Universität für Bodenkultur Wien

University of Natural Resources and Life Sciences, Vienna

Curriculum

for the Master's Programme in

Green Building Engineering

Programme classification no. 066 …

Effective date: October 1st 2023

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§ 1 QUALIFICATION PROFILE

The master's programme in Green Building Engineering is a degree programme which serves to deepen and extend students' pre-vocational academic education, building on the basis provided by a bachelor's degree programme (§ 51 [2] item 5 of the Universities Act UG 2002, Federal Law Gazette BGBl I no. 81/2009).

After successfully completing the master's programme in Green Building Engineering, the graduates have a broad mastery of fundamentals and a depth of expertise in their area of specialisation (green building construction). They are capable of designing and dimensioning new green buildings as well as further developing existing buildings to green buildings. The entirety is based on the principles of a resource-efficient and effective use of raw materials and energy and the integration of the structures in a circular economy. In addition, the graduates have comprehensive competences to choose suitable materials for the specified projects as well as decide on possible maintenance and energy improvement measures with regard to their resource efficiency and effectiveness. Basic knowledge in spatial planning and landscape architecture, law and economics, innovation management and social sciences round off the qualification profile.

1a) Knowledge, Skills, Professional and Personal Competencies

Knowledge: The graduates will have in-depth knowhow of green building construction on both a theoretical and practical level, giving them the ability to develop new green built constructions and further develop existing buildings to green buildings. The obtained knowledge on various construction materials in regard to their properties, their durability and reusability will allow the graduates to select and design in an appropriate resource-efficient and effective manner. In addition to resource-efficient structural design, the graduates will have knowledge on calculating the environmental impact of buildings within construction and use, circular economy approaches, building physics, the design of constructive greenary (e.g. roofs, facades, shading systems), energy-efficient building technology (heating, ventilation, air conditioning), renewable energy supply (calculation and design), irrigation and drainage systems as well as materials and construction bionics among others. Furthermore, the successful finishing students will have basic knowledge in spatial and landscape planning, building engineering law and project management, digital tools like Building Information Modelling (BIM), innovation management and social sciences.

Skills: With the obtained knowledge the graduates will be able to design and dimension new and adapt existing buildings to the chosen standards of resource efficiency and sustainability. They will be able to describe and calculate detailed concepts for green buildings, focusing not only on one factor but on all aspects of the structure, from the structural design to the used resources, building services, building physics and the greenary, among others. The graduates will be capable of presenting resource-efficient and sustainable solutions within the conceptual design of new structures or retrofitting of existing buildings, bringing state-of-the-art concepts into the construction industry. The interdisciplinarity within the master's programme will give the graduates the ability to approach problems from various perspectives in order to find the most suitable solutions and to improve and restructure existing approaches and processes.

Professional/Vocational Competencies: With the in-depth knowledge on the entirety of green building engineering, the graduates will be able to manage and solve complex technical problems and assume decision making responsibility for an entire project to design and assess (e.g. life cycle assessment) green buildings. Due to the interdisciplinary approach of the

master's programme, the graduate will be a well-rounded-off engineer specialised in the entirety of green building construction.

Personal Competencies: Throughout the master's programme, the graduates will learn to communicate ideas, problems and solutions to both a professional and non-specialist audience. The interdisciplinarity within the master's programme will give the graduates the ability to approach problems from various perspectives in order to find the most suitable solutions and express a broad yet personalised view of resource efficiency, effectiveness and circular economy in regard to the industry. BOKU is the university of sustainability and diversity and provides unique boundary conditions for further development of the graduates apart from the core engineering focus of the studies. BOKU and the BOKU spirit in addition foster a trans- and multidisciplinary thinking and cosmopolitanism.

1b) Professional Qualifications

With the sustainable mindset becoming more relevant within society and the construction industry being one of the most influential sectors in terms of resource consumption, the demand for qualified personnel specialised in resource-efficient construction has begun to rise. Graduates of the Green Building Engineering master will be sought out engineers throughout various disciplines of the construction sector and beyond with development opportunities into different areas. They will be able to work either directly in the construction sector (e.g. in engineering or planning offices, construction companies, freelance engineers, consultants) or the public sector (e.g. federal ministries, provincial governments, municipalities), the service sector or in research and development (e.g. universities and in general in the education sector, research institutions, R&D divisions of various companies, consulting).

1c) Vocational Permission

Graduates of the Green Building Engineering master, who have at least three years of practical experience after graduation, and have a Bachelor's degree in Environmental Sciences and Civil Engineering (Umweltingenieurwissenschaften) from the University of Natural Resources and Life Sciences (BOKU), or a Civil Engineering (Bauingenieurwesen/Bauingenieurwissenschaften) from TU Wien, TU Graz or Universität Innsbruck or fulfil the equivalent admission criteria specified below, will be able to take the examination for civil engineers at the Chamber of Civil Engineers Austria (Ziviltechnikerprüfung).

§ 2 Admission Requirements

The official language of the master's programme is English. The proof of English knowledge at level B2 or C1 (Common European Framework of Reference for Languages) must be provided. The following certificates are accepted: Cambridge Certificate of Advanced English, IELTS Acedemic (test score 6.0), TOEFL (paper based 577 or computer-bassed 233 or internet based 90-91, Home Edition 95-100), TOEIC (minimum score of 785) or a completed undergraduate degree from countries where English is the official language.

Graduates of the bachelor's programme in Environmental Sciences and Civil Engineering (Umweltingenieurwissenschaften) offered by BOKU – University of Natural Resources and Life Sciences, Vienna, as well as Civil Engineering (Bauingenieurwesen/Bauingenieurwissenschaften) offered by TU Wien, TU Graz and University of Innsbruck are eligible for admission with no further requirements.

For graduates of the bachelor's programme in Wood and Fibre Technology (Holz- und Naturfasertechnologie) offered by BOKU – University of Natural Resources and Life Sciences, Vienna mastery of the following learning outcomes is required:

- Knowledge of the basics of civil engineering: CAD (2 ECTS) Structural analysis (Baustatik) and strength of materials (Festigkeitslehre) (7 ECTS), Structural engineering (various Materials) (10 ECTS), Waste management (4 ECTS), Soil mechanics (4 ECTS), Geodesy (3 ECTS).
- Basic IT knowledge, text and data processing, CAD-Software for the design and drawing of building components and entire structures.

For graduates of other technically relevant bachelor's programmes, mastery of the following learning outcomes is required for admission:

- Knowledge of the basics of civil engineering: Mathematics including Statistics (9 ECTS), Technical geometry and CAD (4 ECTS), Material science (2 ECTS), Mechanics (4 ECTS), Structural analysis (Baustatik) and strength of materials (Festigkeitslehre) (7 ECTS), Chemistry (2 ECTS), Structural engineering (various Materials) (10 ECTS), Waste management (4 ECTS), Geology (2 ECTS), Soil mechanics (4 ECTS), Construction physics (3 ECTS), Geodesy (3 ECTS).
- The ability to design building components and understand the load-bearing behaviour of entire structures.
- Basic IT knowledge, text and data processing, CAD-Software for the design and drawing of building components and entire structures.

§ 3 PROGRAMME STRUCTURE

3a) Duration, Scope (ECTS credits) and Structure

The programme consists of courses and other requirements worth a total of 120 ECTS credits. This is equivalent to a duration of four semesters (a total of 3,000 60-minute credit hours).

The study programme has a modular structure. A module is a unit that is stringently structured in terms of content, time and didactics, and for which a learning outcome is defined.

The scope of each module is 6 ECTS credits or a multiple thereof (e.g. 12, 18, ... ECTS credits). Depending on the didactic requirements, a module can be divided into two, in exceptional cases three, module courses.

For a module course, immanence in exams or non-immanence in exams can be provided. A module extends over one semester, in justified exceptional cases over two consecutive semesters. A module course extends over one semester.

The Master's curriculum includes compulsory modules with a total of 54 ECTS credits, the master thesis with 30 ECTS and elective modules with a total 24 ECTS credits. Furthermore, 12 ECTS credits are freely selectable, with the possibility of attending module courses at BOKU or at other universities.

Compulsory:	84 ECTS, including:
Master's thesis including defensio:	30 ECTS credits
Elective:	24 ECTS credits
Free electives:	12 ECTS credits

3b) Framework of Mobility

Student mobility and/ or the opportunity to acquire international experience, intercultural skills and global perspectives is expressly recommended as part of a study programme offered at BOKU. There are various options for this:

- Achievement of learning outcomes at foreign universities, in particular within the free electives, internship (see § 7), the master's thesis. (Compulsory and elective module courses not completed at BOKU require recognition for the course of study, the master's thesis requires the appointment of an external supervisor.)
- Achievement of international competences at BOKU by dealing with international, intercultural or global aspects, attending module courses by guest lecturers, excursions abroad, etc.

3c) Three-pillar Principle

The 3-pillar principle serves to solve interdisciplinary issues and is the central identification feature of the bachelor's and master's programmes at BOKU – University of Natural Resources and Life Sciences, Vienna.

In the master's programmes, the content of the compulsory and elective modules, based on the entire curriculum (except for the master's thesis), are assigned to the following areas with a minimum share of 15% each:

- Technology and Engineering
- Natural Sciences
- Economic and Social Sciences, Law

A detailed description of the modules can be found in Annex A.

§ 4 COMPULSORY MODULES

Compulsory modules worth a total of 84 ECTS credits are required to complete the master's programme. This includes the completion of the master's thesis with 30 ECTS credits (see § 8 Master's thesis).

Compulsory Modules	ECTS credits
Sustainable design and construction	**6**
Advanced structural timber products and engineering	**6**
Building greening	**6**
Building physics	**6**
Materials	**6**
Building technology	**6**
Energy and resource-efficient spatial planning and landscape architecture	**6**
Building in a life cycle perspective	**6**
Law for engineers, innovation management and master seminar	**6**

A detailed description of the modules can be found in Annex A.

§ 5 Elective Modules

Elective modules worth a total of 24 ECTS credits are required to complete the master's programme.

Elective Modules	ECTS credits
Digital design and automated construction	**6**
Finite element methods for life-cycle engineering	**6**
Through life management of engineering structures	**6**
Bionics – engineering lessons from nature	**6**
Building greening advanced	**6**
Sustainable Materials	**6**
Wood and composites	**6**
Material testing	**6**
Energy efficiency and renewable energy in buildings	**6**
Advanced building energy systems	**6**
Energy generation and distribution	**6**
Soil resources in green building engineering	**6**
Green geo-environments and -resources	**6**
Logistics and processes in wood construction	**6**
Advanced BIM and lean construction	**6**
Urban mining	**6**
Social ecology and sustainable development	**6**
Circular economy – scientific perspectives and implementation challenges	**6**

A detailed description of the modules can be found in Annex A.

§ 6 Compulsory Internship

Within the curriculum of the Green Building Engineering master an internship is not compulsory. It is recommended to deepen the qualifications and obtained knowledge from the study programme through relevant professional practical experience.

§ 7 Free Electives

Free electives worth a total of 12 ECTS credits are required to complete the master's programme. Free electives may be selected from all courses offered by all recognised universities in Austria and abroad. It is recommended to choose the free electives from the elective modules of the master's programme.

§ 8 Master's Thesis

Master's theses are written scientific works in the Master's programme that serve as a proof of the ability to work independently on scientific topics justifiably in terms of content and method (§ 86 [2] Z 8 UG 2002).

The thesis is worth a total of 30 ECTS credits including the defensio.

The topic of the master's thesis is taken from a subject of the master's programme. The master's thesis is supervised by a person who is authorised to teach this subject (exception: § 86 [7] of the statutes of the University of Natural Resources and Applied Life Sciences Vienna).

Joint supervision by two persons with authorisation to teach is also permissible if at least one of the two persons teaches a subject within the master's programme.

The topic of a master's thesis shall be chosen in such a way that it is reasonable to expect a student to be able to complete it within six months (§ 81 [2] UG 2002).

Multiple students may jointly address a topic, provided that the performance of individual students can be assessed separately (§ 81 [2] UG 2002).

The master's thesis shall be written in English. The thesis defensio must be held in English.

The Master's thesis can also be written abroad.

§ 9 Completion of the Master's Programme

The master's programme is completed once the student has passed all required modules and courses and has received a positive grade on the master's thesis and defensio. The confirmation of the degree will be by notification.

§ 10 Academic Degree

Graduates of the master's programme in Green Building Engineering are awarded the academic degree Master of Science, abbreviated as MSc or M.Sc. The academic degree MSc or M.Sc., if used, shall be placed after the bearer's name (§ 88 [2] UG 2002 BGBl. I no. 81/2009).

§ 11 Examination Regulations

(1) Any didactically required admission requirements for examinations in the form of successfully completed module courses are to be listed in § 4 and § 5.

(2) The master's programme in Green Building Engineering has been completed successfully when the following requirements have been met:

- positive completion of the compulsory modules worth a total of 54 ECTS credits (§ 4)
- positive completion of elective modules worth a total of 24 ECTS credits (§ 5)
- positive completion of free electives worth a total 12 ECTS credits (§ 6)
- a positive grade on the master's thesis and the defensio with 30 ECTS credits

(3) The performance record for the modules is provided by the performance record for the module courses belonging to the modules.

(4) After successful completion of all the courses and examinations required within the framework of the master's programme, the completed and positively evaluated master's thesis is publicly presented by the student and defended in the form of an academic discussion (defensio). The committee consists of a committee chair and two additional university lecturers with a venia docendi or equivalent qualification. The student's performance (thesis and defensio) is assessed with an overall grade. Both the thesis and the defensio must be assessed as "passed" in order for the student to complete the programme. The written evaluations stating the justification for the thesis and the defensio grades are included in the calculation of the final grade and are documented separately.

The final grade is calculated as follows:

- Master's thesis: 70%
- Defensio (incl. presentation): 30%

(5) Student evaluation in modules: The module grade results from the grades given to the students in the individual courses that make up the module. The final grade is calculated from the average of the grades of all module courses, weighted by ECTS credits. Average values of .5 or less are rounded down (better) grade; values above .5 are rounded up (worse) grade. If deemed necessary, the Dean of Studies can set a module examination at his/her discretion.

§ 12 EFFECTIVE DATE

This curriculum shall take effect on October 1st 2023.

ANNEX A MODULE DESCRIPTIONS

Title of the Module	**Sustainable design and construction**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes of the module		
Knowledge:	After successfully completing the course, the students will be able to explain the aspects of resource efficiency within the construction industry and have basic knowledge in regard to natural resources, energy sources and life cycle assessment. They will be able to name advantages and disadvantages of different construction types and materials from both an environmental and economical aspect. They will also know how to develop a resource-efficient architectural and constructional concept for a building and evaluate it over the entire life cycle using their own calculations and research regarding the environmental impact of the chosen building materials.	
Skills:	By the end of the course the students will be able to describe and evaluate various building systems as well as possible levers in building constructions in terms of resource efficiency, identify optimisation potential and develop practical solutions to decrease the environmental impact. They will be able to design buildings with minimal environmental impact and assess the ecological footprint.	
Professional/Vocational Competencies	Within the design phase of the project, the students will have to visualise and conceptualise their ideas and present these in front of an audience, bringing them closer to the reality of being a structural designer. Furthermore, they will be able to apply their obtained knowledge in regard to life cycle assessment of buildings to any project.	
Personal Competencies	The students will learn how to work in teams and how to present their ideas to an audience. Through several rounds of feedback from both their peers and the lecturers the students will learn to incorporate positive and negative feedback into their work and therefore end up with a well-rounded project representing the obtained knowledge throughout the semester.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Sustainable design and construction VO – 3 ECTS-Credits Sustainable design and construction PJ – 3 ECTS-Credits	
Prerequisites	Basic knowledge of civil engineering: structural engineering, building physics (Bachelor courses Hochbau and Bauphysik VO+PJ) Basic knowledge of MS-Excel and CAD programs	

Title of the Module	**Advanced structural timber products and engineering**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the course, the students will have advanced theoretical and practical expertise in technological processes for working, processing and designing with timber and engineered wood products. They will be capable to not only name a wide range of wood-based materials, their raw material, use, their structural composition as well as the essential processing steps and process conditions but also design resource-efficient materials and structures using this natural resource.	
Skills	The students will be able to choose suitable wood-based materials as well as the right process steps for specific engineering structures. They will be able to describe the technical and scientific methods for the different manufacturing processes and model and design timber structures according to the current standards.	
Professional/Vocational Competencies	Students will be able to interpret data and information from the fields of engineered wood products and structural timber engineering and are able to critically reflect their performance and resource need. Practical problems can be assessed, and recommendations can be made. The students will be able to make simple manual and complex digital calculations of details and entire timber structures.	
Personal Competencies	The students will be able to discuss facts, ideas, problems and solutions from the field of engineered wood products and structural timber engineering. The students can further use the available resources to deepen their knowledge independently.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Advanced structural timber engineering VU – 4 ECTS-Credits Engineered wood products VO – 2 ECTS-Credits	
Prerequisites	Basic Knowledge of timber products and engineering (Bachelor Holzphysik und Thermodynamik, Grundlagen des Holzbaus, Angewandte Festigkeitslehre)	

Title of the Module	**Building greening**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	The students know the evolutions of the concepts and theories of (Urban) Green Infrastructure and Nature-based solutions and the corresponding disciplines and instruments for implementation. They have knowledge of the basic technologies for roof and facade greening and have the according plant and material knowledge. They understand the theories of microclimate regulation, the regulation of water and energy balance and the contribution to urban water management. They comprehend impacts and benefits and according facts. Students understand the design concept of the outdoor space with regard to the technical, constructive, functional, site related-topographic and climate-relevant interactions between the building and the open space. Specific interactions relate to rainwater management, planting design, light and shade, spatial design and access.	
Skills	The students can draft concepts for roof and facade greening. They can design building greenary and analyse and calculate the material needed (plants, substrates, multi-layered systems, pots, climbing aids and the necessary technical equipment for maintenance and servicing and according plant care).	
Professional/Vocational Competencies	Students can solve basic design questions on their own and in teams and can apply creative solutions. The students have the competences for adequately communicating, design questions and planning details and pros and cons of building greenary to both experts and laymen.	
Personal Competencies	Students have competences to collect relevant data and state-of-the art knowledge for building greenary design and implementation. They integrate approved design with up-to-date scientific knowledge to create new solutions for complex building and design questions. They can evaluate impacts on technical structures and social benefits.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Basics in urban green infrastructure and nature-based solutions VS – 3 ECTS-Credits Building greenary: functions and basic technologies for roof and facade greening VS – 3 ECTS-Credits	
Prerequisites	Knowledge in plan drawing	

Title of the Module	**Building Physics**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After completing both modules, a student can not only create an energy certificate for a building in accordance with the most important standards, but also suggest sensible improvement measures concerning the energy consumption of a building and typical building physics issues such as moisture and sound propagation. Physical principles and calculation methods are understood. The acquired skills cover all important chapters of building physics such as thermal behaviour, moisture propagation, energy certificates, aspects of thermal bridges, airborne and structure-borne noise. In addition, several references to sustainability and, through the topic of energy certificates, specifically to the ecological aspects of building physics are addressed. The exercise represents a computational deepening of the computational procedures and is supplemented by practically oriented work. After completing the exercises, students can not only create an energy certificate for a building in accordance with the most important standards, but also suggest sensible improvement measures.	
Skills	After completing the lectures and the exercises a student has deepened knowledge about the computational procedures and is able to • carry out calculations of the thermal behaviour of (external) components with different boundary conditions • assess whether the existing calculation results result in a practically permissible construction or if permanent component damage can be avoided • check whether the criteria for permissible condensate load in winter or summer situations are met, or what measures are to be taken so that compliance can be achieved (modification of component structures) • carry out calculations of energy certificates and independently determine improvement measures to reduce heating requirements • calculate sound levels based on different input variables and take into account the effectiveness of soundproofing measures • carry out calculations of the reverberation-time of sound and carry out independent dimensioning of sound absorber surfaces	
Professional/Vocational Competencies	In the exercises the students have to carry out a engineering project in groups and have to interchange results to other group. Each group is showing the main results and challenges within their subject area. Technical problems should be solved by choosing the right combination of constructions and material. All groups have to merge their subject to a complete documentation. These processes need to be managed with a software planning tool. The students will be trained to act with basic management methods.	
Personal Competencies	The graduate has basic knowledge in building physics and the most important skills to calculate basic properties of building components. Beside the training of the basic management methods the students have to apply the computational skills learned in the lectures and train their knowledge by reading and understanding the most important requirements derived by building laws, policies and guidelines which ensures that individual improve their basic understanding of legal matters.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Building physics VO – 3 ECTS-Credits Building physics UE – 3 ECTS-Credits	
Prerequisites	Mathematics and Physics on baccalaureate level	

Title of the Module	**Materials**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the module students will be able to name the most important technical materials and their response to mechanical and environmental influences. Furthermore, students will be able to explain how the physical properties of materials are determined by their micro- and nanostructure and select appropriate materials according to the performance index. In addition to the obtained knowledge in sustainable material selection, the students will have a general knowledge on recyclability and material cycles of mineral materials. The students will be able to give possible solutions for climate protection and resource conservation through the use of different materials in the construction sector.	
Skills	After successfully completing the module the students will have profound knowledge of the structure and chemical bonding of materials, as well as consequences for thermal and electric properties, and scattering techniques for microstructure characterisation. They will be able to apply the concept of material selection, by using the performance index and Ashby diagrams. They will be able to optimally design the material selection based on their knowledge of the mechanical properties of materials, specifying values, testing procedures as well as the resource consumption and availability in a national and global view. They will also be able to assess the amounts of waste generation and recycling rates (nationally and globally) and implement the concept of circular economy.	
Professional/Vocational Competencies	Based on the obtained knowledge regarding various aspects of the characterisation of materials, the students will be able to choose the best possible and most resource-efficient application within future projects. By understanding the impact of the production of different mineral substances on climate and environment they will be able to make informed decisions and implement sustainable designs. They will also be able to reduce the climate impact and conserve resources through reuse of building components and recycling of building materials (“urban mining”) as well as the process of material preparation itself. Furthermore, they will be able to apply their knowledge on the possibilities for recycling excavated soil and excavated tunnel material.	
Personal Competencies	The students will have the ability to make a sensible and sustainable choice of materials and to assess the recyclability of different materials and building materials, knowledge that can also be used outside of professional life to reduce the footprint of each individual. Students will be able to further their education in the field of materials science, as they will understand the necessary terms for reading further technical literature. They can compare and evaluate characteristic values of newly developed materials with those of traditional materials in order to assess their usefulness	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Sustainable design and use of mineral based materials VU – 2 ECTS-Credits Mechanical and physical behaviour of materials VO – 4 ECTS-Credits	
Prerequisites	Mathematics, Physics and Chemistry on baccalaureate level	

Title of the Module	**Building technology**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	Students are familiar with the design and operation of HVAC- (Heating, Ventilation, Air Conditioning) systems in buildings. They know different systems for heat production, heat distribution and heat dissipation in a building. Furthermore, students are introduced into Building Automation and Control Systems (BACS). and are able to identify and optimize the underlying control strategies. Finally, students are familiar with various aspects of smart building systems including Building Information Modelling (BIM) and demand-side-management in buildings.	
Skills	They are able to identify and analyse the most relevant HVAC-components including Domestic Hot Water (DHW) generation and distribution systems. The students can perform simple design calculations of the technical systems and estimate reasonable applications.	
Professional/Vocational Competencies	They understand the thermodynamic processes of heat pumps and air conditioners and can calculate and discuss system performance figures. Students are able to identify and optimise the underlying control strategies of BACS.	
Personal Competencies	Students work in teams/groups as well as individually and are able to organise and coordinate tasks between themselves. Furthermore, they are capable to present, discuss and defend their opinions in an expert group/discussion and are able to state fact-based arguments for their expertise in building technologies.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Energy efficient heating, cooling and hot water supply of buildings VO – 3 ECTS-Credits Building technology and smart building engineering VO – 3 ECTS-Credits	
Prerequisites	None	

Title of the Module	**Energy and resource-efficient spatial planning and landscape architecture**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	Upon completion of the module, the students will be able to understand spatial and urban development dynamics and their implications for energy and resource demand in the built environment. They can identify spatial developments covering environmental, economic, political, and social drivers of change. The students can comprehend principles and objectives of sustainable and resilient urban design and spatial development on international, national, regional, and local scales. Students will be able to understand the design concept of the outdoor space regarding technical, constructive, functional, site related and climate-relevant interactions between the building architecture and the adjacent open space. Specific interactions relate to spatial design, usability, access, rainwater management, planting design, light and shading.	
Skills	By the end of the course the students will be able to describe spatial planning instruments on both local and regional scale and analyse their content regarding building regulations and energy as well as resource related implications and different needs of users. They can apply digital tools to analyse energy and resource efficiency of settlements and provide relevant optimisation scenarios. Students are able to approach design tasks and discuss qualities of designed spaces, especially in the context of buildings and related open spaces.	
Professional/Vocational Competencies	Within the course the students will develop skills in assessing and optimising energy and resource-efficient spatial planning design according to different needs and context. They will be able to integrate various planning measures that cover environmental, social, economic, and political aspects. They will be able to apply their knowledge within the planning process for new and existing developments as well as local and regional spatial planning.	
Personal Competencies	The students will be able to work in interdisciplinary teams and present relevant planning measures with a differentiated perspective on energy and resource efficiency. They will foster their presentation skills by conveying spatial planning solutions to a team of planners as well as decision makers. They will learn how to communicate factual decision support within an interdisciplinary planning process.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Energy and resource-efficient spatial planning VS - 4 ECTS-Credits Interaction between buildings and open space and gender aspects VS - 2 ECTS-Credits	
Prerequisites	None	

Title of the Module	**Building in a life cycle perspective**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	Participants have specific knowledge of planning, construction, operation and deconstruction of buildings as well as the monitoring and assessment of these processes in a life cycle perspective. They gain knowledge on methods for the life-cycle orientated assessment and comprehend their application for production systems and services.	
Skills	Participants understand concepts, processes and technologies for the operation and end of life management of buildings, this includes the legal framework, exploration of contaminants, decontamination, assessment of reuse and recycling potential, and quality assessment of secondary resources.	
Professional/Vocational Competencies	Participants have capability to apply methods for the life-cycle orientated assessment of materials and buildings with respect to economic, environmental and social impacts based on case studies. They are able to evaluate the impacts on circularity aspects regarding operation and deconstruction of buildings.	
Personal Competencies	Participants have specific know-how of planning, construction and deconstruction sector (to be applied e.g., at civil engineering offices, building companies) as well as the monitoring of these processes (to be applied e.g., at authorities)	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Life cycle management VO – 2 ECTS-Credits Deconstruction, reuse and recycling VS – 4 ECTS-Credits	
Prerequisites	Basic knowledge about waste management and construction	

Title of the Module	**Law for engineers, innovation management and master seminar**	
Type of Module (*Compulsory- or Elective)*	***Compulsory***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After completing the module students will be able to explain the strategic importance of innovation for organisations in the construction industry, society and the environment as well as the common legal issues in the area of civil engineering. They can name the most important tools and frameworks in strategic innovation management and define their areas of application. Furthermore, the students will be able to name and describe administrative legal driven procedures, European and Austrian procurement law, contractual needs as well as commercial plant law, environmental law and land register law. Students will demonstrate an understanding of the interplay between innovation, strategy, structure, and culture. They will be able to explain the processes for delivering improved innovation performance related to commercial, societal, and environmental sustainability as well as the basics of jurisdiction in regard to interactions between various partners.	
Skills	At the end of the module students will be able to critically reflect and synthesise concepts to apply selected tools and frameworks to real-world cases and understand the basics of public procurement, contractual and legal issues, to critically reflect legal issues related to practical cases. They will be able to analyse organizational capability development paths to sense and seize strategic innovation opportunities.	
Professional/Vocational Competencies	Within the module students learn how to develop and implement innovation strategies. These skills increase their ability to work in strategic innovation projects in interdisciplinary teams. In addition, they gain the skills necessary for future roles, such as "innovation manager" or "R&D manager" in the construction industry. They obtained knowledge on legal and contractual basics and have the knowledge on how to apply these to practical cases within the construction industry.	
Personal Competencies	The students will learn how to work in teams and how to present their ideas to an audience. They will know how to deal with common legal and contractual issues enabling them to understand public procurement and environmental procedures and giving them the possibility to develop own concepts for possible application	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Law for engineers VO – 2 ECTS-Credits Strategic innovation and change management VO – 2 ECTS-Credits Masterseminar SE – 2 ECTS-Credits	
Prerequisites	Basic knowledge of marketing and management (ideally knowledge about fundamentals in innovation management, technology management, and/or entrepreneurship)	

Title of the Module	**Digital design and automated construction**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After completing the course, the students will be able to identify the individual sub-processes from digital design to production. This starts with the design via CAD models, includes the data preparation for automated woodworking as well as the machining itself using an industrial robot with a milling spindle and ends with the practical implementation. The students will not only know how to construct a digital workflow and simulate the milling of the parts but also how to actually implement the data into the robot and mill the individual components, followed by the assembly of the designed and milled component by hand.	
Skills	The students will be able to work with simple 3D models, converting them into production data and carrying out simple machining operations with an industrial robot. Furthermore, they will have learned or polished up their manual wood working skills.	
Professional/Vocational Competencies	The students will be able to define and work within the individual sub-processes of digital design and automated construction. They will have gained first experiences with working with an industrial robot and applying automation to the woodworking sector.	
Personal Competencies	The design and assembly of the component are done in teams, allowing the students to polish up not only their manual dexterity but also their ability to work in a team.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Digital design and automated construction PJ – 6 ECTS-Credits	
Prerequisites	Knowledge in plan drawing	

Title of the Module	**Finite element methods for life-cycle engineering**	
Type of Module (*Compulsory or Elective)*	***Elective***	
Workload of the Module in ECTS-Credits	**ECTS-Credits total**	**Total hours** (60 minutes)
	6	**150**
Learning outcomes		
Knowledge	After successful completion of the module, students will be able to explain the theoretical principles of Finite Element Analysis (FEA), present the general procedures necessary for an analysis and explain the basic information necessary for a safe application of FEA. Students will be able to identify the application and characteristics of FEA elements such as members, beams, planar and isoparametric elements and asses their suitability for different types of engineering structures. They will be able to name the advantages and disadvantages of different finite element discretisation strategies for different engineering structures and their typical materials from both the mechanical-static point of view and the possible deterioration processes reducing the lifetime performance. They will be able to develop an efficient, stable and meaningful finite element model for an engineering structure and to evaluate its mechanical and environmental performance, serviceability and durability over the planned service life (life cycle) using their own structure, material and environment specific performance indicators or those from the relevant literature.	
Skills	By the end of the module, the students will be able to describe and evaluate different engineering structures as well as possible levers in the structural design using Finite Element Analysis in terms of resource efficiency. Students will be able to use FEA to identify optimisation potential and use FEA efficiently to design structures with minimal environmental impact.	
Professional/Vocational Competencies	The students will elaborate on the contents of the module in the form of project work. In periodic project meetings, students will have to visualise, explain and relate their considerations and proposed solutions to theoretical principles and present them to an audience. Thereby, the students will experience the daily practice of a Civil Engineer. Furthermore, they will be able to utilise their newly acquired knowledge of Finite Element Analysis techniques in Green Civil Engineering.	
Personal Competencies	The students will learn how to work in teams and how to present their ideas to an audience. Through several rounds of feedback from both their peers and the lecturers the students will learn to incorporate positive and negative feedback into their work and therefore end up with a well-rounded project representing the knowledge obtained throughout the semester.	
Module structure – Lectures with respective ECTS-Credits	Finite element methods for structures VU – 3 ECTS-Credits Finite element methods for advanced structures VU – 3 ECTS-Credits	
Prerequisites	Basic knowledge of Civil Engineering and Structural Engineering Basic knowledge of MS-Excel and CAD programs	

Title of the Module	**Through life management of engineering structures**	
Type of Module (*Compulsory or Elective)*	***Compulsory***	
Workload of the Module in ECTS-Credits	**ECTS-Credits total**	**Total hours** (60 minutes)
	6	**150**
Learning outcomes		
Knowledge	On successful completion of the module, students will be able to explain the theoretical basis of Through Life Management of Engineering Structures, present the general procedures necessary for Life Cycle Management and explain the basic information necessary for the safe application of TLM. Students will be able to identify the application and characteristics of TLM elements such as reliability methods, evaluation methods, prediction methods, monitoring and testing methods, decision methods and maintenance strategies as well as assess their suitability for different types of engineering structures. They will be able to identify the advantages and disadvantages of different strategies for evaluating Through Life Performance (reliability, risk, robustness, resilience) using testing, monitoring and probabilistic methods for different engineering structures and their typical materials, They will be able to develop an efficient, stable and meaningful Through Life Management model for an engineering structure and to evaluate its mechanical and environmental performance, serviceability and durability over the planned service life (life cycle) using their own structural, material and environmental performance indicators or those from the relevant literature.	
Skills	By the end of the module, the students will be able to describe and evaluate different engineering structures as well as possible levers in the structural design with respect to the Through Life Management efficiency. Students will also be able to use TLM to identify optimisation potential with respect to minimal environmental impact.	
Professional/Vocational Competencies	The students will elaborate on the contents of the module in the form of project work. In periodic project meetings, students will have to visualise, explain and relate their considerations and proposed solutions to theoretical principles and present them to an audience. Thereby, the students will experience the daily practice of a Civil Engineer. Furthermore, they will be able to utilise their newly acquired knowledge of Through Life Management techniques in Green Civil Engineering.	
Personal Competencies	The students will learn how to work in teams and how to present their ideas to an audience. Through several rounds of feedback from both their peers and the lecturers the students will learn to incorporate positive and negative feedback into their work and therefore end up with a well-rounded project representing the knowledge obtained throughout the semester.	
Module structure – Type Lectures with respective ECTS-Credits	Safety and reliability of structures VU – 3 ECTS-Credits Life cycle monitoring and assessment of structures VU – 3 ECTS-Credits	
Prerequisites	Basic knowledge of Civil Engineering and Structural Engineering Basic knowledge of MS-Excel and CAD programs	

Title of the Module	**Bionics – engineering lessons from nature**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-Credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the module, the students will have state-of-the art knowledge about the principles of bionics. They will be able to cite and explain examples of the successful transfer of concepts from biology to technical problems with a focus on building materials and constructions. Students have an understanding of the bionic process, including identification of promising biological examples, abstraction of functionality principles and translation into technological applications. Furthermore, students will be able to explain the fundamental mechanisms behind successful bionic examples, such as self-cleaning surfaces, hierarchical materials, self-repair, adhesion, fracture properties, etc. They also have the basic insight necessary for potential transfer of new concepts found in nature to technical problems in the building sector.	
Skills	After successful completion of the module, the students will be able to identify and explain bionic approaches to solve technical problems. They will be able to choose more resource efficient and environmentally benign materials and constructions strategies. They will furthermore be able to review, critically assess and discuss the value of different bionic and non-bionic approaches for green building engineering.	
Professional/Vocational Competencies	Students will be able to analyse and understand a variety of (building relevant) biological systems from an engineering perspective. They will be able to evaluate properties of natural and engineering materials and structure-function relationships. By performing hands-on construction exercises, they will be able to design first own examples of bionic structures. In addition, students will be able to perform self-reliant literature research. In their professional career, these skills will allow them to assess and propose innovative solutions based on examples from biology.	
Personal Competencies	Students will be able to present and explain technically challenging topics and discuss them with the perspective of sustainability, climate and global change. Furthermore, students will be able to continue their studies and perform own projects in the future, based on the literature research and project work they have been introduced to.	
Module structure – Type of the Modul-lectures with respective ECTS-Credits	Bionics – technical solutions from nature VO – 2 ECTS-Credits Building like nature & using nature-based materials VS – 2 ECTS-Credits Bionic design VU – 2 ECTS-Credits	
Prerequisites	Mathematics, physics, chemistry and biology on baccalaureate level	

Title of the Module	**Building greening advanced**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	The students know the principles of irrigation technologies and management and have a comprehensive overview on according systems, including grey water re-use. They comprehend the principles of integrated designs. They differentiate the substrate components and varieties and multi-layered modular systems. They understand the impact on plant growth and health and water balance and the principles of care and management.	
Skills	The students can plan and design building integrated irrigation, including grey-water-based systems, and multi-layered modular systems and calculate the required technical equipment. They can develop greenary drafts integrating architectural and greenary principles. They can calculate water and substrate needs and required amendments to enhance technical performance of multi-layered systems.	
Professional/Vocational Competencies	Students can solve basic design and equipment questions referring to irrigation, substrate, use of greywater and recycled material, modular multi-layered systems, pot and climbing aid design and plant health on their own and in teams and generate creative solutions. The students have the competences for adequately communicating design and technical questions and planning details. They can argue on water, substrate and plant needs and on equipment, the use and integration of recycled material and grey-water-based systems.	
Personal Competencies	Students have competences to collect relevant data and state-of-the art knowledge for irrigation design and equipment. They integrate approved systems with up-to-date scientific knowledge to create new solutions for complex building situations. They can evaluate plant needs and impacts on plant health.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Irrigation technologies and management VS – 1.5 ECTS-Credits Use of plants: integrated design of architecture and greenary UE/EXK – 3 ECTS-Credits Modular system and substrate technologies VS – 1.5 ECTS-Credits	
Prerequisites	Knowledge in plan drawing	

Title of the Module	**Sustainable materials**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the module, students will have cutting edge knowledge about recent developments in new materials. They know new materials systems (e.g. additive manufactured materials, high entropy alloys, nano-composites, ultrahigh-strength materials and bio-based / bio-inspired materials) and how to quantify their benefits according to mechanical and environmental influences compared with traditional materials.	
Skills	Skills in the application of fracture mechanics principles, the concept of damage tolerant design and the theory of irreversible deformation will be understood. Students will be able to use prediction approaches for infinite fatigue life of materials. They can quantify material degradation and environmental impacts based on chemical, electrochemical and biological corrosion as well as thermal influences (creep, decomposition).	
Professional/Vocational Competencies	Students will be able to follow new material developments on scientific basis, to apply criteria for best appropriate and sustainable materials selection, and methods to prevent material damage and failure on a quantitative basis.	
Personal Competencies	Successful attendance of the module will enable to read scientific articles, to conduct literature research, to evaluate findings, to relate information to established theories, to design experiments for materials characterization, to write a summary of the most important findings of relevant research, to present finding in a lecture and to discuss them with the audience.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Sustainable materials engineering VO – 3 ECTS-Credits Recent advances in sustainable materials engineering SE – 3 ECTS-Credits	
Prerequisites	Knowledge in plan drawing	

Title of the Module	**Wood and composites**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the courses, the students will understand and explain causal relationships between the structure and properties of wood and natural fibres, as well as their mechanical function in composites. They will be well aware of a wide range of factors, including tree growth and the natural variability of wood characteristics, all critically relevant to the performance of wood, wood-based materials and composites, also in comparison with non-wood materials. Students will understand strengths and weaknesses of wood, of modified wood, and of various wood/natural fibre-based materials. Building on an understanding of structure-property relationships, the mechanisms of performance improvement in terms of structural optimisation and chemical functionalisation are familiar to students as well.	
Skills	The students will be able to conceive and evaluate suitable raw materials, also with respect to a range of conditions in forests, several modification processes, to design wood-based products, and composite materials. They will be capable of identifying optimization potentials and develop practical state-of-the-art material solutions.	
Professional/Vocational Competencies	Students will be able to interpret data and information about wood-based materials, composites, and various functionalisation tasks. Students will be fit to critically appraise property profiles and their material performance. Practical problems of material performance can be skilfully assessed, and recommendations made regarding raw material, composition, structure, and modification. Students will master basic analytical models of anisotropic material properties and straightforward lab scale material modifications.	
Personal Competencies	Students will be competent in critically discussing facts, ideas, problems, and solutions in the field of wood, wood-based materials, composites, including functionalisation and optimisation. Students are getting engaged with essential tools and methodologies to deepen their knowledge and apply them skillfully.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Wood and fibre quality VO – 2 ECTS-Credits Composites VO – 2 ECTS-Credits Wood materials modification VU – 2 ECTS-Credits	
Prerequisites	Basic knowledge in wood physics, wood chemistry, and wood anatomy is required to follow this course. Bachelor (Naturfasern, Naturfaserwerkstoffe und Technologien)	

Title of the Module	**Material testing**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	The aim of the course "Experimental testing on construction materials" is to give an insight into the subject of building material testing. In particular, the determination of material-specific properties for building materials in the field of structural and civil engineering.	
Skills	By the end of the course the students will be able to apply the legal framework in relation to construction products. Graduates are able to follow the development in this field by means of technical literature. Graduates are able to independently plan and carry out various testing tasks to determine material parameters on the basis of normative documents and regulations.	
Professional/Vocational Competencies	Graduates are able to plan, perform and evaluate experimental investigations on various materials at an appropriate technical level. They can read, understand and independently use standards and guidelines. They are able to assess the applicability of certain equipment for the corresponding examinations. The students can assess metrological techniques and perform simple measurement uncertainty calculations.	
Personal Competencies	Subject-specific literature is worked out and discussed together. In the project work, a task is prepared by each group, normatively identified, planned and the associated experiments are carried out. Teamwork is trained including feedback from the other groups and the lecturers.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Experimental testing on construction materials VU – 6 ECTS-Credits	
Prerequisites	Basic knowledge of civil engineering: structural engineering, building physics	

Title of the Module	**Energy efficiency and renewable energy in buildings**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	Upon completion of the module, the students will be able to understand energy efficiency and renewable energy integration in buildings and their implications for energy and resource demand. They can describe the fundamental principles of energy efficient design and apply a methodological approach towards zero carbon buildings. The students can describe the relevant design measures as well as technical solutions towards highly efficient buildings and are familiar with renewable building energy systems, especially concerning PV-technology.	
Skills	By the end of the courses, the students can apply digital tools to simulate energy demand and renewable energy generation in buildings and can size the relevant technical services systems. In particular, they are able to select, simulate and size appropriate building integrated PV systems. They can assess energy relevant measures and simulate relevant optimization scenarios in buildings.	
Professional/Vocational Competencies	Within the courses the students will develop skills in assessing and optimising energy-efficient building design. They will be able to integrate various technical measures related to the overall architecture and technical building services. They will be able to apply their knowledge within the planning process for new and existing buildings and will be able to work in an interdisciplinary planning team.	
Personal Competencies	The students will be able to visualise, and present measures and optimisation potentials related to energy-efficient buildings. They will foster their presentation skills by conveying technical solutions to an interdisciplinary team of architects and engineers. Through the iterative optimisation process they will learn how to incorporate feedback to improve their original approach.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Simulation and optimisation of energy efficiency and renewable energy systems in buildings VU – 4 ECTS-Credits Fundamentals in- and application of PV-technology to non-domestic buildings VU – 2 ECTS-Credits	
Prerequisites	Compulsory Module *Building technology*	

Title of the Module	**Advanced building energy systems**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	The students are familiar with a modeling program for control systems and can set up simple control loops. The students will be able to understand the importance of refrigeration for modern society, especially in the building sector as well as the terms "temperature", "heat", "energy", "heat flow", "power", "cooling power" and "power number".	
Skills	They can discuss different measurement principles and can discuss their measurement ranges. The students can explain different technical possibilities for refrigeration including their advantages and disadvantages and understand the thermodynamic principles of refrigeration and heat pump systems.	
Professional/Vocational Competencies	The students have the ability to work out solutions for typical measurement tasks, can estimate measurement errors and their consequences. They can design simple refrigeration and heat pump systems and check the plausibility of related offers.	
Personal Competencies	Students are capable to present, discuss and defend their opinions in an expert group/discussion and are able to state fact-based arguments for their expertise in advanced building energy systems.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Applied measurement and control systems VU – 3 ECTS-Credits Refrigeration and air-conditioning VO – 3 ECTS-Credits	
Prerequisites	Compulsory Module *Building technology*	

Title of the Module	**Energy generation and distribution**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	The students know the essential parts of the present energy system and the approximate share of the different primary energy sources in Austria as well as basic principles of energy conversion including the conversion of thermal energy to electrical energy. The students know examples of practical energy conversion units and are able to explain the processes	
Skills	They are able to discuss different energy conversion routes on a comparative basis.	
Professional/Vocational Competencies	In the practical part of the module, the theoretical content is tested in practice at selected exercise stations and various energy conversion technologies (e.g. heat pump, wind turbine, motor, battery) are investigated.	
Personal Competencies	Students are capable to present, discuss and defend their opinions in an expert group/discussion and are able to state fact-based arguments for their expertise in energy conversion technologies.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Energy engineering VO – 3 ECTS-Credits Practical course in energy engineering PR – 3 ECTS-Credits	
Prerequisites	Compulsory Module *Building technology*	

Title of the Module	**Soil resources in green building engineering**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	Upon course completion, the students know / understand fundamentals of soil science, including the composition and spatial organization of soils and related processes and characteristics. They know about soil analytical methods for soil characterization relevant for the re-use of soil materials and the protection of soil functions and ecosystem services, including contaminated soil. Students know about legislation, regulations and norms for protecting and managing soil resources in the context of (green) building engineering.	
Skills	Upon course completion, students can assess the environmental impact of conventional and innovative / sustainable on-site and off-site handling and re-use of excavated soil materials by informed interpretation of soil data, relevant guidelines and norms. They can select / decide between alternative options for re-using soils on-site and off-site in a sustainable manner during the planning process. They are able to select the most appropriate excavation and storage methods for soil during construction.	
Professional/Vocational Competencies	The students can integrate objectives and measures for sustainable soil resource management in the planning process. They are trained to supervise excavation, re-use and protection of soil resources at construction sites and can apply their skills to any building project.	
Personal Competencies	The students can present their project to other experts and public audiences and communicate the need for sustainable soil management to clients, planners, and companies / workers during the planning and implementation of constructions. They are aware of possible conflicts and can contribute to conflict resolution.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Soil resources in green building engineering VU – 6 ECTS-Credits	
Prerequisites	Fundamental physics, chemistry and biology (at least high school level)	

Title of the Module	**Green geo-environments and -resources**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the module, the students **know** • how green buildings are situated in the context of geo-environments • how green buildings best fit in geo-process-areas • how to evaluate the fate of green buildings on the background of geological resources and sinks • how to investigate and use geothermal energy for green buildings. The students will be able to describe the spectrum of geo-resources (minerals, rocks, geothermal energy), which are available for green buildings. The students know the principles of clay building, natural stone production and green cement. The students will learn about the genesis and distribution of raw materials on local and global scales, the historical development of building materials and their application. The students recognise the essential basic concepts concerning cohesion, swelling capacity, adhesion of clay, the mechanical properties, extraction and use of natural stone as well as raw materials, production process, types and applicability of green cements. Students are able to explain advantages and disadvantages of different building materials.	
Skills	By the end of the courses the students will be able to describe the way to harmonise green buildings with geological environments. The students understand the characteristics and the application of the materials in theory and practice. They are capable of an optimal material selection and they know their limits of the application. They can apply the concept of a sustainable and near natural construction materials.	
Professional/Vocational Competencies	Students will be able to investigate geological circumstances of green buildings in the office and in the field. They learn how to interpret geological maps and understand exact dimensions and connections between surface areas and subsurface features. The students have knowledge about the practical application of the building materials clay, natural stone and mineral binder. They can apply the materials discussed in the most efficient way.	
Personal Competencies	The students will learn how to work in teams and how to present their ideas to an audience. Through several rounds of feedback from both their peers and the lecturers the students will learn to incorporate positive and negative feedback into their work and therefore end up with a well-rounded project representing the obtained knowledge throughout the semester. The students have the ability to process and manufacture materials with own hands. The students learn how to work in teams and to present their ideas to an audience.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Green geo-environments EX – 3 ECTS-Credits Green geo-resources VU – 3 ECTS-Credits	
Prerequisites	Basic understanding of geological principles and materials science, basic craft skills	

Title of the Module	**Logistics and processes in wood construction**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the module, the students will have advanced theoretical and practical expertise in logistical building processes and technological processes to produce solid wood products. Students will be able to define the requirement for logistics management at construction sites and construction logistic centers which serve these sites. They will be capable to describe and improve essential process sequences for a wide range of solid wood-based construction materials and elements and their raw material request. They will be able to name advantages and disadvantages of the relation of process and performance and are able to estimate their material efficiency. Students know the role and importance of time and space dependencies at construction sites, and they know how to deal with resource and material bottlenecks.	
Skills	By the end of the module the students will be able to describe, model and choose various suitable process steps for producing specific construction materials and elements, evaluate their resource efficiency and identify optimisation potential. They also work out detailed and optimized schedules for supplying the construction site with the required materials and resources by using simulation-based optimization methods.	
Professional/Vocational Competencies	The students will be able to design decision models to improve operations planning. Students will be able to interpret data and information from the fields of construction logistics and solid wood processing and are able to critically reflect their performance, resource need and efficiency. Practical problems can be assessed, and recommendations can be made.	
Personal Competencies	The students will be able to discuss facts, ideas, problems and solutions from the field of logistics and processes in wood construction. The students can further use the available resources to deepen their knowledge independently.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Construction logistics VU – 4 ECTS-Credits Wood industrial processes: solid wood processing VO – 2 ECTS-Credits	
Prerequisites	None	

Title of the Module	**Advanced BIM and lean construction**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the course, the students will have a better understanding of the fundamentals of technical geometry and computer-aided design. They will be able to create digital building models suitable for BIM workflows and understand digital design from an architectural and engineering point of view. The students will also be able to apply lean construction management methods to projects.	
Skills	By the end of the course the students will be able to create and work with CAD programs and understand the entire BIM process. They will be able to create and revise parametrised building models, enter integrated component-related information into their projects, generate component lists and determine masses and define interfaces for data exchange. By applying lean construction management to projects they will be able to increase productivity, profits and innovation in the industry by analysing the construction process, identifying waste and reducing the identified waste.	
Professional/Vocational Competencies	The knowledge of BIM and Lean construction management is an asset sought for within the construction industry. The students will have a good knowledge basis for any future projects within the field. They will not only be able to create BIM compatible designs but also evaluate these based on a lean construction management approach.	
Personal Competencies	With the module being a mixture of lectures, tutorials and independent working with set deadlines, the students will have to apply their skills of time management. The students can further use the available resources to deepen their knowledge independently.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Advanced BIM VU – 3 ECTS-Credits Lean construction management VU – 3 ECTS-Credits	
Prerequisites	Knowledge of CAD programs (Bachelor Technische Geometrie und Computer gestütztes Zeichnen / Planzeichnen)	

Title of the Module	**Urban mining**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	Participants have specific knowledge of Urban Mining approaches and processes in the context of construction and deconstruction of buildings.	
Skills	Participants understand concepts for deconstruction, for reuse and recycling, the specific treatment and recycling technologies for construction elements and waste materials like bricks, concrete, wood, isolation materials, glass, metal, compound materials, the reuse of treated wastewater. They have the competence to implement such concepts organizationally and can work with relevant business models (e.g., social urban mining models) based on a project case study.	
Professional/Vocational Competencies	Participants are familiar with specific treatment and recycling technologies. They can apply concepts for deconstruction for reuse, organizational issues and business models (like social urban mining). They are able to evaluate the impacts on circularity aspects regarding operation and deconstruction of buildings.	
Personal Competencies	Specific know-how for planning, construction and deconstruction sector (e.g., civil engineering offices, building companies) as well as the monitoring of these processes (e.g., authorities)	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Urban mining: specific concepts for reuse and recycling in the construction sector VO – 2 ECTS Interdisciplinary urban mining project PJ – 4 ECTS-Credits	
Prerequisites	Compulsory Module *Building in a Life Cycle Perspective*	

Title of the Module	**Social ecology and sustainable development**	
Type of Module (*Compulsory- or Elective)*	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After completion of the course, the students will have gained an overview on Social Ecology as an inter- and transdisciplinary research field concerned with interactions between societies and their natural environment. Topics covered are, among others, the development of material and energy use, land use, the decoupling of resource use and economic development, bio-economy and circular economy, degrowth, long-term legacies of human interventions, urban mining, sustainable cities, energy transition, the stock-flow-service nexus, and policy strategies on sustainable resource use. Participants will be familiar with the key concepts of social ecology including "social metabolism" and "colonization of ecosystems" and will have a basic understanding of a social-ecological perspective on global sustainability problems, their historical origins, major driving forces and societal response strategies. Students will be familiar with different strategies for social-ecological transformations and will be able to critically discuss their potentials and limitations.	
Skills	After the successful completion of the course, students will be able to … • understand basics of the key theories, concepts and indicators of the interdisciplinary field "Social Ecology" and their application in sustainability science. • critically discuss strategies of sustainable resource use and their respective application in different fields of research and policy making. • identify and address inter- and transdisciplinary challenges in the context of sustainable resource use from a systemic, socio-ecological perspective.	
Professional/Vocational Competencies	In the two lectures, students will have gained skills in critically reading current academic literature, excerpting main scientific messages, and discussing those in plenary discussions with peers and experts.	
Personal Competencies	Due to the disciplinary mix of students and lecturers, participants develop skills in interdisciplinary communication in the context of sustainable development. In the guided plenary and group discussions of academic literature and lecture inputs, students improved their presentation and discussion skills.	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Social ecology and sustainable development VO – 3 ECTS-Credits Sustainable resource use VS – 3 ECTS-Credits	
Prerequisites	None	

Title of the Module	Circular economy - scientific perspectives and implementation challenges	
Type of Module (*Compulsory- or Elective*)	***Elective***	
Workload of the Module in ECTS-credits	**ECTS-Credits total**	**Total hours** (à 60 min.)
	6	**150**
Learning outcomes		
Knowledge	After successfully completing the course, the students have a basic understanding of circular economy concepts and gained knowledge on the basics of System Thinking and Transformation research in relation to circular economy issues. They acquired insights on biophysical society-nature interactions and an understanding of institutional arrangement and implementation in formal modelling. Moreover, they gained knowledge and the understanding of specific waste management issues and current framework (e.g., legal requirements, technical possibilities) relevant for circular thinking/circular economy.	
Skills	By the end of the course the students will be able to describe and evaluate concepts of circular economy from different disciplinary perspectives and agendas. They can approach the concept of circular economy from various angles, (1) from a sociometabolic perspective on resource inputs to production, consumption and wastes derived, (2) from a waste prevention and management perspective, and (3) from an economic perspective on scarcities and institutional arrangements. They will be able to integrate these perspectives and a CE thinking in their future decisions and planning strategies.	
Professional/Vocational Competencies	• Screening, critically reading and interpreting current scientific literature, policy programs and assessment reports • Preparation and conduction of stakeholders interviews • Critically reflecting on results from the group work in relation to the concepts presented in the lecturing part • Application of system thinking and circular economy issues in future planning processes, which is important for the construction and deconstruction sector as well as the monitoring of building processes. • Presentation and discussion of research results in in plenary setting. • Integrated understanding of measures avoiding market failures taken along supply-and-reuse chains, thereby optimising the overall outcome. • Understand the respective roles of incentives and culturally determined rules of behaviour. • Estimation of impact on labour market and capital requirements resulting from a shift from resource extraction and final disposal to refurbishment and reuse. • Estimation of distributional effects of a transition to CE, based on welfare economic analysis.	
Personal Competencies	Students will have • improved their ability to work in interdisciplinary teams • improved abilities to organise and implement research plans • learned to critically read and reflect on academic literature • learned to participate in discussions in a constructive and well-informed manner • learned to incorporate positive and negative feedback from both their peers and the lecturers in their work • improved presentation and discussion skills in groups and individually	
Module structure – Type of the Modul-lectures with respective ECTS-credits	Circular economy: scientific perspectives and implementation challenges VU – 3 ECTS-Credits Mapping of circular economy agendas in organisations VS – 3 ECTS-Credits	
Prerequisites	None	