



Modulhandbuch  
Studiengang  
Master Technology of Circular  
Economy

(PO 2024)

Hochschule Emden/Leer  
Fachbereich Technik  
Abteilung Naturwissenschaftliche Technik

(Stand: 8. August 2024)

# Inhaltsverzeichnis

<b>1</b>	<b>Abkürzungen der Studiengänge des Fachbereichs Technik</b>	<b>3</b>
<b>2</b>	<b>Modulverzeichnis</b>	<b>4</b>
2.1	Pflichtmodule	5
	Circular Economy Project	5
	Introduction to Circular Economy	7
	Masterarbeit	9
2.2	Wahlpflichtmodule	11
	WPM Advanced Topics in Technology of Circular Economy 1	11
	WPM Advanced Topics in Technology of Circular Economy 2	13
	WPM Biodegradability and Environmental Impact	15
	WPM Biopolymers	17
	WPM Energies and materials in biotechnology	19
	WPM Modelling and Simulation	21
	WPM Recovery of Recyclable Materials	22
	WPM Soil remediation	23
	WPM Solid Waste and Recycling	24
	WPM Water Reuse	26

# 1 Abkürzungen der Studiengänge des Fachbereichs Technik

## Abteilung Elektrotechnik und Informatik

<b>BET</b>	Bachelor Elektrotechnik
<b>BETPV</b>	Bachelor Elektrotechnik im Praxisverbund
<b>BI</b>	Bachelor Informatik
<b>BIPV</b>	Bachelor Informatik im Praxisverbund
<b>BMT</b>	Bachelor Medientechnik
<b>BOMI</b>	Bachelor Medieninformatik (Online)
<b>BORE</b>	Bachelor Regenerative Energien (Online)
<b>BOWI</b>	Bachelor Wirtschaftsinformatik (Online)
<b>MII</b>	Master Industrial Informatics
<b>MOMI</b>	Master Medieninformatik (Online)

## Abteilung Maschinenbau

<b>BIBS</b>	Bachelor Industrial and Business Systems
<b>BMD</b>	Bachelor Maschinenbau und Design
<b>BMDPV</b>	Bachelor Maschinenbau und Design im Praxisverbund
<b>BNPM</b>	Bachelor Nachhaltige Produktentwicklung im Maschinenbau
<b>MBIDA</b>	Master Business Intelligence and Data Analytics
<b>MMB</b>	Master Maschinenbau
<b>MTM</b>	Master Technical Management

## Abteilung Naturwissenschaftliche Technik

<b>BBT</b>	Bachelor Biotechnologie
<b>BBTBI</b>	Bachelor Biotechnologie/Bioinformatik
<b>BCTUT</b>	Bachelor Chemietechnik/Umwelttechnik
<b>BEEEE</b>	Bachelor Erneuerbare Energien und Energieeffizienz
<b>BEP</b>	Bachelor Engineering Physics
<b>BEPPV</b>	Bachelor Engineering Physics im Praxisverbund
<b>BNPT</b>	Bachelor Nachhaltige Prozesstechnologie
<b>BNPTPV</b>	Bachelor Nachhaltige Prozesstechnologie im Praxisverbund
<b>BSES</b>	Bachelor Sustainable Energy Systems
<b>MALS</b>	Master Applied Life Sciences
<b>MEP</b>	Master Engineering Physics
<b>MTCE</b>	Master Technology of Circular Economy

## 2 Modulverzeichnis

## 2.1 Pflichtmodule

<b>Modulbezeichnung</b> <i>Module</i>	<b>Circular Economy Project</b>
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	1 (jedes Wintersemester) ( <i>every winter semester</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Pflichtmodul ( <i>compulsory module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	30 h Kontaktzeit + 150 h Selbststudium <i>30 h contact time + 150 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	project report, approx. 2000 words and approx. 6 tables or figures (Prüfungsleistung, graded exam)
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	seminar, group work
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	M. Rüsç gen. Klaas
<p><b>Qualifikationsziele</b> <i>Aims and Objectives</i> After completion of this course, the students have ...</p> <ul style="list-style-type: none"> <li>• dealt in depth with a special topic in the field of circular economy,</li> <li>• independently compiled (scientific) information and used the knowledge gained from it used the knowledge gained for the project,</li> <li>• applied scientific methods to present and discuss the results obtained, and discuss,</li> </ul> <p>by ...</p> <ul style="list-style-type: none"> <li>• independently planning the necessary milestones to reach the project goal,</li> <li>• dividing and reuniting the necessary work packages in the team, and performing any necessary correction loops,</li> <li>• evaluating/merging the results and presenting/illustrating them accordingly,</li> </ul> <p>in order to ...</p> <ul style="list-style-type: none"> <li>• be able to design and work on a scientific task/question by themselves,</li> <li>• independently estimate and control the required time management,</li> <li>• present the results in a scientific context, to present them and to discuss them further (in a scientific circle).</li> </ul>	
<p><b>Lehrinhalte</b> <i>Course content</i> Project management, literature research, scientific communication and presentation</p>	
<p><b>Literatur</b> <i>Literature</i> Literature on the circular economy (depending on the project topic)</p>	
<p><b>Lehrveranstaltungen</b> <i>Courses</i></p>	

<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
all lectures in the masters course	Circular economy project	4

<b>Modulbezeichnung</b> <i>Module</i>	<b>Introduction to Circular Economy</b>
<b>Modulbezeichnung (eng.)</b>	Introduction to Circular Economy
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	1 (jedes Wintersemester) ( <i>every winter semester</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Pflichtmodul ( <i>compulsory module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 120 h Selbststudium <i>60 h contact time + 120 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	Lecture: written exam 1,5h or oral exam, Seminar: presentation
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Lecture, seminar
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	S. Steinigeweg
<p><b>Qualifikationsziele</b> <i>Aims and Objectives</i> At the end of the module students will be able to</p> <ul style="list-style-type: none"> <li>• classify CE as part of sustainable development</li> <li>• present the current status and developments in Europe and the world</li> <li>• Describe technical solutions to implement CE</li> </ul> <p>by</p> <ul style="list-style-type: none"> <li>• identification of options and barriers to implement CE</li> <li>• apply evaluation approaches (technical, economic, environmental) of CE processes.</li> </ul> <p>in order to</p> <ul style="list-style-type: none"> <li>• enable the use of CE technologies</li> <li>• develop and implement CE compliant processes</li> <li>• introduce CE in companies</li> </ul>	
<p><b>Lehrinhalte</b> <i>Course content</i> CE is discussed as a concept for achieving SDGs. In addition to administrative and legal framework conditions, the various technologies in particular are presented in a comparative manner. The interdisciplinary concept of CE, which goes beyond pure recycling, is discussed. Practical studies and examples from industry will be used to show how CE can be introduced in a company. In addition to technical requirements, particular attention is paid to economic and ecological factors.</p>	
<p><b>Literatur</b> <i>Literature</i> v. Hauff Grundwissen Circular Economy, utb, 2023 Gosh (ed.); Circular Economy: Global Perspective, Springer, 2020</p>	

<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
S. Steinigeweg	Introduction to Circular Economy (lecture)	2
S. Steinigeweg	Introduction to Circular Economy (seminar)	2



<b>Modulbezeichnung</b> <i>Module</i>	<b>Masterarbeit</b>
<b>Modulbezeichnung (eng.)</b>	Master Thesis
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	3 (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	30 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Pflichtmodul ( <i>compulsory module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	30 h Kontakt + 870 h Selbststudium 30 h Kontaktzeit + h Selbststudium <i>30 h Kontakt + 870 h Selbststudium h contact time + h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	siehe Prüfungsordnung MPO Teil B
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	Schriftliche Dokumentation und mündliche Präsentation
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Projekt ( <i>project</i> )
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	Alle Professor*Innen/Dozierenden
<b>Qualifikationsziele</b> <i>Aims and Objectives</i> After successful completion of the master's thesis, <ul style="list-style-type: none"> <li>students can independently solve a given practice-oriented problem from the subject area within a given period of time</li> <li>be able to act and decide competently in a typical situation of everyday working life</li> </ul> By ... <ul style="list-style-type: none"> <li>analyze and modularize the task/problem</li> <li>apply scientific and practical methods to solve individual modules</li> <li>assemble the sub-modules and check the function of the overall system</li> </ul> In order to use it later ... <ul style="list-style-type: none"> <li>to work on job-specific problems/tasks</li> </ul>	
<b>Lehrinhalte</b> <i>Course content</i> The master's thesis is an independent achievement with a theoretical, constructive, experimental, model-building or any other scientific/engineering task with a detailed written description and explanation of its solution. In technically suitable cases, it can also be a written term paper with specialist literary content. The master thesis can also be carried out in industrial companies, research institutes or working groups of the university.	
<b>Literatur</b> <i>Literature</i>	

<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>

Alle Professor*Innen im Fachbereich	Master thesis	11
Alle Professor*Innen im Fachbereich	Colloquium for the master thesis	1

## 2.2 Wahlpflichtmodule

<b>Modulbezeichnung</b> <i>Module</i>	<b>Advanced Topics in Technology of Circular Economy 1</b>
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	30 h Kontaktzeit + 150 h Selbststudium <i>30 h contact time + 150 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	written exam (1,5 h) or oral exam or presentation (30 min) or project report (approx. 2000 words and approx. 6 tables or figures) or experimental work or documentation of programming script at the choice of the examiner (Prüfungsleistung, graded exam)
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	seminar, group work
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	Alle ProfessorInnen/Dozierenden
<p><b>Qualifikationsziele</b> <i>Aims and Objectives</i></p> <p>In this module, the content of another elective compulsory module from the Technology of Circular Economy degree program is intended to be deepened in the form of an additional project, a seminar or experimental work. The elective module can be freely chosen by the students; the person responsible for this module then determines the topic and the type of examination.</p> <p>The qualification objectives are based on the selected module. Additionally, after completion of this course, the students have ...</p> <ul style="list-style-type: none"> <li>• dealt in depth with a special topic in the field of circular economy,</li> <li>• applied scientific methods to present and discuss the results obtained, and discuss,</li> </ul> <p>by ...</p> <ul style="list-style-type: none"> <li>• independently planning the necessary milestones to reach the (project) goals,</li> <li>• evaluating/merging the results and presenting/illustrating them accordingly,</li> </ul> <p>in order to ...</p> <ul style="list-style-type: none"> <li>• be able to design and work on a scientific task/question by themselves,</li> <li>• present the results in a scientific context, to present them and to discuss them further (in a scientific circle).</li> </ul>	
<p><b>Lehrinhalte</b> <i>Course content</i></p> <p>depending on the chosen elective compulsory module</p>	
<p><b>Literatur</b> <i>Literature</i></p> <p>depending on the chosen elective compulsory module</p>	

<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
all lectures in the masters course	Advanced Topics in Technology of Circular Economy	4

<b>Modulbezeichnung</b> <i>Module</i>	<b>Advanced Topics in Technology of Circular Economy 2</b>
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	30 h Kontaktzeit + 150 h Selbststudium <i>30 h contact time + 150 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	written exam (1,5 h) or oral exam or presentation (30 min) or project report (approx. 2000 words and approx. 6 tables or figures) or experimental work or documentation of programming script at the choice of the examiner (Prüfungsleistung, graded exam)
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	seminar, group work
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	Alle ProfessorInnen/Dozierenden
<p><b>Qualifikationsziele</b> <i>Aims and Objectives</i></p> <p>In this module, the content of another elective compulsory module from the Technology of Circular Economy degree program is intended to be deepened in the form of an additional project, a seminar or experimental work. The elective module can be freely chosen by the students; the person responsible for this module then determines the topic and the type of examination.</p> <p>The qualification objectives are based on the selected module. Additionally, after completion of this course, the students have ...</p> <ul style="list-style-type: none"> <li>• dealt in depth with a special topic in the field of circular economy,</li> <li>• applied scientific methods to present and discuss the results obtained, and discuss,</li> </ul> <p>by ...</p> <ul style="list-style-type: none"> <li>• independently planning the necessary milestones to reach the (project) goals,</li> <li>• evaluating/merging the results and presenting/illustrating them accordingly,</li> </ul> <p>in order to ...</p> <ul style="list-style-type: none"> <li>• be able to design and work on a scientific task/question by themselves,</li> <li>• present the results in a scientific context, to present them and to discuss them further (in a scientific circle).</li> </ul>	
<p><b>Lehrinhalte</b> <i>Course content</i></p> <p>depending on the chosen elective compulsory module</p>	
<p><b>Literatur</b> <i>Literature</i></p> <p>depending on the chosen elective compulsory module</p>	

**Lehrveranstaltungen** *Courses*

<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
all lectures in the masters course	Advanced Topics in Technology of Circular Economy	4

<b>Modulbezeichnung</b> <i>Module</i>	<b>Biodegradability and Environmental Impact</b>
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 90 h Selbststudium <i>60 h contact time + 90 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	Vorlesung: Klausur 1h oder mündliche Prüfung und Referat (40 Minuten) (Prüfungsleistung) / written exam 1 h or oral exam and presentation (40 minutes)
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Vorlesung und Seminar / Lecture and Seminar
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	C. Gallert
<b>Qualifikationsziele</b> <i>Aims and Objectives</i> The students will be able ... <ul style="list-style-type: none"> <li>• to know principles of Environmental Impact Assessment</li> <li>• to distinguish between different biodegradation tests according to respective standard protocols</li> <li>• to evaluate the result of such biodegradation tests</li> </ul> by... <ul style="list-style-type: none"> <li>• searching respective methodological information (e.g. according to OECD or similar)</li> <li>• comparison of biodegradability results from different commercial products available from literature or by own search in shops, stores, etc.</li> </ul> to ... <ul style="list-style-type: none"> <li>• relate 'biodegradability' and possible impact of products from daily life onto different environmental compartments</li> <li>• implement a biodegradability test protocol of a product of interest according to respective standards</li> </ul>	
<b>Lehrinhalte</b> <i>Course content</i> Objectives, methods, steps and tools of EIA and biodegradability tests, respective regulations, methodological overview, biochemical background information	
<b>Literatur</b> <i>Literature</i> Magnus Fröhling, Michael Hiete (eds.): Sustainability and Life Cycle Assessment in Industrial Biotechnology, Springer Nature Switzerland AG, 2020. James T. Maughan: Environmental Impact Analysis: Process and Methods, CRC Press, Boca Raton, 2013. ISO- and OECD guidelines	

<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
C. Gallert	Biodegradability and Environmental Impact: Lecture	2
C. Gallert	Biodegradability and Environmental Impact: Seminar	2



<b>Modulbezeichnung</b> <i>Module</i>	<b>Biopolymers</b>
<b>Modulbezeichnung (eng.)</b>	Biopolymers
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul (Sommersemester) ( <i>compulsory elective module (summer semester)</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 120 h Selbststudium <i>60 h contact time + 120 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	Mündliche Prüfung oder Klausur 1,5 h (PL)
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Vorlesung, Praktikum ( <i>lecture, lab course</i> )
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	M. Rüsç gen. Klaas
<p><b>Qualifikationsziele</b> <i>Aims and Objectives</i> At the end of the semester the students are able to</p> <ul style="list-style-type: none"> <li>• differentiate und understand different types of biopolymers,</li> <li>• understand structure- property- relationships of polymers,</li> <li>• use biopolymers for product development,</li> </ul> <p>by</p> <ul style="list-style-type: none"> <li>• knowing the basic rules of polymer chemistry and technology,</li> <li>• understanding the differences between man-made polymers and nature's polymers,</li> <li>• preparing samples of biopolymers in the lab and analyzing their properties,</li> </ul> <p>to</p> <ul style="list-style-type: none"> <li>• develop and produce biopolymers,</li> <li>• use these biopolymers for product development</li> <li>• contribute to a more sustainable polymer industry</li> </ul>	
<p><b>Lehrinhalte</b> <i>Course content</i> Ambiguity of the term 'biopolymer', principle of poly reactions, structure and property( thermo and duro plastics, degradation), man-made polymers, polymers in nature, basics of polymer technology and analysis, polymers to materials to products, importance and impact of plastic production, PLA as a case study.</p>	
<p><b>Literatur</b> <i>Literature</i> A detailed list of literature is supplied to the students and will be explained at the beginning of the module.</p>	

<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
M. Rüsç gen. Klaas	Biopolymers, Vorlesung	2
M. Rüsç gen. Klaas	Biopolymers, Praktikum	2

<b>Modulbezeichnung</b> <i>Module</i>	<b>Energies and materials in biotechnology</b>
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 120 h Selbststudium <i>60 h contact time + 120 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	Written exam 2 hour or oral exam at the choice of the examiner as well as group work with reports and presentations (academic assessment)
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Lecture with practical exercises and/or project work
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	I. de Vries
<p><b>Qualifikationsziele</b> <i>Aims and Objectives</i> After completing the module, students will be able to ...</p> <ul style="list-style-type: none"> <li>• describe biotechnological basics and basics of the biopharmaceutical industry</li> <li>• know different energies and materials in biotechnology with a focus on the biopharmaceutical industry</li> <li>• assess the advantages and disadvantages of disposable systems with a focus on energy and circular economy</li> </ul> <p>by ...</p> <ul style="list-style-type: none"> <li>• using, applying and bringing together the knowledge provided</li> <li>• drawing up balances to compare the different materials</li> <li>• deepening the knowledge based on current literature in group and project work</li> </ul> <p>in order to ...</p> <ul style="list-style-type: none"> <li>• gather basic knowledge for activities in the biopharmaceutical industry</li> <li>• be able to contribute concepts and ideas for the better use and reuse of resources in industry, research and development</li> </ul>	
<p><b>Lehrinhalte</b> <i>Course content</i> Basics of biotechnology, introduction to the biopharmaceutical industry, basics of bioprocess engineering, materials in biotechnology, disposable elements in the biopharmaceutical industry, advantages and disadvantages of disposable elements, energy balances of disposable systems compared to conventional stainless steel systems, cleaning and sanitization, regulatory requirements, personalized active ingredients</p>	

**Literatur** *Literature*

Lecture manuscript and supplementary material

Technical literature

Gstraunthaler, G. Lindl, T.: Zell- und Gewebekultur; Springer, 2021

Eibl, R., Eibl D., Pörtner, R., Catapano, G., Czermak, P.: Cell and Tissue Reaction Engineering, Springer, 2009

Hass, V., Pörtner, R.: Praxis der Bioprozesstechnik mit virtuellem Praktikum, Spektrum, 2011

Chmiel, H.: Bioprozesstechnik, Springer Spektrum, Berlin, 2018

K. Muttzall, Einführung in die Fermentationstechnik, Behr's Verlag 1993

**Lehrveranstaltungen** *Courses*

<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
I. de Vries	Energies and materials in biotechnology (lecture)	2
I. de Vries	Energies and materials in biotechnology (practical exercises and/or project work)	2

<b>Modulbezeichnung</b> <i>Module</i>	<b>Modelling and Simulation</b>
<b>Modulbezeichnung (eng.)</b>	Modelling and Simulation
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 120 h Selbststudium <i>60 h contact time + 120 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	Written exam 1,5 h or implementation and documentation of computer programmes
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Lecture
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	I. Herraez
<b>Qualifikationsziele</b> <i>Aims and Objectives</i> The students are familiar with the basics of scientific computing with Matlab/Octave. They can work out and understand simple third-party programs. They are able to plot 2D and 3D diagrams. They know the basics of modelling and simulation of dynamic systems. They are able to develop simple models and carry out their own simulations.	
<b>Lehrinhalte</b> <i>Course content</i> Introduction to Matlab/Octave, basics of programming and scientific computing, non-linear equations, complex numbers, polynomials, numerical differentiation and integration, partial differential equations.	
<b>Literatur</b> <i>Literature</i> <ul style="list-style-type: none"> <li>• Quarteroni, A., Saleri, F, Gervasio, P.: Scientific Computing with Matlab and Octave, Springer, 2010</li> </ul>	

<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
I. Herraez	Modelling and Simulation	4

<b>Modulbezeichnung</b> <i>Module</i>	<b>Recovery of Recyclable Materials</b>
<b>Modulbezeichnung (eng.)</b>	Recovery of Recyclable Materials
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 90 h Selbststudium <i>60 h contact time + 90 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	Klausur 2h oder mündliche Prüfung (Prüfungsleistung)
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Vorlesung, Seminar ( <i>lecture, seminar</i> )
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	J. Hüppmeier
<b>Qualifikationsziele</b> <i>Aims and Objectives</i> After completing the module, students will be able to <ul style="list-style-type: none"> <li>• identify recyclable materials from industrial and household residues and waste materials and classify them economically and ecologically in a global context,</li> <li>• select, balance and design suitable processes for the recovery of recyclable materials and evaluate them ecologically and economically,</li> </ul> by... <ul style="list-style-type: none"> <li>• planning a process for a special recyclable material or a mixture of recyclable materials as an example,</li> </ul> in order to... <ul style="list-style-type: none"> <li>• be able to make a contribution to the future of chemistry in the sense of the circular economy.</li> </ul>	
<b>Lehrinhalte</b> <i>Course content</i> see qualification goals...	
<b>Literatur</b> <i>Literature</i>	

<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
J. Hüppmeier	Recovery of Recyclable Materials (lecture)	2
J. Hüppmeier	Recycle-project	2

<b>Modulbezeichnung</b> <i>Module</i>	<b>Soil remediation</b>	
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )	
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)	
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )	
<b>Sprache(n)</b> <i>Language(s)</i>	English	
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 120 h Selbststudium <i>60 h contact time + 120 h self-study</i>	
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none	
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none	
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE	
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	theoretical part: written exam 1,5 h or oral exam (Prüfungsleistung) practical part: practical course (Studienleistung)	
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	lecture, practical course	
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	G. Walker	
<b>Qualifikationsziele</b> <i>Aims and Objectives</i> Qualification goals: At the end of the semester, students will be able to ... <ul style="list-style-type: none"> <li>take samples from contaminated sites (e.g. contaminated soils), determine heavy metals by ICP-OES and AAS as well as PAHs by HPLC and fluorescence spectroscopy</li> </ul> by ... <ul style="list-style-type: none"> <li>understand the appropriate sampling techniques, digestion and extraction procedures as well as ICP-OES and AAS equipment and chromatographic and spectroscopic techniques and apply them under guidance</li> <li>write scientific reports</li> </ul> to .... <ul style="list-style-type: none"> <li>select and apply appropriate techniques for soil analysis and remediation issues</li> <li>classify analytical results in the context of the method used and in the context of other characteristics of soil and contaminated site</li> </ul>		
<b>Lehrinhalte</b> <i>Course content</i> Chromatography (HPLC, GC), fluorescence spectroscopy, metal analysis by AAS and ICP-AES		
<b>Literatur</b> <i>Literature</i> Georg Schwedt: 'The Essential Guide to Environmental Chemistry' (2001), Wiley Scheffer/Schachtschabel: 'Soil Science' (English Edition) 1st ed. (2016), Springer		

<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
G. Walker	Soil remediation, lecture	1
G. Walker	Soil remediation, practical course	3

<b>Modulbezeichnung</b> <i>Module</i>	<b>Solid Waste and Recycling</b>
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 120 h Selbststudium <i>60 h contact time + 120 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	Written exam 1,0 h or oral exam and project draft (15 - 20 pages) (academic assessment)
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Lecture and project
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	R. Habermann
<p><b>Qualifikationsziele</b> <i>Aims and Objectives</i> After completing the module, students will be able to ...</p> <ul style="list-style-type: none"> <li>• identify the legal framework for the treatment of solid waste and to implement it in action measures.</li> <li>• analyze and synthesize the concepts of waste collection</li> <li>• record the function of selected plant components for waste processing, delimit their areas of application and develop plant concepts for the processing of solid waste</li> </ul> <p>by ...</p> <ul style="list-style-type: none"> <li>• analysing the relevant legal framework and working out requirements on the recycling procedure</li> <li>• designing concepts for solid waste collection</li> <li>• drafting a rough plant design for solid waste recycling of a study case</li> </ul> <p>in order to ...</p> <ul style="list-style-type: none"> <li>• analyse existing recycling plants for debottlenecking and optimisation</li> <li>• determine approximate capacity expansions of plant sections</li> <li>• describe the qualitative and quantitative requirements of a recycling plant in communication with a recycling plant manufacturer</li> </ul>	
<p><b>Lehrinhalte</b> <i>Course content</i> Terms and definitions of legal framework for solid waste recycling, concepts for solid waste collection, fundamentals of preparation and sorting of solid multi-component waste, machines and apparatus for solid waste recycling, procedural plant concepts and economic aspects.</p>	
<p><b>Literatur</b> <i>Literature</i> Lecture manuscript and supplementary material Technical literature G. Tchobanoglous, F. Kreith: Handbook of Solid Waste Management, McGraw-Hill, New York, 2002</p>	



<b>Lehrveranstaltungen</b> <i>Courses</i>		
<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
R. Habermann	Lecture Solid Waste and Recycling	2
R. Habermann	Project Solid Waste and Recycling	2

<b>Modulbezeichnung</b> <i>Module</i>	<b>Water Reuse</b>
<b>Semester (Häufigkeit)</b> <i>Semester (frequency)</i>	WPM (nach Bedarf) ( <i>as required</i> )
<b>ECTS-Punkte (Dauer)</b> <i>ECTS (duration)</i>	6 (1 Semester)
<b>Art</b> <i>Method of Examination</i>	Wahlpflichtmodul ( <i>compulsory elective module</i> )
<b>Sprache(n)</b> <i>Language(s)</i>	English
<b>Studentische Arbeitsbelastung</b> <i>Student's Workload</i>	60 h Kontaktzeit + 120 h Selbststudium <i>60 h contact time + 120 h self-study</i>
<b>Voraussetzungen (laut MPO)</b> <i>Entry Requirements (MPO)</i>	none
<b>Empf. Voraussetzungen</b> <i>Recommended Requirements</i>	none
<b>Verwendbarkeit</b> <i>Applicability</i>	MTCE
<b>Prüfungsart und -dauer</b> <i>Type/Duration of Assessment</i>	(K1+R)/K2 + EA
<b>Lehr- und Lernmethoden</b> <i>Teaching Method</i>	Lecture and practical course
<b>Modulverantwortlicher</b> <i>Module Coordinator</i>	G. Illing
<p><b>Qualifikationsziele</b> <i>Aims and Objectives</i> After completing the module, students will be able to ...</p> <ul style="list-style-type: none"> <li>• differentiate between impurities in used water and methods of water recycling</li> <li>• choose suitable methods, materials and technologies and combine machinery for specific cleaning tasks</li> <li>• to calculate important parameters in water cleaning technology</li> <li>• to combine water cleaning technologies to meet the requirements</li> </ul> <p>by ...</p> <ul style="list-style-type: none"> <li>• using, applying and combining water cleaning and knowledge provided</li> <li>• using flowcharts, choice of water treatment technology, assessment of water types, calculating of specific material-constants</li> <li>• design and application to specific problems, calculating group discussion and project work</li> </ul> <p>in order to ...</p> <ul style="list-style-type: none"> <li>• be able to select suitable design variants for selected areas of application</li> <li>• to perform calculations to assess the scope and efficiency of water treatment plants and to combine different water treatment processes</li> <li>• to maintain the efficiency of water treatment processes</li> </ul>	
<p><b>Lehrinhalte</b> <i>Course content</i> Challenges for recycling and reuse of water. Basic water cleaning processes including filter technologies, membrane filtration and reverse osmosis. Concepts for the description of molecular transport models in membranes, characterisation of membranes, materials, processing and membrane modules. Application of membrane processes and calculations to evaluate the performance. Challenges in practical operation. Use of new technologies for disinfection, removal of trace substances and particles.</p>	

**Literatur** *Literature*

Lecture manuscript

Nunes, S., Peinemann K., Friedrich, H., Membrane Technology In The Chemical Industry, 2006 Pinnekamp, J., Membrane Technology for Waste Water Treatment, 2007 Wilhelm, S., Wasseraufbereitung, Springer, 2008

**Lehrveranstaltungen** *Courses*

<b>Dozent</b> <i>Lecturer</i>	<b>Titel der Lehrveranstaltung</b> <i>Course Title</i>	<b>SWS</b> <i>SPPW</i>
G. Illing	Water Reuse	4