
Project Assessment																						x	
Project report																							
Essay																							x
Term paper																x			x				
Laboratory report															x			x					
Poster presentation																							
Presentation																				x		x	x
Theis																				x			
Module achievements					x	x															x	x	x

*Competencies: A-scientific/academic proficiency; E-competence for qualified employment; P-development of personality; S-competence for engagement in society

Figure 2: Intended Learning Outcomes Assessment-Matrix