Curriculum for the Master's Degree Programme

Green Process Engineering

Curriculum 2025

This curriculum was approved by the Senate of Graz University of Technology during its meeting on 23 June 2025. The legal bases of this degree programme are the Universities Act 2002 (UG) and the Excerpt of Statutes: Legal Regulations for Academic Affairs of TU Graz, as amended.

(Please note: The English version of this document is a courtesy translation. Only the German version is legally binding.)

Table of Contents:

I. General

§ 1 Subject matter of the degree programme and qualification profile

The Master's Degree Programme Green Process Engineering (abbrev. GPE) is an engineering degree. Graduates of this degree programme are awarded the academic degree "Diplom-Ingenieurin" or "Diplom-Ingenieur," abbreviated as "Dipl.-Ing." or "DI". The international equivalent of this university degree is "Master of Science," abbreviated as "MSc."

The Master's Degree Programme Green Process Engineering is provided as a foreign-language degree programme in English.

(1) Subject matter of the degree programme

The Master's Degree Programme Green Process Engineering is designed to teach students the knowledge, skills and tools they need to develop and implement sustainable technical solutions that address global challenges in the areas of climate change, energy needs, the environment, and resource efficiency. Students acquire in-depth knowledge in the areas of (green) process engineering, the production of products based on renewable raw materials, energy technology, and the circular economy. A particular focus is on the design of environmentally friendly industrial processes and technologies that are both ecologically and economically viable. Furthermore, green chemistry methods are covered as they form an important building block to support the transition to a sustainable industry.

The degree programme combines sound engineering fundamentals with application-oriented content and strong connections to current research topics at the participating institutes. Students work on real-world issues and gain access to cutting-edge technologies, especially with regard to the development of technical systems for the use of renewable raw materials, renewable energies, emission reduction, and resource efficiency. Methodological tools such as simulation, process modelling, and ecological assessment are used to analyse and optimise the complex interactions in technical and ecological systems.

Furthermore, the courses of this degree programme are primarily held in English and thus provide a great opportunity for international exchange, promote intercultural skills and prepare students for international careers.

(2) Qualification profile and competences

Graduates of the Master's Degree Programme Green Process Engineering have the following knowledge, skills and competencies:

Knowledge and understanding

Graduates

- have significantly expanded their specialist knowledge in the following areas:
  - Sustainable process engineering: development and optimisation of environmentally friendly chemical and biotechnological processes for the production of products based on renewable raw materials, pollutant reduction, and resource conservation.
  - Sustainable energy technologies: technologies for the use of renewable energies, energy storage and conversion, and energy management systems.

- Resource efficiency and circular economy: techniques for recycling materials, closing material cycles, and minimising waste and emissions.
- Green chemistry/sustainable engineering: application of environmentally friendly chemical reactions and processes to minimise hazardous substances and their transfer to industrial processes in production.

- have mastered the fundamentals for developing and/or applying ideas in a research context aimed at analysing and optimising environmentally friendly, green technologies and developing resource-efficient process engineering production processes.
- can interpret the characteristics, limitations, terminology, and doctrines of the disciplines covered in the degree programme.
- have specialised knowledge in at least two of the following subject areas:
  - Materials and process engineering
  - Renewable energy and energy systems
  - Technology assessment and sustainability management
  - Green chemistry and biotechnology

Application of knowledge

Graduates are able to

- apply complex scientific methods.
- independently work on scientific and engineering tasks, particularly in the fields of energy and sustainable process technology, as well as green chemistry.
- apply their knowledge and problem-solving skills even in new and unfamiliar situations, for example, in the development of innovative energy and sustainable process technologies.

Evaluation and assessment

Graduates are able to

- handle complex situations, particularly in the assessment of technical, ecological, and societal challenges in the field of sustainable engineering.
- formulate reasoned opinions in the terms of the relevant disciplines, including taking account of incomplete or limited information.
- consider the societal, social, and ethical impacts of their professional or scientific activities, particularly when introducing new technologies and processes for the production of sustainable products and innovative energy systems.

Communicative and social skills

Graduates

- have mastered communication and presentation techniques and can use them appropriately to convey complex technical issues to a broad audience in an understandable way.
- can communicate information, ideas, problems and their solutions clearly and unambiguously to an audience of both specialists and non-specialists.
- are able to write precise scientific and academic texts in a way that is appropriate for the target group.

- are flexible, adaptable, and able to work effectively in interdisciplinary and international teams.

Organisational skills

Graduates are able to

- use learning strategies that enable them to further develop their knowledge independently and continuously in the field of green process engineering and related disciplines.
- work independently or in teams, motivating themselves and others, particularly in interdisciplinary projects and research initiatives.
- take initiative and implement new technical solutions in the context of producing products from sustainable raw materials or residues, renewable energy technologies, and resource conservation.

(3) Need and relevance of the degree programme for science and the labour market

The global transition toward a sustainable economy and society requires highly qualified experts capable of developing pioneering technologies and processes. Graduates of the Master's Degree Programme Green Process Engineering are best prepared for these challenges and positioned to play a key role in the design of environmentally friendly, resource-conserving, and energy-efficient systems. They possess technical and scientific skills that make them sought-after specialists and leaders in a wide range of industries, including power generation, environmental technology, the chemical industry, resource management, and consulting.

Through strong involvement in current research projects and in international collaborations, graduates benefit from an application- and research-oriented education that is valuable for both academia and industry. They are able to develop innovative solutions in interdisciplinary teams and drive technological transformation toward a sustainable future.

Graduates have excellent career prospects in international businesses, research institutions, and the public sector. The master's degree programme also provides graduates with the skills required for independent scientific work within the framework of a doctoral programme. With this broad yet in-depth education, they are well positioned to set the course for a sustainable future in leading positions and to actively participate as changemakers in the global materials and energy transition and in environmental management.

§ 2 Admission requirements

(1) The Master's Degree Programme Green Process Engineering builds on the Bachelor's Degree Programmes Environmental Systems Sciences / Natural Sciences-Technology (USW / NAWI-Tech), Chemistry and Molecular Biology offered as part of NAWI Graz. Graduates of these bachelor's degree programmes thus meet the admission requirements for the Master's Degree Programme Green Process Engineering. Furthermore, the following degree programmes are eligible for admission to the Master's Degree Programme Green Process Engineering without further requirements:

a. Bachelor's Degree Programme Mechanical Engineering at TU Graz
b. Bachelor's Degree Programme Mechanical Engineering and Business Economics at TU Graz
c. Bachelor's Degree Programme Physics at TU Graz / Uni Graz (NAWI Graz)

d. Any bachelor's degree programmes in chemistry, molecular biology, biotechnology, physics, mechanical engineering or mechanical engineering-business economics at another Austrian, German or Swiss university

e. Any master's or diploma degree programmes in chemistry, molecular biology, biotechnology, mechanical engineering, mechanical engineering-business economics or chemical and process engineering at another Austrian, German or Swiss university

(2) Any degree programmes that are not mentioned in (1) are considered eligible for admission if at least 130 ECTS credit points have been positively completed in the following subject areas:

a. 30 ECTS credit points from courses on natural sciences (mathematics, physics)

b. 30 ECTS credit points from courses on engineering sciences

c. 20 ECTS credit points from courses in chemistry and molecular biology

d. 10 ECTS credit points from courses in computer-aided data processing

If a student is admitted to this master's degree programme in accordance with § 6, the officer responsible for study matters decides which of the Bridge Modules A.1–A.3 the student must complete as their entry path to the degree programme.

(3) Any degree programmes that are not mentioned in (1) and that do not meet the requirements of (2) are not considered equivalent to a subject-related degree programme. If at least 100 ECTS credit points have been completed in the subject areas mentioned in (2), full equivalence may be established by requiring supplementary examinations. Additional completion of supplementary examinations may be required to the extent of a maximum of 30 ECTS credit points. Supplementary examinations worth a maximum of 5 ECTS credit points may be recognised as free-choice subjects for this master's degree programme.

If a student is admitted to this master's degree programme in accordance with § 6, the officer responsible for study matters decides which of the Bridge Modules A.1–A.3 the student must complete as their entry path to the degree programme.

(4) Any degree programmes that are not mentioned in (1) and do not meet the requirements of (2) and (3) are not close enough in subject matter to establish full equivalency. In such cases, admission to the Master's Degree Programme Green Process Engineering is not possible.

(5) Proof of sufficient English language skills is a prerequisite for admission to the degree programme. The type of proof required is specified in a regulation issued by the Rectorate.

§ 3 Structure of the degree programme

(1) The Master's Degree Programme Green Process Engineering with a total workload of 120 ECTS credit points comprises four semesters and is structured into modules as follows:

	ECTS
Compulsory Module A (A.1-A.3): Bridge Courses[0]	17
Compulsory Module B: Green Process Engineering Basics	13
Compulsory Module C: Chemical and Analytical Aspects	14
Compulsory Module D: Green Technologies	16
Elective Modules E–G: Elective Subjects	24
Master's thesis	30
Free-choice subjects	6
Total	120

[0] One of the modules A.1–A.3 must be completed in full. The module the student must complete is defined in § 2.

(2) In order to ensure that a bachelor's degree programme and subsequent subject-related master's degree programme combined comprise a total workload of 300 ECTS credit points, one and the same course cannot be recognised for both the bachelor's degree programme qualifying the student for admission to a master's degree programme, and the master's degree programme in question.

§ 4 Group sizes

The following maximum numbers of participants (group sizes) have been established:

Lecture (VO) Lecture part of lecture with integrated exercises (VU)	no restriction
Exercise (UE) Exercise part of lecture with integrated exercises (VU)	25
Laboratory course (LU)	6
Seminar (SE)	20
Seminar project (SP)	20
Project (PT)	20
Excursion (EX)	30

§ 5 Guidelines for the allocation of places in courses

(1) If the number of students exceeds the number of available places, students are allocated places on a course according to the following priority criteria, whereby the individual criteria are to be applied in the order given:

a. Position of the course in the curriculum (acc. to § 6 and § 7): Priority is given to students for whom the course is compulsory according to their curriculum over those who are taking the course as part of an elective module or free-choice subject.

b. Total of completed/recognised ECTS credit points for the degree programme: All study achievements completed in the degree programme for which the student wants to take

the course are taken into account for the ranking. Students with the highest total of ECTS credit points already completed in their current degree programme are ranked preferentially.

c. Number of semesters spent studying the degree programme so far: Students are ranked according to the number of semesters they have already studied in the degree programme. Priority is given to those who have studied for longer.

d. Decision by lot: If it is not possible to rank students according to the above criteria, admission to the course is decided by lot.

(2) Up to 10% of the existing places on the course are reserved for students completing part of their studies at TU Graz as part of a mobility programme.

II. Degree Programme Content and Structure

§ 6 Modules, courses and semester assignment

(1) The individual courses of this master's degree programme and their designation as compulsory and elective modules are set out below. The knowledge, methods or skills to be taught in each course are described in detail in Appendix I. The assignment of courses to specific semesters is a recommendation for students and ensures that the sequence of courses is best able to build on prior knowledge and that the workload of an academic year does not exceed 60 ECTS credit points.

(2) Modules A (Bridge Courses) are designed to serve as an introduction to the degree programme. One of the modules A.1–A.3 must be completed in full. The entry path and corresponding Bridge Module is predetermined by the degree programme that a student has previously completed in accordance with § 2 (1) of this curriculum. If a student is admitted to this master's degree programme in accordance with § 2 (2) or (3), the officer responsible for study matters decides which of the Bridge Modules A.1–A.3 the student must complete as their entry path to the degree programme.

(3) If a student can prove that they have previously completed study achievements that match the content of one or more courses in a Bridge Module, the number of ECTS credit points to be completed for the Bridge Module A.1–A.3 may be reduced by the respective course(s) and, to offset this, the scope of Elective Modules E–G must be increased by at least the same amount of ECTS credit points. The decision is made by the officer responsible for study matters in charge of academic recognition.

Master's Degree Programme Green Process Engineering

Module	Course	SSt	Cou. Type	ECTS	Semester with ECTS credit points I	II	III	IV
Module A: Bridge Courses								
Compulsory Module A.1: Bridge Courses for Students with a Bachelor's Degree in Chemistry or Molecular Biology								
A.1.1	Engineering Mathematics	2	VU[1]	3	3			
A.1.2	Mass and Energy Balances	2	VU[1]	3	3			
A.1.3	Thermodynamics	2	VO	3	3			

Master's Degree Programme Green Process Engineering

Module	Course	SSt	Cou. Type	ECTS	Semester with ECTS credit points I	II	III	IV
A.1.4	Thermodynamics	2	UE	2	2			
A.1.5	Transport Processes I	2	VU[1]	3	3			
A.1.6	Transport Processes II	2	VU[1]	3	3			
Subtotal Compulsory Module A.1		**12**		**17**	**17**			
Compulsory Module A.2: Bridge Courses for Students with a Bachelor's Degree in Environmental Systems Sciences / Natural Sciences-Technology or Physics								
A.2.1	Bioprocess Technology I	2	VO	3	3			
A.2.2	Mass and Energy Balances	2	VU[1]	3	3			
A.2.3	Chemical Reaction Engineering I	3	VU[1]	4	4			
A.2.4	Chemical Reaction Engineering Laboratory	1	LU	1		1		
A.2.5	Transport Processes I	2	VU[1]	3	3			
A.2.6	Transport Processes II	2	VU[1]	3	3			
Subtotal Compulsory Module A.2		**12**		**17**	**16**	**1**		
Compulsory Module A.3: Bridge Courses for Students with a Bachelor's Degree in Mechanical Engineering / Mechanical Engineering and Business Economics								
A.3.1	Bioprocess Technology I	2	VO	3	3			
A.3.2	Mass and Energy Balances	2	VU[1]	3	3			
A.3.3	Chemical Reaction Engineering I	3	VU[1]	4	4			
A.3.4	Analytical Chemistry	2	VO	3	3			
A.3.5	Applied Chemistry I	1.33	VO	2	2			
A.3.6	Applied Chemistry II	1.33	VO	2	2			
Subtotal Compulsory Module A.3		**11.66**		**17**	**17**			
Modules B–D: Core Areas								
Compulsory Module B: Green Process Engineering Basics								
B.1	Introduction to Green Process Engineering	1.5	VO	2.5	2.5			
B.2	Chemical Thermodynamics I	2	VO	3		3		
B.3	Chemical Thermodynamics I	1	UE	1		1		
B.4	Mass Transfer Unit Operations	3	VO	4.5		4.5		
B.5	Mass Transfer Unit Operations	2	UE	2		2		
Subtotal Compulsory Module B		**9.5**		**13**	**2.5**	**10.5**		
Compulsory Module C: Chemical and Analytical Aspects								
C.1	Bio-Based Materials: Processing, Engineering and Analysis	2	VO	3	3			
C.2	Bio-Based Materials: Processing, Engineering and Analysis	4	LU	3	3			
C.3	Materials Chemistry	1.33	VO	2		2		
C.4	Green Chemistry and Technology	1.33	VO	2		2		
C.5	Bioresources	4	SE	4		4		
Subtotal Compulsory Module C		**12.66**		**14**	**6**	**8**		
Compulsory Module D: Green Technologies								
D.1	Bioresource Process Technologies	4	VU[1]	5			5	
D.2	Thermal Conversion Routes for Energetic Biomass Utilisation I	2	VO	3			3	
D.3	Fundamentals of Electrical Power Systems GPE	2	VO	3		3		

Master's Degree Programme Green Process Engineering								
Module	**Course**	**SSt**	**Cou. Type**	**ECTS**	**Semester with ECTS credit points I**	**II**	**III**	**IV**
D.4	Industry Excursion Green Process Engineering	1	EX	1		1		
D.5	Life Cycle Assessment GPE	3	SP	4			4	
Subtotal Compulsory Module D		**12**		**16**		**4**	**12**	
Total Compulsory Modules		**45.82-46.16**		**60**	**24.5-25.5**	**22.5-23.5**	**12**	
Elective Modules E–G: Elective Subjects				**24**	**4.5**	**7.5**	**12**	
Total Elective Modules acc. to § 7				**24**	**4.5**	**7.5**	**12**	
Master's thesis				**30**				**30**
Free-choice subjects acc. to § 8				**6**			**6**	
Overall Total				**120**	**29-30**	**30-31**	**30**	**30**

[1]: 2/3 semester course hours lecture part, 1/3 semester course hours exercise part.

§ 7 Elective modules

As outlined in § 3 (1), 24 ECTS credit points must be completed from the three Elective Modules E–G. Of these, at least 14 ECTS credit points must be exclusively from only one of the three Elective Modules E–G in order to establish a specialisation. With prior approval by the officer responsible for study matters, students may also complete courses up to a maximum of 10 ECTS credit points from the TU Graz Lifelong Learning offerings in the field of Green Transformation or Sustainability and recognise these for Elective Modules E–G. The officer responsible for study matters decides to which of the Elective Modules E–G these courses are allocated. Students must apply for these courses separately via the website of TU Graz Lifelong Learning.

(1) For Elective Module E: Green Energy and Energy Management, courses from the following course catalogue must be completed.

Elective Module E: Green Energy and Energy Management					Semester allocation	
	Course	SSt	Cou. Type	ECTS	WS	SS
E.1	Energy System Modelling and Optimisation	2	VU[1]	3	3	
E.2	Energy Analytics and Machine Learning	2	VU[2]	3	3	
E.3	Energy Storage and Conversion	1.33	VO	2		2
E.4	Liquid Biofuels	1	SE	1		1
E.5	Energy and Environmental Science	1.33	VO	2	2	
E.6	Photovoltaics, Thermal Energy Storage and Application	1.33	VO	2		2
E.7	Fuel Cells and Energy Storage	2	VO	3		3
E.8	Gas and Fuel Cell Technology	2	VO	3		2
E.9	Micro- and Macro Economics for Electrotechnicians	2	VO	3	3	
E.10	Energy and Environment	2	VO	3		3
E.11	Innovative Energy Technologies and Energy Efficiency	2	VO	3		3
E.12	Innovative Energy Technologies and Energy Efficiency	1	UE	1.5		1.5
E.13	Hydrogen Production and Storage	2	VO	3	3	
E.14	Advanced Studies of Polymer Electrolyte Fuel Cells	3	VU[1]	4		4
E.15	Entrepreneurship	2	VO	3		3
E.16	Entrepreneurship	1	UE	1		1
E.17	Energy Management in Industries	2	VU[1]	3	3	
E.18	Geothermal Energy	1.33	VO	2		2
E.19	Laboratory Exercises for Energy Engineers[3]	3	LU	3		3
E.20	Thermal Engineering I[3]	2	VO	3	3	
E.21	Industrial Energy Management	1	VO	1.5	1.5	
E.22	Industrial Energy Management	1	UE	1	1	
E.23	Power Stations and Thermal Units	2	VO	3		3
E.24	Selected Topics in Green process Engineering – Energy	2	SE	2	2	(2)[4]
E.25	Green Process Engineering Project	6	PT	6	6	(6)[4]

[1]: 2/3 semester course hours lecture part, 1/3 semester course hours exercise part.
[2]: 1/2 semester course hours lecture part, 1/2 semester course hours exercise part.
[3]: This course is offered in German only.
[4]: The course may also be offered in this semester.

(2) For Elective Module F: Green Process Engineering Technologies, courses from the following course catalogue must be completed.

Elective Module F: Green Process Engineering Technologies					Semester allocation	
	Course	SSt	Cou. Type	ECTS	WS	SS
F.1	Computer Programming CE I	3	VU[3]	3	3	
F.2	Chemical Reaction Engineering I	3	VU[1]	4	4	
F.3	Chemical Reaction Engineering Laboratory	1	LU	1		1
F.4	Chemical Reaction Engineering II	2	VU[1]	3		3
F.5	Chemical Reaction Engineering Laboratory II	2	LU	2		2
F.6	Introduction to Process Simulation and Process Design	3	VU[3]	4		4
F.7	Model Development and Simulation	4	VU[2]	5	5	
F.8	Particle Technology I	3	VO	4.5		4.5
F.9	Particle technology I	2	UE	2		2
F.10	Mass Transfer Unit Operations Laboratory	1	LU	1		1
F.11	Mass Transfer Unit Operations II	2	VO	3	3	
F.12	Mass Transfer Unit Operations II	1	UE	1.5	1.5	
F.13	Mass Transfer Unit Operations Laboratory II	2	LU	2	2	
F.14	Lignocellulosic Biorefinery Processes	1.5	VO	2	2	
F.15	Lignocellulosic Biorefinery Laboratory	3	LU	3		3
F.16	Bio-Based Circular Economy	2	VU[1]	3	3	
F.17	Wastewater Treatment[4]	3	VU[1]	4	4	
F.18	Off-Gas Purification Processes[4]	3	VU[1]	4		4
F.19	Environmental Technologies Laboratory[4]	2	LU	2		2
F.20	Paper and Board Production Basics[4]	2	VO	3	3	
F.21	Biological and Bio-Based Materials	2	VO	3		3
F.22	Green Process Engineering Project	6	PT	6	6	(6)[5]
F.23	Continuous Process Engineering	2	VO	3		3
F.24	Electrochemical Engineering	2	SE	2	2	
F.25	Selected Topics in Green Process Engineering - Technologies	2	SE	2	2	(2)[5]

[1]: 2/3 semester course hours lecture part, 1/3 semester course hours exercise part.
[2]: 1/2 semester course hours lecture part, 1/2 semester course hours exercise part.
[3]: 1/3 semester course hours lecture part, 2/3 semester course hours exercise part.
[4]: The course is only offered every other academic year.
[5]: The course may also be offered in this semester.

(3) For Elective Module G: Green Chemistry and Biotechnology, courses from the following course catalogue must be completed.

Elective Module G: Green Chemistry and Biotechnology					Semester allocation	
	Course	SSt	Cou. Type	ECTS	WS	SS
G.1	Nanocellulose Processes and Products	1.5	VO	2	2	
G.2	Biopolymers for Advanced Material Applications	1.5	VO	2	2	
G.3	Transformation and Shaping of Bio-Based Systems	1.33	VI	2		2
G:4	Carbohydrate Technologies	1.33	VU[3]	2		2
G.5	Macromolecular Materials and Material Technologies III – Composite Materials	1.33	VO	2		2
G.6	Bionanomaterials and Biomimetrics	2	VO	3		3
G.7	Polymeric Biomaterials	2	VO	3	3	
G.8	Polymers in Life Science and Environment	1.33	VO	2		2
G.9	Carbohydrate Chemistry[4]	2	VO	3		3
G.10	Biotechnology for Biorefineries	2	VO	3	3	
G.11	Bioprocess Technology I	2	VO	3	3	
G.12	Laboratory Biotechnology GPE	4	LU	4		4
G.13	Seminar Laboratory Biotechnology GPE	1	SE	1		1
G.14	Biotechnology TC	2	VO	3		3
G.15	Bioremediation	2	VU[2]	2	2	
G.16	Fermentation Technology	1.33	VU[1]	2	2	
G.17	Bioprocess Optimisation and Process Control	2	VO	3		3
G.18	Materials and the Environment	2	VU[1]	2	2	
G.19	REACH – Registration, Evaluation, Authorisation and Restriction of Chemical Substances	2	VO	3		3
G.20	Diversity Management	2	SE	2	2	(2)[5]
G.21	Batteries and Supercapacitors	3	VO	4		4
G.22	High-Pressure and Supercritical Fluid Processes	2	SE	2		2
G.23	Applied Flow Chemistry: Design and Operation of Continuous Processes	3	LU	3	3	
G.24	Selected Topics in Green Process Engineering – Green Chemistry and Biotechnology	2	SE	2	2	(2)[5]
G.25	Green Process Engineering Project	6	PT	6	6	(6)[5]

[1]: 2/3 semester course hours lecture part, 1/3 semester course hours exercise part.
[2]: 1/2 semester course hours lecture part, 1/2 semester course hours exercise part.
[3]: 1/3 semester course hours lecture part, 2/3 semester course hours exercise part.
[4]: The course is only offered every other academic year.
[5]: The course may also be offered in this semester.

§ 8 Free-choice subjects

(1) The courses to be completed as part of the free-choice subjects in the Master's Degree Program Green Process Engineering are designed to provide an individual strategic focus and further development of the students. They may be freely selected from the courses offered by any recognised national or international universities and also recognised national or international post-secondary educational institutions. Appendix II contains a list of recommended free-choice subjects.

(2) If a specific free-choice course does not have an allocation of ECTS credit points, each semester hour (SSt) of this course is counted as one ECTS credit point. However, if such courses are lecture-type courses (VO), they are assigned 1.5 ECTS credit points for each semester course hour.

(3) Additionally, the possibility exists, in accordance with § 11, to complete a professionally-oriented internship or short study period abroad as part of the free-choice subjects for up to 6 ECTS credit points.

§ 9 Master's thesis

(1) The purpose of the master's thesis is to demonstrate a student's ability to work on scientific topics on their own, both with regard to content and methodology. The scope of the master's thesis must be determined in such a way that its completion can be reasonably and feasibly be accomplished by the student within a period of six months.

(2) The topic of the master's thesis must be taken from or meaningfully related to the compulsory modules or the elective modules in accordance with § 6 and § 7.

(3) The master's thesis must be registered with the respective officer responsible for study matters via the Dean's Office before beginning work on it.

§ 10 Registration requirements for courses/examinations

To register for the final master's examination before a committee, the student must provide proof of positive assessment of all study achievements/examinations outlined in § 6 to 0 as well as positive assessment of the master's thesis.

§ 11 Stays abroad and internships

(1) Recommended stays abroad

It is recommended for students to spend time abroad in the course of their studies. In this master's degree programme, the 2nd or 3rd semesters are particularly suitable for this purpose.

It is also possible to obtain recognition of work done during shorter stays abroad, for example while participating in summer or winter schools, as part of the free-choice subjects, by application to the officer responsible for study matters.

(2) Internships

Students are strongly encouraged to complete a job-related internship within the framework of the free-choice subjects.

Each week of full employment corresponds to 1.5 ECTS credit points; a maximum of 6 ECTS credit points may be recognised this way. This internship must be approved by the officers responsible for study matters in advance and considered a useful addition to the degree programme.

III. Examination Regulations and Conclusion of Studies

§ 12 Assessment of modules

The overall grade for a module is the average grade of all examinations completed as part of the module, weighted according to ECTS credit points. The grade is rounded up if the decimal place exceeds 0.5. Otherwise, the grade is rounded down. Examinations that are assessed only as "successfully completed/not completed" are not included in the calculation of the overall module assessment. Positive assessment of a module requires the positive assessment of all individual examinations to be completed within the module.

§ 13 Master's examination

(1) The master's examination is an oral examination before a committee and consists of

- the presentation of the master's thesis (max. 30 minutes),
- the defence of the master's thesis (examination interview on the subject matter of the master's thesis and other subject-related areas), as well as
- an examination interview on another subject area covered in the master's thesis.

(2) The subject areas according to (1) are determined by the officer responsible for study matters based on the candidate's suggestion. The total duration of the master's examination before a committee is usually 60 minutes and must not exceed 75 minutes.

(3) The examination committee for the mater's examination includes the supervisor of the master's thesis and two other members who are nominated by the officer responsible for study matters, after hearing any recommendations from the candidate. The examination committee must be chaired by one of the members who is not the supervisor of the master's thesis.

(4) The master's examination is graded by the committee based on the performance during the examination.

§ 14 Completion of studies

(1) The master's degree programme is completed once all academic achievements pursuant to 0 have been assessed positively.

(2) Successful completion of the degree programme is documented by issuing a certificate. The master's degree certificate for the Master's Degree Programme Green Process Engineering is composed of

a. a list of all completed modules set out in 0 (along with their ECTS credit points) and their assessments,
b. the title and assessment of the master's thesis,
c. the assessment of the master's examination,
d. the total in ECTS credit points completed in free-choice subjects, as defined in 0, and
e. the overall assessment.

IV. Entry Into Force and Transitional Provisions

§ 15 Entry into force

This curriculum shall come into effect on 1 October 2025.

§ 16 Transitional provisions

Students of the Master's Degree Programme Green Process Engineering who are subject to the 2017 curriculum in its 2022 version (previously Master's Degree Programme Biorefinery Engineering) when this curriculum enters into force on 1 October 2025, are entitled to complete their studies according to the provisions of the 2017 curriculum in its 2022 version by 30 September 2028. If the degree programme is not completed by 30 September 2028, students become subject to the curriculum as amended. Students are entitled to voluntarily opt for the new curriculum at any time within the admission periods. To this end, an irrevocable written declaration must be sent to the officer responsible for study matters. The equivalence between those examinations completed within the framework of the curriculum version 2017 and those completed within the framework of the curriculum version 2025 is established in Appendix IV: Equivalence List.

Appendices to the curriculum of the Master's Degree Programme Green Process Engineering

Appendix I: Module Descriptions

Compulsory Module A.1	**Bridge Courses for Students with a Bachelor's Degree in Chemistry or Molecular Biology**
ECTS credit points:	17
Contents:	• Linear algebra: vectors, matrices, solving systems of linear equations; analysis: total and partial derivatives, integral calculus, differential equations, Fourier analysis, and applications to wave and heat propagation • Material and energy balances with and without chemical reactions; analysis of degrees of freedom; flow diagrams, computer methods • First law of thermodynamics, properties and equations of state, gas mixtures, changes of state of ideal gases, cyclic processes, second law of thermodynamics, technical work, evaporation and liquefaction, steady-state flow processes, heat power processes, exergy, refrigeration processes • Fundamentals of the transport of mass and momentum in moving fluids • Dynamics of incompressible frictional and frictionless flows, interplay of inertial, pressure, viscosity, and mass forces acting on the fluid element under consideration • Fundamentals of diffusive and convective transport of thermal energy and components in mixtures, as well as methods for solving problems of heat conduction, convective heat transfer, diffusive mass transport, and convective mass transfer in multiphase systems
Learning outcomes:	After completing this module, students are able to • apply methods of analysis and linear algebra to engineering science. • balance process engineering processes. • explain and convert the individual forms of energy according to the first law of thermodynamics. • explain the limits of energy conversion according to the second law of thermodynamics. • distinguish between state variables and process variables. • identify the forces relevant to a specific flow problem and describe the problem mathematically appropriately, as well as mathematically describe and solve flow problems from the pharmaceutical/chemical industry. • mathematically explain and describe specific tasks from industrial chemistry with regard to diffusive and convective transport of thermal energy and components in mixtures of substances.
Prerequisites for participation:	Fundamental knowledge of mathematics and natural sciences
Frequency in which the module is provided:	Every academic year

Compulsory Module A.2	Bridge Courses for Students with a Bachelor's Degree in Environmental Systems Sciences / Natural Sciences-Technology or Physics
ECTS credit points:	17
Contents:	• Unit operations, fermentation kinetics, material and energy balances, sterilisation, mass and heat transfer, mixing and residence time distribution behaviour, fermentation scale-up, process design • Material and energy balances with and without chemical reactions; degree of freedom analysis; flow diagrams, computer methods; combustion calculation • Introduction to chemical reaction engineering of ideal homogeneous gas and liquid phase reactions, creation and interpretation of temperature-dependent rate laws, development of the reactor design algorithm for ideal isothermal reactors; laboratory for heterogeneous and homogeneous catalysis • Fundamentals of the transport of mass and momentum in moving fluids • Dynamics of incompressible frictional and frictionless flows, interplay of inertial, pressure, viscosity, and mass forces acting on the fluid element under consideration • Fundamentals of diffusive and convective transport of thermal energy and components in mixtures, as well as methods for solving problems of heat conduction, convective heat transfer, diffusive mass transport, and convective mass transfer in multiphase systems
Learning outcomes:	After completing this module, students are able to • connect and apply kinetics and transport processes to the planning and development of industrial biotechnological processes. • balance process engineering processes. • work through and apply the basic steps of reactor design. • critically examine and correctly interpret kinetic data. • create the material and energy balance for an ideal reactor, describe isothermal and non-isothermal reactor operation and simulate them in the laboratory. • identify the forces relevant to a specific flow problem and describe the problem mathematically appropriately, as well as mathematically describe and solve flow problems from the pharmaceutical/chemical industry. • mathematically explain and describe specific tasks from industrial chemistry with regard to diffusive and convective transport of thermal energy and components in mixtures of substances.
Prerequisites for participation:	Fundamental knowledge of mathematics and natural sciences
Frequency in which the module is provided:	Every academic year

Compulsory Module A.3	Bridge Courses for Students with a Bachelor's Degree in Mechanical Engineering / Mechanical Engineering and Business Economics
ECTS credit points:	17
Contents:	• Unit operations, fermentation kinetics, material and energy balances, sterilisation, mass and heat transfer, mixing and residence time distribution behaviour, fermentation scale-up, process design • Material and energy balances with and without chemical reactions; degree of freedom analysis; flow diagrams, computer methods; combustion calculation • Introduction to chemical reaction engineering of ideal homogeneous gas and liquid phase reactions, creation and interpretation of temperature-dependent rate laws, development of the reactor design algorithm for ideal isothermal reactors; laboratory for heterogeneous and homogeneous catalysis • Classical wet chemical analysis methods, sampling methods, fundamentals of electrochemistry, optical analysis methods, chromatographic methods • Fundamentals of inorganic and organic chemistry • Chemical bonds in organic molecules, nomenclature, substance classes, stereochemistry, essential chemical reactions (e.g. radical reactions, nucleophilic substitution...), structural analysis of organic molecules
Learning outcomes:	After completing this module, students are able to • connect and apply kinetics and transport processes to the planning and development of industrial biotechnological processes. • apply quantitative principles using examples from industry. • balance process engineering processes. • work through and apply the basic steps of reactor design. • critically examine and correctly interpret kinetic data. • create the material and energy balance for an ideal reactor, describe isothermal and non-isothermal reactor operation and simulate them in the laboratory. • apply essential analytical methods from chemistry to a problem. • estimate the reactivity and substance properties of the essential chemical substances. • name organic molecules correctly and explain essential chemical reactions. • name the most important classes of substances and their explain structural properties as well as the methods necessary for structural analysis.
Prerequisites for participation:	Fundamental knowledge of mathematics and natural sciences
Frequency in which the module is provided:	Every academic year

Compulsory Module B	Green Process Engineering Basics
ECTS credit points:	13
Contents:	• Resources and technologies in a bioeconomy, bioeconomy sectors, energy transition, and the development of sustainable materials • Phase diagrams of pure substances and mixtures; thermal equations of state for pure substances; Gibbs thermodynamics; application of Maxwell's relations; standard calorific data; thermodynamics of mixtures; calculation of real phase equilibria; vapor-liquid equilibrium • Introduction to thermal separation processes, calculation methods, and design methods (separation stage concept, HTU-NTU) for the separation operations of absorption, distillation, and extraction
Learning outcomes:	After completing this module, students are able to • identify and explain the key factors for a transition to a bioeconomy. • place and explain the need to adapt existing technologies and develop new ones in the context of a bioeconomy. • apply the fundamentals, essential methods, and models of chemical thermodynamics. • understand various approaches for calculating material properties and phase equilibria in unit processes and systems, and assess their applications and limitations. • explain the unit operations of absorption, distillation, drying, and extraction and apply the relevant calculation methods.
Prerequisites for participation:	Fundamental knowledge of thermodynamics
Frequency in which the module is provided:	Every academic year

Compulsory Module C	Chemical and Analytical Aspects
ECTS credit points:	14
Contents:	• Analytical methods: theoretical and practical introduction to direct analytical methods for the identification and characterisation of bio-based materials • Overview of the major classes of bio-based materials and possibilities for modifying these materials • Material classes: polysaccharides and oligosaccharides, proteins, DNA, polyamides, and polyesters • Surface analysis methods (SEM, AFM, ATR, PECVD, PVD) • Introduction to the principles of green chemistry with application examples • Availability, composition, and utilisation of woody biomass and crops (starch, sugar, oil, and proteins) • Key analytical methods for biomass characterisation • Development of value chains based on crops and woody biomass
Learning outcomes:	After completing this module, students are able to • explain and apply basic and advanced analytical methods for bio-based materials. • explain the major classes of bio-based materials and their respective production routes. • explain and independently implement chemical modification routes for the functionalisation of bio-based materials. • develop strategies for the production of bio-based materials. • explain the principles of green chemistry and apply them within their scope. • calculate the land and nutrient requirements for cultivating crops or woody biomass (mass and energy balances). • explain biorefineries / value chains based on woody biomass and/or crops and evaluate the generated products in terms of potential yield.
Prerequisites for participation:	Fundamental knowledge of chemistry and analytics
Frequency in which the module is provided:	Every academic year

Compulsory Module D	Green Technologies
ECTS credit points:	16
Contents:	• State-of-the-art technology and new processes for biomass utilisation and fractionation, or for the increased material utilisation of renewable resources, complex biomass, C1 utilisation • Fundamentals of renewables for energy generation; biomass as an energy raw material • Key conversion processes (combustion, gasification, pyrolysis, hydrothermal processing) and their application to heat, electricity, and biofuel generation • Tools for modelling conversion processes (CFD) in process analysis and technology development – with practical examples • Energy, energy flow, and parameters; loads and load profiles, basic technologies for power generation; basic technologies for transport and distribution; the power grid, structure of energy supply systems, future developments and forecasts; costs; system stability and control; grid disruptions and security/protective measures; power quality; decentralised power generation; smart grids • Fundamentals of life cycle assessment and application using specific examples
Learning outcomes:	After completing this module, students are able to • apply the biorefinery concept to different raw materials (e.g., CO_2, biomass) and explain the upstream, midstream, and downstream processes. • explain the technological challenges and opportunities of the transfer process towards a bioeconomy and their own technically well-reasoned point of view. • mathematically map upstream, midstream, and downstream processes (mass and energy balances). • apply thermochemical technologies for the energetic use of biomass (heat, electricity, biofuels). • identify biomass-based conversion pathways and develop a utilisation concept (mass and energy balances). • provide an overview of the determining elements of the energy supply system, their basic functions, and determining parameters. • describe the relationship between load profile and system design and identify the requirements and effectiveness of protective measures. • independently prepare and present information/knowledge about businesses in the bio-based industrial sector. • conduct a life cycle assessment (LCA) using a standard tool.
Prerequisites for participation:	Fundamental knowledge of electrical engineering, complex calculations, thermodynamics, mass and energy balances, organic chemistry
Frequency in which the module is provided:	Every academic year

Appendix II: Recommended Free-Choice Subjects

Students can choose free-choice courses as desired in accordance with 0 of this curriculum.

For students to broaden their knowledge, courses in the fields of foreign languages, social competence, technological impacts assessment and women's and gender studies are recommended. In particular, the following institutions and service departments as well as the TU Graz certificate programme for key competencies are recommended:

- Languages, Key Competencies and In-House Training of TU Graz,
- Science, Technology and Society Unit (STS Unit) of TU Graz,
- Treffpunkt sprachen – Centre for Language, Plurilingualism and Didactics at Uni Graz,
- the transfer initiative for management and entrepreneurship fundamentals, awareness, training and employability ("TIMEGATE"), and
- Centre for Social Competence of Uni Graz.

Additionally, the following courses are recommended:

Course	SSt	Type	ECTS	Semester
Safety and Sustainability	2	VO	3	SS
General Management and Organisation	2	VO	3	SS
General Management and Organisation	2	UE	3	SS
Gender and Diversity in Research and Inclusive Design	2	VU	2	WS

Appendix III: Equivalence List

(1) Equivalency of courses when switching from the expiring Master's Degree Programme Biorefinery Engineering curriculum version 2017 to the new Master's Degree Programme Green Process Engineering curriculum version 2025

The courses of the new curriculum are listed on the left-hand side of the table. The corresponding equivalent courses in the expiring Master's Degree Programme Biorefinery Engineering are listed on the right-hand side of the table. Any courses of the expiring curriculum that have no equivalent course according to this list may be taken as free-choice courses.

Courses that have the same title and type, number of ECTS credit points and number of semester hours are considered to be equivalent and are thus not explicitly listed in the equivalence list.

Curriculum Green Process Engineering 2025					**Expiring curriculum Biorefinery Engineering 2017 in the version of 2022**				
	Course	Course type	ECTS	SSt		Course	Course type	ECTS	SSt
	Mass and Energy Balances	VU	3	2		no equivalency (individual recognition)			
	Energy Mathematics	VU	3	2		no equivalency (individual recognition)			
	Analytical Chemistry	VO	3	2		no equivalency (individual recognition)			
	Analytical Chemistry I	VO	2	1.33		no equivalency (individual recognition)			
	Analytical Chemistry II	VO	2	1.33		no equivalency (individual recognition)			
	Bioresource Process Technologies	VU	5	4		Chemical Engineering and Bio-Based Products	VU	4.5	3.5
	Introduction to Green process Engineering and Green Chemistry and Technology	VO VO	2.5 2	1.5 1.33		Business Development for Bioresources	SE	5	5
	Life Cycle Assessment GPE	SP	4	3		LCA of Bioresource Value Chains and LCA of Bioresource Value Chains	VO UE	3 1	2 1
	Bio-Based Materials: Processing, Engineering and Analysis	LU	3	4		Bio-Based Materials: Processing, Engineering and Analysis	LU	2	2
	Bioresources	SE	4	4		Crop Bioresources – Characterisation and Properties and Lignocellulose Bioresources – Characterisation and Properties	VO VO	3 3	2 2

Curriculum Green Process Engineering 2025					Expiring curriculum Biorefinery Engineering 2017 in the version of 2022				
	Course	Course type	ECTS	SSt		Course	Course type	ECTS	SSt
	Industry Excursion Green Process Engineering	EX	1	1		Industry Excursion Biorefinery	EX	1	1
	Green Process Engineering Project	PT	6	6		Biorefinery Project	PT	6	6
	Fundamentals of Electrical Power Systems GPE	VO	2	3		Fundamentals of Electrical Power Systems for Biorefineries	VO	2	3
	Introduction to Process Simulation and Process Design	VU	3	4		Introduction to Process Simulation and Process Design and Introduction to Process Simulation and Process Design	VO UE	1 2	2 2
	ECTS credit points from courses in Elective Module E: Green Energy and Energy Management					ECTS credit points from courses in the Elective Module "Energy Utilisation"			
	ECTS credit points from courses in Elective Module F: Green Process Engineering Technologies OR Elective Module G: Green Chemistry and Biotechnology					ECTS credit points from courses in the Elective Module "Materials Utilisation and Recovery"			

(2) Regulations for continuing with the expiring Master's Degree Programme Biorefinery Engineering curriculum 2017 in the version of 2022

The courses of the expiring Master's Degree Programme Biorefinery Engineering are listed on the left-hand side of the table. On the right side of the table is a list of courses from the new curriculum that may be completed instead of the courses originally listed in the curriculum if the student wishes to remain in the expiring curriculum and the original courses are no longer offered.

Courses that have the same title and type, number of ECTS credit points and number of semester hours are considered to be equivalent and are thus not explicitly listed in the equivalence list.

Expiring curriculum Biorefinery Engineering2017 in the version of 2022					**Curriculum Green Process Engineering 2025**				
	Course	Course type	ECTS	SSt		Course	Course type	ECTS	SSt
	Bio-Based Materials: Processing, Engineering and Analysis	LU	2	2		Bio-Based Materials: Processing, Engineering and Analysis	LU	3	4
	Business Development for Bioresources	SE	5	5		Entrepreneurship and Entrepreneurship	VO UE	3 1	2 1
	LCA of Bioresource Value Chains and LCA of Bioresource Value Chains	VO UE	3 1	2 1		Life Cycle Assessment GPE	SP	4	3
	Crop Bioresources – Characterisation and Properties and Lignocellulose Bioresources – Characterisation and Properties	VO VO	3 3	2 2		Bioresources	SE	4	4
	Chemical Engineering of Bio-Based Products	VU	4.5	3.5		Bioresource Process Technologies	VU	5	4
	Industry Excursion Biorefinery	EX	1	1		Industry Excursion Green Process Engineering	EX	1	1
	Biorefinery Project	PT	6	6		Green Process Engineering Project	PT	6	6
	Fundamentals of Electrical Power Systems for Biorefineries	VO	2	3		Fundamentals of Electrical Power Systems GPE	VO	2	3
	Introduction to Process Simulation and Process Design and Introduction to Process Simulation and Process Design	VO UE	1 2	2 2		Introduction to Process Simulation and Process Design	VU	3	4

Expiring curriculum Biorefinery Engineering2017 in the version of 2022					Curriculum Green Process Engineering 2025				
	Course	Course type	ECTS	SSt		Course	Course type	ECTS	SSt
	ECTS credit points from courses in the Elective Module "Energy Utilisation"					ECTS credit points from courses in Elective Module E: Green Energy and Energy Management			
	ECTS credit points from courses in the Elective Module "Materials Utilisation and Recovery"					ECTS credit points from courses in Elective Module F: Green Process Engineering Technologies OR Elective Module G: Green Chemistry and Biotechnology			