Curriculum for the ”International Master’s Programme on Circular Economy“

The legal basis for the interdisciplinary “International Master’s Programme on Circular Economy” are the Austrian Universities Act (Universitätsgesetz – UG) and the Statues of the University of Graz.

The following curriculum for the Erasmus Mundus Master's Programme in Industrial Ecology was issued by the Senate on 25.05.2011 according to § 25 subsection 1 number 10 of the Austrian Universities Act (UG).

The first amendment to the curriculum for the International Master's Programme in Industrial Ecology was issued by the Senate on 28.06.2017 according to § 25 subsection 1 number 10 of the Austrian Universities Act (UG).

The second amendment to the curriculum for the International Master's Programme in Industrial Ecology was issued by the Senate on 27.06.2018 according to § 25 subsection 1 number 10 of the Austrian Universities Act (UG).

The third amendment to the curriculum for the International Master's Programme on Circular Economy was issued by the Senate on 08.05.2019 according to § 25 subsection 1 number 10 of the Austrian Universities Act (UG).

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§ 1 Subject of study, Qualifications and Relevance of the Programme

(1) Subject of Study

Following the Lisbon Strategy, the European Union (EU) adopted a ten-year strategy “Europa 2020”, which aims at a smart, sustainable and inclusive growth of the economy in the European Union. In addition to this, the European Commission adopted the “Circular Economy Package” promoting closed loop approaches in production processes (e.g. recycling and reusing) for the benefit of the environment as well as the economy. The EU already plays a significant role in the field of global green technologies, and it promotes a further expansion of this position. The underlying objective is the development of innovative technologies to encourage economic growth as well as at the same time reduce resource consumption and emissions. The development of such technologies demands for them to be part of a comprehensive sustainability solution. Simplified solutions with adverse side effects or shifting the burdens to other geographical areas or into the future should be prevented. All this reflects a need for a systematic approach.

Graduates of various studies can use the knowledge they have gained to create and optimize technologies for sustainable development. With its integrated approach, the International Master’s Programme on Circular Economy (CIRCLE) enables the graduates to comprehensively analyze and evaluate sustainable developments and technical systems.

Circular Economy is an expanding interdisciplinary field combining natural, social as well as technical sciences. Through an integrated systematic approach, it is present at various levels ranging from global to local ones. Issues related to the environment require a systemic approach so that the connections and feedbacks between industrial activity, human actions and ecological processes can be incorporated in the assessment and problem solving.

The field of “Circular Economy” encompasses physical, chemical and biological links and correlations among several industrial systems as well as between industrial and ecological systems.

The objective of the “International Master's Programme on Circular Economy” is to offer an international and interdisciplinary Master's programme of the best quality, which allows the participants to make an essential contribution to understanding key issues as well as finding solutions for these problems to support the transition towards a sustainable society, cf. Art. 1(3).

The composition of the consortium offers the participants a unique view on “Circular Economy” at global, European and local levels. In this way, the students develop a methodologically correct approach to complex interdisciplinary issues. At the same time, experts from the partner universities introduce them to specific subject areas. In this way, a strong emphasis is placed both on research and application of practical solutions in the context of sustainable development.

The “International Master's Programme on Circular Economy” is a leading interdisciplinary study programme of the best quality. Because of its international character, it is held exclusively in English. The possible career paths for graduates are based on the specialisations offered by the partner universities. Based on the Bachelor education of individual students, the selected specializations, the study stays abroad and the topic of the master thesis, the students are given diverse opportunities in science as well as an appropriate foundation for them to apply their knowledge in practice.

(2) Qualifications and Skills

Upon completing the International Master's Programme on Circular Economy, the graduates should be able:

- To understand and adequately describe the dynamics, complexity and correlations among natural, technical, social and economic processes and systems in terms of sustainable development.
- To apply and improve methods and techniques in the field of circular economy according to the latest scientific developments. This includes methods of system analysis, life cycle assessment, material flow analysis, input-output analysis, stakeholder analysis, transition management, recycling, reusing, remanufacturing, refurbishing and the implementation, monitoring and management of innovation processes.
- To analyze problems in the field of circular economy such as waste, resource and technology management from a multidisciplinary perspective.
- To identify, analyze and assess environmental impacts of processes, products, projects and strategies.
- To apply general academic skills to the context of circular ecology, such as the use of research methods and tools from statistics, data collection, modelling techniques, IT, as well as the critical application and evaluation of theories, concepts and principles.

- To prepare the findings in a clear written form and in form of presentations for academic and non-academic target groups.
- To apply their knowledge and scientific skills on complex issues in inter- and transdisciplinary teams, furthermore to demonstrate necessary social skills (e.g. discussion, conflict management, teamwork, project management) and therefore to be able to contribute to a transition towards a sustainable society.

(3) Demand and Relevance of the Programme for Science and the Job Market

Career paths for which the competences are developed are strongly related to the chosen specialization and include the academic, private, public and semi-public sectors. Graduates can find a position in the following fields (in alphabetical order):

- Administration
- Applied scientific research in the field of circular economy
- Environmental and management consultancy
- Industrial companies (e.g. product design, waste management)
- International organisations
- Management, including quality assurance and environmental management
- Non-government organisations
- Service industry
- Teaching as well as subsequent studies in the field of circular economy

The Joint Master's Programme entitles the students to continue their education at the doctoral level.

§ 2 General Regulations

(1) Conditions for Admission

1. The requirement for the admission to the International Master's Programme on Circular Economy is the completion of one of the following subject-specific Bachelor's degrees:

- Bachelor's Programme Environmental System Sciences – Business Administration at the University of Graz
- Bachelor's Programme Environmental System Sciences – Geography at the University of Graz
- Bachelor´s Programme Environmental System Sciences – Economics Bachelor's programme at the University of Graz
- Bachelor´s Programme Environmental System Sciences – Natural Sciences-Technology at the University of Graz

2. A study programme in the fields of engineering sciences, natural sciences, environmental sciences, social sciences or economics of at least 180 ECTS credits of which a total of at least 36 ECTS credits were awarded in the following fields is equivalent to a subject-specific Bachelor's programme/first higher education programme:

- Courses with a total of at least 12 ECTS credits in Mathematics and Statistics and
- Courses with a total of at least 12 ECTS credits in Environmental Sciences and/or Natural Science and
- Courses with a total of at least 12 ECTS credits in Social Sciences and/or Economics

3. A study programme in the fields of engineering sciences, natural sciences, environmental sciences, social sciences or economics of at least 180 ECTS credits of which a total of at least 24 ECTS credits were awarded in the fields named in number 2 is partly equivalent to a subject-specific Bachelor's programme/first higher education programme. A complete equivalence to a subject-specific Bachelor's programme/first higher education programme can be achieved by taking and passing additional exams in the amount of maximum 12 ECTS credits in the fields named in number 2.

4. Study programmes in which less than 24 ECTS credits named in number 2 are awarded or study programmes for which a complete equivalence would be achieved by having to earn more than 12 additional ECTS credits are not equivalent to a subject-specific Bachelor's programme/first higher education programme.

5. Aa part of the prerequisites for the admission, students must prove they have the knowledge of English necessary for taking part in the study programme. The character of the language certificate is determined in the relevant regulations of the Rector’s office.

(2) Double Degree Programme

The lnternational Master's Programme on Circular Economy is a joint study programme according to §§ 51 subsection 2 number 26 in conjunction with 54d UG. The programme is offered as a Double Degree Program in cooperation with the following partner universities:

- Chalmers University of Technology (Sweden, SE),
- Delft University of Technology (The Netherlands, NL),
- Leiden University (NL),
- Norwegian University of Science and Technology (Norway, NO),

These universities constitute the CIRCLE consortium.

The associated partner universities of the consortium:

- Curtin University Perth (Australia, AU),
- Waseda University Tokyo (Japan, JP) and
- Tsinghua University Beijing (China, CN)

offer an additional not-obligatory mobility opportunity for students to either take their specialization module (3rd semester, except for Tsinghua University) or to write their Master Thesis (4th semester).

The prerequisite for admission to the Double Degree Programme is a successful completion of the selection process carried out by the CIRCLE Admission Committee. The CIRCLE Admission Committee consists of one member per European university named above. The Leiden University and the Delft University of Technology are represented by one joint member. Based on a system of criteria, the CIRCLE Admission Committee selects the most eligible candidates. The criteria and the deadlines for the selection process are annually posted on the following website: http://www.emcircle.eu. The candidates will be informed about the decisions of the Admission Committee in writing. For the Double Degree Program, a maximum of 10 students per European partner university will be chosen, of which the Leiden University and the Delft University of Technology are considered as one university. The selected students must then complete an admission process at the respective universities to be admitted to the programme.

(3) Duration and Structure of the Programme

The Master Programme with a workload of 120 ECTS credits lasts four semesters and has a modular character.

Module Abbreviation and Module	ECTS
Module A: Basic Knowledge and Circular Economy Tools	30
Module B: Implementation, Management and Design	15
Module C: Specialisation Module	30
Master Thesis[1] *or* Master Thesis[2] *and* Master Seminar[2] *and* Master Exam[2]	30 (27) (2) (1)
Free Electives	15
Total	120

[1] Chalmers (SE), Delft/Leiden (NL), Trondheim (NO), Perth (AU), Tokyo (JP), Beijing (CN)
[2] Graz (AT)

(4) Academic Degree

Upon completion of the "Erasmus Mundus Master's Programme in Circular Ecology", the students are awarded a Master of Science degree, abbreviated "MSc".
The two European Universities of the CIRCLE consortium at which graduates of the Master´s Programme completed their studies, award the graduates a Double Degree. A Double Degree can only be awarded, if the graduates fulfill the respective legal prerequisites of the universities in the CIRCLE consortium (cf. § 2 subsection 2) for awarding an academic degree.

(5) Limitation of Places in Courses and Selection Criteria

1. In some course types, there might be a limited number of allowed participants. This is due to educational reasons, space, device and equipment availability as well as safety reasons:

Course type	Nr. of participants
Lectures ("Vorlesung", VO)	No limitation
Courses ("Kurs", KS)	25
Seminar ("Seminar", SE)	15
Working group ("Arbeitsgemeinschaft", AG)	20

2. If the maximal number of students is exceeded, the students are awarded places in the courses according to the criteria of the URBI ranking system. The ranking system is determined in the current version of the relevant directives of the Senate on awarding places in the courses where the number of participants is limited.

§ 3 Structure of the Studies

(1) Modules and Exams

In the table below, the modules and exams are named by module title, course title, course type, ECTS credits (ECTS), contact hours (ConH) and the recommended semester (Reco. Sem.). For module descriptions see Annex 1.

1. Students who have been selected by the CIRCLE consortium to participate in the Double Degree Programme and who fulfill the criteria for admission to the University of Graz in the first year complete the following study path:

	Modules and Exams	Type	ECTS	ConH.	Reco. Sem.
Year 1 (University of Graz)					
Module A.I	**Basic Knowledge and Circular Economy Tools**		**30**	**16**	
A.I.1	Eco-Controlling	KS	4	2	1/2
A.I.2	Sustainability Entrepreneurship	KS	4	2	1/2
A.I.3	Research Project Sustainability Management	AG	6	4	1/2
A.I.4	Product and Service Development	KS	4	2	1/2
A.I.5	Environmental and Technology Assessment	KS	4	2	1
A.I.6	Waste and Recycling	KS	4	2	1/2
A.I.7	Fundamentals of Circular Economy and Industrial Ecology	SE	4	2	1
Module B.I	**Implementation, Management and Design**		**15**	**8**	
B.I.1	Earth's Climate System and Climate Change	VO	3	2	1/2
B.I.2	Strategic Sustainability Management	KS	4	2	1/2
B.I.3	Value Chain Management	KS	4	2	2
B.I.4	Selected Topics of Sustainability and Innovation Management	KS	4	2	1/2
	Free Electives		**15**		2
Year 2: Students choose one of the modules from C.II to VI and one of the options for their Master Thesis.					
Module C	**Specialisation Module**				
Module C.II	**Climate Change Mitigation and Sustainable Energy Systems in a Circular Economy Chalmers University of Technology, SE**		**30**		**3**
C.II.1	Sustainable Energy Futures	KS	7.5		3
C.II.2	Industrial Energy Systems	KS	7.5		3
C.II.3	Technical Change and the Environment	KS	7.5		3
C.II.4	Fuel Cells – Functions and Materials	KS	7.5		3
C.II.5	Sustainable Transportation	KS	7.5		3
C.II.6	Environmentally Adapted Product Development	KS	7.5		3
C.II.7	Sustainable Power Production and Transportation	KS	7.5		3
C.II.8	Assessing Sustainability	KS	7.5		3
C.II.9	Leadership for Sustainable Transitions	KS	7.5		3
C.II.10	Sustainable Electric Power Systems	KS	7.5		3
C.II.11	Managing Stakeholders for Sustainable Development	KS	7.5		3
C.II.1 is compulsory; from C.II.2 to C.II.11, students choose three courses (total: 30 ECTS)					

Module C.III	**Design of Circular Economy Delft University of Technology / Leiden University, NL**		**30**		**3**
C.III.1	Interdisciplinary Project Groups	AG	12		3
C.III.2	Master Thesis Preparation	SE	6		3
C.III.3	LCA Practice and Reporting	KS	9		3
C.III.4	GIS and Urban Mining	KS	4		3
C.III.5	Environmental Input-Output Analysis	KS	6		3
C.III.6	Advanced Material Flow Analysis	AG	6		3
C.III.1 and C.III.2 are compulsory; from C.III.3 to C.III.6, students choose courses in the amount of 12 ECTS (total: 30 ECTS)					
Module C.IV	**Modelling of Circular Economy Norwegian University of Science and Technology, NO**		**30**		**3**
C.IV.1	Industrial Ecology Project	KS	15		3
C.IV.2	Environmental Management and Corporate Governance	KS	7.5		3
C.IV.3	Critical Review and Communication of Science	KS	7.5		3
C.IV.4	Revision of the Basic Tools	KS	7.5		3
C.IV.5	Lifecycle Performance of Aluminium Products	KS	7.5		3
C.IV.1 is compulsory; from C.IV.2 to C.IV.5, students choose two courses (total: 30 ECTS)					
Module C.V	**Recycling and Remanufacturing for Circular Economy Curtin University of Technology, AU**		**30**		**3**
C.V.1	Corporate Stewardship	KS	7.5		3
C.V.2	Sustainable Energy	KS	7.5		3
C.V.3	Environmental Systems (Recycling Systems)	KS	7.5		3
C.V.4	Organisational Strategies for Sustainability	KS	7.5		3
C.V.5	Eco-Efficiency (Remanufacturing Systems)	KS	7.5		3
Students choose 4 out of 5 courses from C.V.1 to 5 (total: 30 ECTS)					
Module C.VI	**Economics of Circular Economy Waseda University, JP**		**30**		**3**
C.VI.1	Research Seminar on Industrial Ecology and Econometrics	SE	5		3
C.VI.2	Hybrid Input-Output Analysis in Industrial Ecology	KS	5		3
C.VI.3	Industrial Ecology	KS	5		3
C.VI.4	Econometrics	KS	5		3
C.VI.5	Environmental Economics	KS	5		3
C.VI.6	Asian Economy	KS	5		3
	Master Thesis (Chalmers University of Technology, SE)		**30**		**4**
	Thesis Research Project (Delft University of Technology / Leiden University, NL)		**30**		**4**
	Master Thesis (Norwegian University of Science and Technology, NO)		**30**		**4**
	Master Thesis (Curtin University, AU)		**30**		**4**
	Master Thesis (Waseda University, JP)		**30**		**4**
	Master Thesis (Tsinghua University, CN)		**30**		**4**

The basis for the curriculum of the Double Degree Programm at the respective European partner universities are the following Master's Programms:

- Chalmers University of Technology, SE - M.Sc. in Industrial Ecology: https://www.chalmers.se/en/education/programmes/masters-info/Pages/Industrial-Ecology.aspx

- Delft University of Technology and Leiden University, NL - M.Sc. in Industrial Ecology: https://www.universiteitleiden.nl/en/education/study-programmes/master/industrial-ecology

- Norwegian University of Science and Technology Trondheim, NO - M.Sc. in Industrial Ecology with focus on Circular Economy: https://www.ntnu.edu/studies/msindecol

When deciding on the option for the Master Thesis, the legal provisions in force for obtaining a Double Degree of individual European partner universities should be considered.

2. The students who spend the second year of the Double Degree Programme at the University of Graz and who completed the modules A and B in the first year at one of the European Universities complete the following study path:

	Modules and Exams	Type	ECTS	ConH	Reco. Sem.
Year 1 (choice: module A.II and B.II or A.III and B.III or A.IV and B.IV)					
Module A	**Basic Knowledge and Circular Economy Tools**		**30**		**1**
A.II	**Chalmers University of Technology, SE**				
A.II.1	Science of Environmental Change	KS	7.5		1
A.II.2	Technical Change and the Environment	KS	7.5		1
A.II.3	Sustainable Development	KS	7.5		1
A.II.4	Environmental Systems Analysis	KS	7.5		1
A.III	**Delft University of Technology / Leiden University, NL**				
A.III.1	Fundamentals of Systems, Data, Models and Computational Thinking	KS	6		1
A.III.2	General Introduction to Industrial Ecology	KS	6		1
A.III.3	System Earth	KS	6		1
A.III.4	Analytical Methodologies and Tools	KS	6		1
A.III.5	Renewable Energy Systems	KS	6		1
A.IV	**Norwegian University of Science and Technology, NO**				
A.IV.1	Life Cycle Assessment	KS	7.5		1
A.IV.2	Material Flow Analysis	KS	7.5		1
A.IV.3	Climate Change Mitigation	KS	7.5		1
A.IV.4	Solid Waste Technology and Resource Recovery	KS	7.5		1

Module B	**Implementation, Management and Design**		**30**		**2**
B.II	**Chalmers University of Technology, SE**				
B.II.1	Environmental Management	KS	7.5		2
B.II.2	Environmental Policy Instruments	KS	7.5		2
B.II.3	Life Cycle Assessment	KS	7.5		2
B.II.4	Circular Economy	KS	7.5		2
B.III	**Delft University of Technology / Leiden University, NL**				
B.III.1	Design of Sustainable Technological Systems	KS	6		2
B.III.2	Social Systems – Policy and Management	KS	6		2
B.III.3	Sustainable Innovation and Social Change	KS	6		2
B.III.4	Specialization Module Circular Economy	KS	6		2
B.III.5	Free Electives (z.B. CIRCLE Summer School, Closed Loop Supply Chains, Urban Environments and Infrastructure)		6		2
B.IV	**Norwegian University of Science and Technology, NO**				
B.IV.1	Experts in Teamwork	KS	7.5		2
B.IV.2	Environmental and Resource Economics	KS	7.5		2
B.IV.3	Understanding and Quantifying Environmental Impacts on Ecosystems	KS	7.5		2
B.IV.4	Input-Output Analysis	KS	7.5		2
B.IV.5	Modeling of Built Environment Systems	KS	7.5		2
B.IV.1 is compulsory; from B.IV.2–B.IV.5, students choose three courses (total: 30 ECTS)					
Year 2 (University of Graz)					
Module C	**Specialisation Module**				
Module C.I	**The Human Dimension of Circular Economy Universität Graz, AT**		**30**		**3**
C.I.1	Environmental Decision-Making	KS	4	2	3
C.I.2	Integrated Management Systems	KS	4	2	3
C.I.3	Methods for Inter- and Transdisciplinary Problem-Solving	SE	2	2	3
C.I.4	Sustainable Innovation	KS	4	2	3
C.I.5	Research Project Innovation Management	AG	6	4	3
C.I.6	Interdisciplinary Practical Training	AG	10	6	3
	Master Thesis		**27**		**4**
	Master Seminar	**SE**	**2**		**4**
	Master Exam		**1**		**4**

The basis for the curriculum of the Double Degree Programme at the respective European partner universities are the following Master´s Programmes:

- Chalmers University of Technology, SE - M.Sc. in Industrial Ecology: https://www.chalmers.se/en/education/programmes/masters-info/Pages/Industrial-Ecology.aspx

- Delft University of Technology and Leiden University, NL - M.Sc. in Industrial Ecology: https://www.universiteitleiden.nl/en/education/study-programmes/master/industrial-ecology

- Norwegian University of Science and Technology Trondheim, NO - M.Sc. in Industrial Ecology with focus on Circular Economy: https://www.ntnu.edu/studies/msindecol

(2) Master Thesis

The topic of the master thesis is to be determined based on one of the following modules:

- Module A: Basic Knowledge and Circular Economy Tools
- Module B: Implementation, Management and Design
- Module C: Specialisation Module

This provision applies to all partner universities.
The Master Thesis must be written in English.

(3) Free Electives

1. It is recommended to choose the "CIRCLE Summer School" which amounts to a total of 3 ECTS credits.

2. It is recommended to choose the electives from the following fields:

   Courses at the Wegener Center, courses in the field of women and gender studies, foreign languages, courses from the offer "Timegate" or courses of the center for social competences as well as of the STS Unit of the Graz University of Technology.

3. It is recommended that the students complete a study related internship as their elective subject in the amount of 12 ECTS credits where one week in the sense of a regular employment corresponds to 1,5 ECTS credits.

(4) Mobility

During the application process, students can name three European universities, in order of their preference, as their host university 1 and host university 2. These preferences will be, if possible, considered in the allocation procedure.
The first year must be completed at one of the European universities, of which the Leiden University and Delft University of Technology represent one university.
In the second year, students choose one of the modules C.I to C.VI and one of the options for the Master Thesis. It should be considered that each student must successfully complete at least one semester (total of 30 ECTS credits) at one of the European partner universities which is not the same as the university that the student attended in the first year.
Per year, a total of three students of the whole consortium have the opportunity to complete the 3rd or 4th semester at one of the non-European partner universities. Only one student will be chosen for each non-European partner university (selection criteria: quality of motivation letter, research project/study, accademic success).

(5) Language

The whole study will be conducted exclusively in English.

§ 4 Examination Regulations

Master Exam

The Master Exam is conducted by an exam board and is awarded 1 ECTS credit. The exam board is set up of three people.
The Master Exam consists of (a) a public defense of the Master Thesis and (b) the module to which the Master Thesis is allocated.
The exam can be taken when all other exams of the Master´s Programme and the Master Thesis receive a positive evaluation.

§ 5 Coming into Effect of the Curriculum

(1) The present curriculum comes into effect on 01.10.2011. (Curriculum 2011)

(2) The 1st amendment to this curriculum, disclosed in the University´s bulletin on 29.06.2017, Issue 38.v, 126th Special issue, comes into effect on 01.10.2017. (Curriculum 2011 in the version of 2017)

(3) The 2nd amendment to this curriculum, disclosed in the University´s bulletin on 28.06.2018, Issue 38.e, 65th Special issue, comes into effect on 01.10.2018. (Curriculum 2011 in the version of 2018)

(4) The 3rd amendment to this curriculum, disclosed in the University´s bulletin on 15.05.2019, Issue 30.g, 97th Special issue, comes into effect on 01.10.2019. (Curriculum 2011 in the version of 2019)

§ 6 Transitional provisions

(1) Students of the Erasmus Mundus Master's Programme in Industrial Ecology who are subject to the curriculum 11W when the amended curriculum comes into effect on 01.10.2017 become subject to the amended curriculum 17W on 01.10.2017. The students do not have to complete the Master seminar, in respect thereof their Master Thesis will be awarded 28 ECTS credits. These students are still awarded their academic title according to § 2 subsection 3 of the curriculum in the version 11W.

(2) Students of the Erasmus Mundus Master's Programme in Industrial Ecology who are subject to the curriculum 17W when the amended curriculum comes into effect on 01.10.2018 become subject to the amended curriculum 18W on 01.10.2018.

(3) Students of the International Master's Programme in Industrial Ecology who are subject to the 2018 version of the curriculum when the amended curriculum comes into effect on 01.10.2019 become subject to the curriculum in the version 2019 on 01.10.2019. If the students have already completed the seminar “Introduction to Industrial Ecology”, is the seminar “Fundamentals of Circular Economy and Industrial Ecology”, which is part of the 2019 curriculum, considered as completed as well. If the students finish their studies by 30.09.2022, they are still awarded the academic title according to § 2 subsection 3 of the curriculum in the version 2018.

Annex I: Description of Modules

Module A	Basic Knowledge and Circular Economy Tools
ECTS credits	30
Content	• Circular economy tools (CE) and basic knowledge of CE • Methods of system evaluation • Sustainability and sustainable development • Environmental impact and technology assessment • Resource and waste management • Renewable energy systems
Expected learning results and acquired competences	<u>Professional and methodological competences:</u> Upon completing the module, students are able to • understand the main tools for CE and their application • analyse, understand und assess systems in terms of sustainability • conduct environmental impact and technology assessments • analyse resource, waste management and recycling systems • design renewable energy systems <u>Social and personal skills:</u> Upon completing the module, students are able to • research subject-specific academic literature • present findings in clear oral and written form • work in an interdisciplinary manner • critically question ideas and models, to assess existing ones and to develop new ones • independently design the continuation of their learning process
Teaching methods, learning activities	Lecture; homework; participation in class; literature research; computer aided simulations; writing scientific papers; exemplification of concepts
Offered	Yearly

Module B	Implementation, Management and Design
ECTS credits	15
Content	• Integration of sustainability into business management • Analysis and systematization of sustainability strategies • Development and implementation of sustainable business strategies • Influence of organizational culture • Standards, tools and methods for eco-controlling • Analysis of planning, steering and controlling the ecological business performance • Reporting on the eco-performance • Ecological entrepreneurship in the context of sustainable development • Analysis and preparation of business plans • Modern aspects of designing product development processes

Expected learning results and acquired competences	<u>Professional and methodological competences:</u> Upon completing the module, students are able to • understand sustainability management approaches, different sustainability strategies and the application of management tools • create tailor-made sustainability management solutions according to specific contexts • develop sustainability strategies • apply sustainable management tools • analyse and reflect on the implementation of sustainability strategies (e.g. in terms of designing an effective and eco-efficient business performance) • conduct process related sustainability analyses for certain product developments • apply stakeholder analysis, systems creation and scenario technique concerning entrepreneurship and development of services and products • prepare business plans • analyse, reflection on and design product development processes • apply policy instruments in the context of Circular Ecology <u>Social and personal skills:</u> Upon completing the module, students are able to • work in interdisciplinary teams and to design negotiation procedures • independently create and reflect on individual and collaborative problem-solving processes in a holistic way • design communication processes for particular stakeholders • design and critically analyse the interaction processes between experts and stakeholders • work in teams and on projects • understand complex problems in a holistic way • handle self-management
Teaching methods, learning activities	Lecture; case studies; individual and group work based on case studies; reflection and discussion; lectures of practitioners; excursions; homework; participation in class; literature research; writing scientific papers; presentations, research
Offered	Yearly

Module C.I	**Specialisation Module – The Human Dimension of Circular Economy** **(University of Graz, AT)**
ECTS credits	30
Content	Specialisation in the following fields: • Environmental decision-making • Integrated management systems • Sustainable innovation and innovation management • Interdisciplinary cooperation • Inter- and transdisciplinary methods

Expected learning results and acquired competences	<u>Professional and methodological competences:</u> Upon completing the module, students are able to • analyse the human impact on different problem areas • understand and model factors that influence human activities related to the environment • develop sustainable innovation concepts • independently initiate an interdisciplinary project, work on its relevant issues and develop solutions <u>Social and personal skills:</u> Upon completing the module, students are able to • research the subject-specific literature • present findings in clear oral and written form • work in an interdisciplinary manner • critically question, assess and develop ideas and models • independently design the continuation of their learning process
Teaching methods, learning activities	Group work; lecture; homework; participation in class; work on selected literature; computer aided simulations; writing scientific papers; exemplification of concepts
Offered	Yearly

Module C.II	**Specialisation Module – Climate Change Mitigation and Sustainable Energy Systems in a Circular Economy (Chalmers University of Technology, SE)**
ECTS credits	30
Content	Specialisation in the following fields: • Development and assessment of sustainable technical systems in the energy sector • Assessment methodology in the environmental and sustainability context • Project management for sustainable development • Examples for areas of application of CE (energy sector, transport)
Expected learning results and acquired competences	<u>Professional and methodological competences:</u> Upon completing the specialization module, students are able to • understand and implement assessment methods in the environmental and sustainability context (e.g. energy sector, transport) • understand and to assess factors that influence human activities related to the environment • design sustainable technical systems, especially in the energy sector • understand and to purposefully implement project management methods <u>Social and personal skills:</u> Upon completing the module, students are able to • research the subject-specific literature • present findings in clear oral and written form • work in an interdisciplinary manner • critically question, assess and develop ideas and models • independently design the continuation of their learning process
Teaching methods, learning activities	Lecture; homework; participation in class; literature research; computer aided simulations; writing papers; exemplification of concepts
Offered	Yearly

Module C.III	Specialisation Module – Design of Circular Economy (Delft University of Technology / Leiden University, NL)
ECTS credits	30
Content	Specialisation in the following fields: • Life cycle analysis • Design aspects of CE • Modelling material and substance flows • Geographic information systems (GIS) • Urban mining • Interdisciplinary collaboration • Preparation of the Master Thesis
Expected learning results and acquired competences	Professional and methodological competences: Upon completing the specialization module, students are able to • initiate interdisciplinary projects in groups, work on relevant issues and develop solutions • understand and implement life cycle analyses in theory and praxis • understand and model factors that influence human activities related to the environment • model material and substance flows • implement GIS • prepare a Master Thesis Social and personal skills: Upon completing the module, students are able to • research the subject-specific literature • present findings in clear oral and written form • work in an interdisciplinary manner • critically question, assess and develop ideas and models • independently design the continuation of their learning process
Teaching methods, learning activities	Group work; lecture, homework; participation in class; literature research; computer aided simulations; writing scientific papers; exemplification of concepts
Offered	Yearly

Module C.IV	Specialisation Module – Modelling of Circular Economy (Norwegian University of Science and Technology, NO)
ECTS credit	30
Content	Specialisation in the following fields: • Practice-based project in the field of CE • Modelling and CE (e.g. life cycle assessment) • Environment management • Science communication
Expected learning results and acquired competences	Professional and methodological competences: Upon completing the specialization module, students are able to • analyse human impact on various issues • develop modelling skills and implement them in the context of CE • understand project management methods and purposefully implement them for CE • properly communicate and convey scientific findings Social and personal skills: Upon completing the module, students are able to • research the subject-specific literature

	• present findings in clear oral and written form • work in an interdisciplinary manner • critically question, assess and develop ideas and models • independently design the continuation of their learning process
Teaching methods, learning activities	Lecture; homework; participation in class; literature research; computer aided simulations; writing scientific papers; exemplification of concepts
Offered	Yearly

Module C.V	**Specialisation Module – Recycling and Remanufacturing for Circular Economy (Curtin University of Technology, AU)**
ECTS credits	30
Content	Specialisation in the following fields: • Recycling and remanufacturing • Corporate stewardship • Organisational strategies for sustainability • Sustainable energy systems
Expected learning results and acquired competences	<u>Professional and methodological competences:</u> Upon completing the specialization module, students are able to • understand corporate stewardship • understand, assess and design recycling and remanufacturing concepts • develop sustainable energy systems for CE • classify, understand and devise organisational strategies in a sustainable context <u>Social and skills competences:</u> Upon completing the module, students are able to • research the subject-specific literature • present findings in clear oral and written form • work in an interdisciplinary manner • critically question, assess and develop ideas and models • independently design the continuation of their learning process
Teaching methods, learning activities	Lecture; homework; participation in class; literature research; computer aided simulations; writing scientific papers; exemplification of concepts
Offered	Yearly

Module C.VI	Specialisation Module – Economics of Circular Economy (Waseda University, JP)
ECTS credits	30
Content	Specialisation in the following fields: • Input-output analysis • Econometrics • Environmental economy • Resource management • Economic aspects of CE, especially from an Asian perspective
Expected learning results and acquired competences	Professional and methodological competences: Upon completing the specialization module, students are able to • prepare input-output analyses with an application focus on resource and waste management • understand econometric methods und apply them to the relevant issues • develop environmental-economic approaches • understand and further develop resource management concepts Social and personal skills: Upon completing the module, students are able to • research the subject-specific literature • present findings in clear oral and written form • work in an interdisciplinary manner • critically question, assess and develop ideas and models • independently design the continuation of their learning process
Teaching methods, learning activities	Lecture; homework; participation in class; literature research; computer aided simulations; writing scientific papers; exemplification of concepts
Offered	Yearly

Annex II: Sample Study Path

The following sample study path is not mandatory. It is a mere recommendation that offers students guidance. The sample curriculum is intended for students who start their studies at the University of Graz.

	Course title/exam	ECTS
1st semester	**Basic Knowledge and Circular Economy Tools**	**30**
A.I.1	Eco-Controlling	4
A.I.2	Sustainability Entrepreneurship	4
A.I.3	Research Project Sustainability Management	6
A.I.4	Product and Service Development	4
A.I.5	Environmental and Technology Assessment	4
A.I.6	Waste and Recycling	4
A.I.7	Fundamentals of Circular Economy and Industrial Ecology	4
2nd semester	**Implementation, Management and Design**	**30**
B.I.1	Earth's Climate System and Climate Change	3
B.I.2	Strategic Sustainability Management	4
B.I.3	Value Chain Management	4
B.I.4	Selected Topics of Sustainability and Innovation Management	4
	Free Electives	15
3rd semester	**Specialisation Module**	**30**
Year 2: Students choose one of the modules from C.II to VI and one of the options for the Master Thesis.		
	Specialisation Module – Climate Change Mitigation and Sustainable Energy Systems in a Circular Economy Chalmers University of Technology, SE	
C.II.1	Sustainable Energy Futures	7.5
C.II.2	Industrial Energy Systems	7.5
C.II.3	Technical Change and the Environment	7.5
C.II.4	Fuel Cells – Functions and Materials	7.5
C.II.5	Sustainable Transportation	7.5
C.II.6	Environmentally Adapted Product Development	7.5
C.II.7	Sustainable Power Production and Transportation	7.5
C.II.8	Assessing Sustainability	7.5
C.II.9	Leadership for Sustainable Transitions	7.5
C.II.10	Sustainable Electric Power Systems	7.5
C.II.11	Managing Stakeholders for Sustainable Development	7.5
C.II.1 is compulsory; from C.II.2-C.II.11, students choose three courses (total: 30 ECTS)		
	Specialisation Module – Design of Circular Economy Delft University of Technology / Leiden University, NL	
C.III.1	Interdisciplinary Project Groups	12
C.III.2	Master Thesis Preparation	6
C.III.3	LCA Practice and Reporting	9
C.III.4	GIS and Urban Mining	4
C.III.5	Environmental Input-Output Analysis	6
C.III.6	Advanced Material Flow Analysis	6
C.III.1 and C.III.2 are compulsory; from C.III.3 to C.III.6, students choose courses in the amount of 12 ECTS (total: 30 ECTS)		
	Specialisation Module – Modelling of Circular Economy Norwegian University of Science and Technology, NO	
C.IV.1	Industrial Ecology Project	15

C.IV.2	Environmental Management and Corporate Governance	7.5
C.IV.3	Critical Review and Communication of Science	7.5
C.IV.4	Revision of the Basic Tools	7.5
C.IV.5	Lifecycle Performance of Aluminium Products	7.5
C.IV.1 is compulsory; from C.IV.2 to C.IV.5, students choose two courses (total: 30 ECTS)		
	Specialisation Module – Recycling and Remanufacturing for Circular Economy Curtin University of Technology, AU	
C.V.1	Corporate Stewardship	7.5
C.V.2	Sustainable Energy	7.5
C.V.3	Environmental Systems (Recycling Systems)	7.5
C.V.4	Organisational Strategies for Sustainability	7.5
C.V.5	Eco-Efficiency (Remanufacturing Systems)	7.5
Students choose 4 out of 5 courses from C.V.1-5 (total: 30 ECTS)		
	Specialisation Module – Economics of Circular Economy Waseda University, JP	
C.VI.1	Research Seminar on Industrial Ecology and Econometrics	5
C.VI.2	Hybrid Input-Output Analysis in Industrial Ecology	5
C.VI.3	Industrial Ecology	5
C.VI.4	Econometrics	5
C.VI.5	Environmental Economics	5
C.VI.6	Asian Economy	5
4th semester		**30**
	Master Thesis (Chalmers University of Technology, SE)	
	Thesis Research Project (Delft University of Technology / Leiden University, NL)	
	Master Thesis (Norwegian University of Science and Technology, NO)	
	Master Thesis (Curtin University, AU)	
	Master Thesis (Waseda University, JP)	
	Master Thesis (Tsinghua University, CN)	