Consecutive

Master Study Programme

Biotechnology and Process Engineering

at

University of Applied Sciences Flensburg

Flensburg, October 2013

This document includes:

1. **Concept and Realization of the Program (extract from the self-evaluation report presented to the accreditation agency ASIIN e.V.)**
2. **Module Manual / Modulhandbuch (page 9)**

1.1 Objectives of the Master Program Biotechnology and Process Engineering

This is a consecutive Master Program following the Bachelor Program *Biotechnologie und Verfahrenstechnik [Biotechnology and Process Engineering]* at FH Flensburg. The program is thus mainly targeted at students of our university and grants them the opportunity to gain further qualification at the interface of sciences and technology. As the Program is conducted in English, it is also targeted at foreign students from related subjects of studies.
The Master Program aims to convey the knowledge and know-how necessary to enable students to recognise and analyse problems in the fields of biotechnology and process engineering, to develop own technical and scientific solutions for these problems and to successfully transfer these solutions into market-ready products and services.
This objective is achieved through the teaching of in-depth knowledge on specialized aspects of biotechnology and process engineering on the one hand. On the other hand the curriculum addresses the application of this knowledge to scientific problems from the field. Aside from expertise in the respective field, a number of general skills are further developed with this approach. These qualifications include independent and self-contained working when structuring a problem, identification and application of suitable methods as well as goal oriented, cooperative team work to just name a few.
In the final part of the Program the ability to approach new and unknown topics in a methodical and systematic manner will be further developed by means of continuously working on scientific projects supported and guided by teaching staff.
As stated in the first accreditation already, any graduate of the Master Program *Biotechnology und Process Engineering* shall be granted admission to Higher Civil Service [*Höherer Dienst* in German Civil Service].

1.2 Program Outcomes

The qualifications to be acquired as outcomes of the Program may be divided into three main areas:

- Technical and professional skills
- Personal skills
- General skills

In general all students are to be equipped with thorough abilities to analyse and solve technical and scientific problems as they occur in the material converting industry. Aside from a solid basis of knowledge and the ability to draw connections between different fields of expertise this requires the training of goal oriented action and the acquisition of the ability to independently acquire knowledge in the sense of lifelong learning.
According to a recommendation of the Association for Process Engineering and Chemistry Engineering at the Association of German Engineers [VDI-GVC] graduates from

the highly application oriented Master Program *Biotechnology and Process Engineering* may pursue careers doing highly specialized work as well as taking on management and C-level positions in the development, design and realisation as well as management and operation of processes and plants or they may seek an employment within the Higher Civil Service [*Höherer Dienst* in German Civil Service].
Only a combination of the relevant skills and competences named in the following list will lead to success in a professional context; the list furthermore allows for a placement of the different modules and the content of teaching into the context of skills to be acquired in the course of the Program.

- Technical and professional skills
  - Competences in technology and sciences
  - Methodical competence
  - Intercultural competence
- Personal skills
  - Self- and Project Management
  - Communication Skills
  - Responsibility
  - Ability to accept criticism
  - Language Competence (English)
- General skills
  - Problem solving skills
  - Ability for autonomous and lifelong learning
  - Ability to act successfully and focused
    (Do the right things the right way.)

The following overview in form of a table visualises the allocation of each type of qualification into the Program's different modules in the form of a matrix of objectives.

	Program's Modules													
Classification of the Objectives of the Master Program, 1st semester	Advanced Theory of Cell Biology	Cell Culture Technology	Advanced Instrumental Analysis	Advanced Theory of Process Engineering	Bioanalysis	Design, Economy, and Sustainability ...	Fluid Flow in Process Equipment	Quality Systems in Food Industry	Presentation Skills	Professional Leadership and Rhetoric	Identification and Evaluation of ...	Particles and Cells Measuring Techniques	Disintegration of Particles and Cells	First-Time Manager
Technical and professional skills														
technical and scientific	x	x	x	x	x		x					x	x	
methodical	x	x	x	x	x	x	x	x	x	x	x	x	x	x
intercultural	achieved through international students													
Personal skills														
Self and project management					x						x			
Communication skills									x	x				x
Responsibility						x		x		x				x
Ability to accept criticism									x	x				x
Language competence	active and passive use of the English language													
General skills														
Problem solving skills								x						x
Autonomous and lifelong learning											x			
Successful and strategic action											x			

Matrix part 1: Modules and Electives in the 1st semester

	Program's Modules								
Classification of the Objectives of the Master Program, 2nd and 3rd semester	Protein Factory - Theory	Protein Factory - Team Project	Chem. and Green Eng. - Theory	Chem. and Green Eng. - Team Project	Separation Techn. - Theory	Separation Techn. - Team Project	Food Biotechn. and Processing - Theory	Food Biotechn. and Processing - Team Project	Master-Thesis
Technical and professional skills									
technical and scientific	x		x		x		x		
methodical	x		x		x		x		x
intercultural	achieved through international students								
Personal skills									
Self and project management		x		x		x		x	x
Communication skills		x		x		x		x	x
Responsibility	x	x	x	x	x	x	x	x	x
Ability to accept criticism		x		x		x		x	
Language competence	active and passive use of the English language								
General skills									
Problem solving skills		x		x		x		x	x
Autonomous and lifelong learning		x		x		x		x	x
Successful and strategic action		x		x		x		x	x

Matrix part 2: Modules in the 2nd and 3rd semesters and Master Thesis

1.3 Objectives of the Modules

Please also see the module handbook following this!
The respective coordinator will outline the objectives of each module in the module description. Apart from the acquisition of specialised knowledge further aspects on the acquisition of skills will be addressed or result from the form of teaching. Without being categorised according to module, these are:

- Skills to find solutions to problems with the help of state-of-the-art experimental or numeric methods
- Working together with others to achieve a goal (team work, project management)
- Processing and presentation of results (written and oral communication)

Chapter 1.2 matches the objectives and results of the modules as described in the module handbook with the Program's objectives.

Module Advanced Theory of Cell Biology and Cell Culture Technology:
The module is divided into two parts and teaches the students the necessary background knowledge to enable them to work with cell cultures. The first part will deal with current research results from molecular biology and current methods from cell biology. The processes and methods will be revised, extended and transferred to the requirements of cell culture technology.
In the second part students will acquire in-depth knowledge on bio process engineering necessary for the application in animal cell cultures. Thus students will be enabled to design and measure fermentation with cell cultures. Students will be able to analyse, evaluate and communicate operating data and results from cell culture processes.

Module Advanced Instrumental Analysis:
This module aims at familiarising the students with the basic principles, the terminology, methodology, instrumentation, implementation and characteristics of the most commonly used spectroscopic measuring techniques and chromatographic separation methods.
Students will acquire the ability to appropriately apply these methods to identify physical and chemical data which need to be determined as part of biotechnological and process engineering control and research processes.
In the end students will have gained the competence to design and manage analytical procedures as well as to evaluate the data thus generated for the purpose of process control and management.

Module Advanced Theory of Process Engineering:
This module builds on classes on Thermodynamics and Heat and Mass Transfer from the Bachelor Program. In regards to Thermodynamics knowledge on the behaviour of real fluids and real mixtures in particular will be taught, in regards to Mass Transfer the module will address the specific characteristics of Mass Transfer in analogy to Heat and Impulse Transfer as well as their differences. Typical processes in which mass transfer plays a key role will be addressed. The difference between the balance based processes the Bachelor Program focused on in large parts and transfer based processes will be paid special attention to.
Accompanying tutorials will further enhance the knowledge thus acquired: Thermodynamic state variables will be determined and reported for basic operations in process engineering, in the field of mass transfer the students will learn to set up transfer models and to generate results for the transfer variables.
Students will be able to integrate thermodynamic and mass transfer specific models into the design of typical basic operations. They will be able to evaluate results from research and actual plant operation.

Module Bioanalysis:
Students are introduced to suitable measuring sensors for a number of biological and physic-chemic parameters and their function.
On the basis of this knowledge measuring sensors are chosen and applied to identify biological and physic-chemic parameters, e.g. microorganisms, for various tasks that are to be executed in a laboratory.
Students will be able to tackle bio analytical tasks on a microscopic as well as on a macroscopic level.

Module Design, Economy and Sustainability in Chemical Engineering:
Students will acquire basic knowledge and methods to be able to design biotechnological and procedural processes in regards to plant design and construction. Special focus

will be paid to a holistic approach to consider economic, ecologic and social aspects in the same manner and thereby follow the principles of sustainability.

Module Fluid Flow in Process Equipment:
The flow of fluids in multi-phase mixtures is the rule rather than the exception in process equipment. The basics of this flow will be taught. Tutorials will focus on the design of equipment and components to generate dispersed phases, guide them through the apparatus in the desired manner and separate them again later on.
Students will be able to hydraulically design suitable apparatuses and plants for multi-phase reaction and separation processes in a basic draft.

Module Quality Systems in Food Industry:
Students will acquire the characteristics of a quality management system. Finding solutions to quality problems will be part of the module as well as the specific requirements of the food industry. Examples from the food industry will be used to analyse quality problems and arrive at solutions for them. Students will be able to apply the principles of quality management.

Module Professional Leadership and Rhetoric:
Students will acquire basic knowledge on Human Resources Management, Rhetoric and verbal and non-verbal communication.
Tutorials and trainings will enable the students to acquire a number of basic techniques such as “active listening” and “coaching” in Human Resources Management as well as argumentative and persuasion techniques to be used when dealing with staff and colleagues. Students will thus improve their language and communication skills which are necessary for Human Resources Management.

Module Identification and Evaluation of Relevant Literature for Scientific Projects:
Students will be introduced to the methods of scientific bibliographic research with the help of examples. They will develop the ability to identify and evaluate the scientific status quo of a project according to literature and use literature to solve problems. They will be able to manage a project more efficiently based on their knowledge of the scientific background.

Module Particles and Cells Measuring Techniques:
Taking into account the most recent scientific literature the students will acquire knowledge on measurement in the field of particle technology and purification technology. Some of the measurement methods will be applied as part of hands-on lab classes. The students will evaluate the results of the work carried out here in regards to their significance for practical application.
Students will be able to choose the appropriate method of measurement, evaluate the results gained through it and draw conclusions regarding a product’s properties and characteristics.

Module Disintegration of Particles and Cells:
Taking into account the most recent scientific literature students will acquire knowledge on disintegration and disruption techniques in the field of particle technology and purification technology. The use of appropriate measuring methods for process management will be discussed; the design of disintegration processes from development to testing level as well as the process design will be addressed. A process in a laboratory mill will be used to study and experience the topic in greater detail.

Students will be able to design appropriate disintegration processes, evaluate their performance and thus generate the desired product properties and characteristics.

Module First-Time Manager:
Current management principles will be employed to familiarise students with the characteristics of and requirements for managing positions. Examples will help to teach students management and leadership, teamwork and means for efficient communication. Students will thus be enabled to apply management and communication skills.

Module Project Theory und Team Project:
These 24 CP elective modules provide a thematic unit made up of theory and practice (project). Each lecturer may decide on the manner of teaching the theory part of the module, this may be done in the form of seminar classes or lectures. In either form students will acquire the theoretical background required to successfully execute the complex project work in a group. Not only will the participation in this module help to develop technical skills, it will also and especially train personal and general skills as mentioned and discussed in chapter 1.2 of this report.
Students will be able to define goals for a complex problem, take measures, i.e. use their theoretical and practical knowledge to decide on what steps to take to achieve these goal or sub-goals, to visualise and evaluate generated results as well as to communicate the results orally or in a written text.

2. Module Manual / Modulhandbuch

Modules / Module:

Abbreviations:
NTE: Non-Technical Elective
TE: Technical Elective

Curriculum / Studienplan

Consecutive Study Programme — Stand: 17.04.2013

Master of Science *Biotechnology and Process Engineering*

Flensburg University of Applied Sciences

Term	Semester 1	Semester 2	Semester 3
hours	Summer	Winter	Summer
1	VMNIG Advanced Theory of Cell Biology and Cell Culture Technology	VIA Project Theory [2)]	TH Master-Thesis
4			
5	VMNIG Advanced Instrumental Analysis		
8			
9	VBVF Advanced Theory of Process Engineering	VIA Team Project / Practical Experience [2)]	
12			
13	VBVF Technical Elective Courses [1)]		
16			
17	NT Non-Technical Elective Courses	VIA Technical Elective Courses [1)]	
20			
	20 h, 30 ECTS	20 h, 30 ECTS	30 ECTS

[1)] Elective Courses (Examples)	Bioanalysis Design, Economy and Sustainability in Chem. Eng. Disintegration of Particles and Cells Particles and Cells Measuring Techniques Quality Systems in Food Industry Professional Leadership and Rhetoric
[2)] Projects	Protein Factory Chemical Process Engineering / Green Engineering Separation Technology Food Biotechnology and Processing

Recommendations made by VDI-Gesellschaft Verfahrenstechnik und Chemieingenieurwesen (VDI-GVC): „Qualification Framework and Curricula of Degree Programmes in Process Engineering, Biochemical and Chemical Engineering at Universities and Universities of Applied Science , 2. ed., 2008

- VMNIG: Vertiefung der mathematisch-naturwissenschaftlichen und Ingenieurwissenschaftlichen Grundlagen
- VBVF: Vertiefung und Erweiterung biotechnologischer und verfahrenstechnischer Fächer
- VIA: Vertiefung der Ingenieuranwendungen
- NT: Nichttechnische Fächer
- TH: Thesis

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Advanced Theory of Cell Biology and Cell Culture Technology
Abbreviation:	ATCB
Subtitle:	---
Title of Class:	**Advanced Theory of Cell Biology**
Semester:	1
Responsible for Module:	Prof. Dr. Helmut Erdmann
Lecturer:	Prof. Dr. Helmut Erdmann Prof. Dr. Udo Peters
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 1
Class Type / Hours:	Lecture / 2 h per week
Workload:	Study time in class: 30 h Study time at home: 60 h
Credits:	3 in combination with CCT
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals / Skills:	Students will be introduced to newest results of research in molecular biology and state of the art methods in cell biology; they learn to use basic skills of molecular biology and transfer them to applications in cell culture techniques.
Content:	Isolation of cells, purification and characterization of proteins, intracellular compartimentation and protein sorting, intravesicular traffic, cell communication, cell birth, apoptosis, cancer
Assessment:	Written or oral exam
Media:	Lecture Notes, Slides, Board, E-Learning
Literature:	➢ Alberts et al.: Molecular Biology of the Cell ➢ Alberts et al.: Essential Cell Biology ➢ Lodish et al.: Molecular Cell Biology

Degree Program:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Advanced Theory of Cell Biology and Cell Culture Technology
Title of Class:	**Cell Culture Technology**
Abbreviation:	CCT
Semester:	1
Responsible for Module:	Prof. Dr. Helmut Erdmann
Lecturer:	Prof. Dr. Hans-Udo Peters
Language:	English
Assignment to Program:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 1
Class Type / Hours:	Seminar 2 h per week
Workload:	Study time in class: 30 h Study time at home: 60 h
Credits:	3 in combination with ATCB
Requirements:	Registered students to M.Sc. BPE or on request
Study Goals / Skills:	**Knowledge:** • The lecture will address extended bioprocess engineering principles to apply to the advanced technology of mammalian cell culture **Skills:** • Design of cell culture fermentation processes **Expertise:** • Analysis and interpretation of cell culture fermentation data • Communicate scientific contents by oral presentations in English language
Content:	1 Lecture topics, presentations, textbooks/literature 2 Historic outline, products and future trends 3 Cell cultures 4 Complete media 5 Serum free media (pres.) 6 Insect cell-based rec. protein production (pres.) 7 Bioreactors for cell cultures 8 Contamination (pres.) 9 Quality control of biotechnological products (pres.) 10 Safety and regulatory aspects (pres.)
Assessment:	Written or oral exam
Media:	Lecture notes, slides, videos, illustrative material
Literature:	• Freshney, R.I., 6th Edition, 2010: Culture of Animal Cells. Wiley& Sons. • Eibl, R., Eibl, D., Pörtner, R., Catapano, G. and Czermak, P. 2009: Cell and Tissue Reaction Engineering. Springer-Verlag Berlin Heidelberg. • Castilho, L.R., Moraes, A.M., Augusto, E.F.P. and Butler, M. (Eds.) 2008: Animal Cell Technology: From Biopharmaceuticals to Gene Therapy. Taylor & Francis.

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Advanced Instrumental Analysis
Abbreviation:	AIAL
Title of Class:	**Advanced Instrumental Analysis**
Semester:	1
Responsible for Module:	Prof. Dr. Werner Baumeister
Lecturer:	Prof. Dr. Werner Baumeister
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 1
Class Type / Hours:	Lecture / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals / Skills:	The goal of this lecture is to provide students with ***knowledge*** of the fundamental principles, terminology, methodology, instrumentation, implementation and characteristics of the most widely applied spectroscopic measurement and chromatographic separation methods. Students should gain the ***ability to apply*** these methods for the determination of physical and chemical data commonly employed in biotechnology and process engineering. Students should gain the ***competence*** to select and supervise analytical procedures and to analyse and evaluate analytical chemical data for process analysis and design.
Content:	1. Spectrochemical Measurement Methods Ultraviolet and Visible Absorption Spectrometry Infrared Spectrometry Luminescence Spectrometry Infrared Spectrometry Light Scattering 2. Chromatographic Separation Methods Mechanism of Retention Mechanism of Dispersion Chromatography Column Design Optimization of Separation 3. Applications of Analytical Measurements in Biotechnology and Process Engineering Determination of Phase Equilibrium Parameters Determination of Binding Constants Determination of Chemical and Physical Rate Constants
Assessment:	Written or oral exam
Media:	Blackboard, overhead projector, beamer
Literature:	D.A. Skoog, J.J. Leary: Principles of Instrumental Analysis, Thomson Brooks/Cole, Belmont, Calif., 6th ed., 2007, Reading List (to be distributed during lectures)

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Advanced Theory of Process Engineering
Abbreviation:	ATPE
Title of Class:	**Advanced Theory of Process Engineering**
Semester:	1
Responsible for Module:	Prof. Dr.-Ing. Jürgen Teifke
Lecturer:	Prof. Dr.-Ing. Jürgen Teifke Prof. Dr.-Ing. Claus Werninger
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 1
Class Type / Hours:	Lecture / 4 h/week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Fundamentals in Fluid Flow and Heat Transfer
Study Goals:	**Knowledge:** • Thermodynamic behaviour of real fluids and mixtures • Extended knowledge on diffusion and convection mass transfer • Analogy between heat and mass transfer **Skills:** • Extend fundamental principles of thermodynamics to process fluids • Calculate state and operational variables in typical processes • Evaluate process operation according to the type and intensity of mass transfer • Estimate material property data for process operation • Set-up mass transfer models • Solve mass transfer models (numerically with the help of software) **Expertise:** • Integrate thermodynamic and mass transfer calculations into a design process for various process operations • Validate results from calculation with operational data
Content:	1. Thermodynamic Equilibrium - of pure components - of mixtures (VLE, VLLE) 2. Calculational methods to predict thermodynamic equilibrium 3. Mass Transfer - diffusion, diffusion coefficients - mass transfer models - mass transfer coefficients - mass transfer applications
Assessment:	Written or oral exam
Media:	Lecture Notes, Slides, Board, E-Learning
Literature:	➢ Sandler: Chemical and Engineering Thermodynamics JOHN WILEY & SONS ➢ Bird, Stewart, Lightfoot: Transport Phenomena, JOHN WILEY & SONS ➢ Treybal:

	Mass-Transfer Operations, McGRAW-HILL ➢ Baehr, Stephan: Heat and Mass Transfer, SPRINGER ➢ Benitez: Mass Transfer Operations, JOHN WILEY & SONS

Degree Program:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Project Theory 1: Protein Factory I
Title of Class:	**Project Theory 1: Protein Factory**
Abbreviation:	PROFA TH1
Semester:	2
Responsible for Module:	Prof. Dr. Helmut Erdmann
Lecturer:	Prof. Dr. Helmut Erdmann Prof. Dr. Hans-Udo Peters
Language:	English
Assignment to Program:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 2
Class Type / Hours:	Seminar / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6 in combination with PROFA TH2
Requirements:	Advanced Theory of Cell Biology and Cell Culture Technology
Study Goals / Skills:	**Knowledge:** Specific knowledge according to the project topic: • Pathogens, infection, and innate immunity • The adaptive immune system • Therapeutic monoclonal antibody expression in mammalian cells • The DHFR/MTX-amplification system **Skills:** • Increased understanding of the application of therapeutic mAbs • Molecular design of antibody production cell lines **Expertise:** • Target oriented reading of literature to prepare for scientific projects
Content:	Accompanying Lecture for Team Project Protein Factory
Assessment:	Written or oral exam
Media:	Slides, Paper
Literature:	Primary Literature as announced in class

Degree Program:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Project Theory 2: Protein Factory II
Title of Class:	**Project Theory 2: Protein Factory**
Abbreviation:	PROFA TH2
Semester:	2
Responsible for Module:	Prof. Dr. Hans-Udo Peters
Lecturer:	Prof. Dr. Hans-Udo Peters Prof. Dr. Helmut Erdmann
Language:	English
Assignment to Program:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 2
Class Type / Hours:	Seminar / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6 in combination with PROFA TH1
Requirements:	Advanced Theory of Cell Biology and Cell Culture Technology
Study Goals / Skills:	**Knowledge:** • Theoretical background of Anti-IL-8 production with CHO-DP12, ATCC CRL124451 comprising up-stream and down-stream-processing **Skills:** • Explanation and discussion of general theoretical project backgrounds • Explanation and discussion of experimental results taken from project work **Expertise:** • Find, read, understand and integrate literature in the field of monoclonal antibody production, comprising the aspects mentioned under the previous points • Communicate scientific contents by oral presentations in English language
Content:	Accompanying Seminar for Team Project Protein Factory
Assessment:	Oral presentation or oral exam
Media:	Slides, Papers
Literature:	Primary Literature as announced in class

Degree Program:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Team Project: Protein Factory
Title of Class:	**Protein Factory**
Abbreviation:	PROFA PRJ
Semester:	2
Responsible for Module:	Prof. Dr. Hans-Udo Peters
Lecturer:	Prof. Dr. Hans-Udo Peters Prof. Dr. Helmut Erdmann
Language:	English
Assignment to Program:	M.Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Project / 8 h per week
Workload:	Study time in class: 120 h Study time at home: 240 h
Credits:	12
Requirements:	Advanced Theory of Cell Biology and Cell Culture Technology
Study Goals / Skills:	**Knowledge:** • Introduction to basic tissue culture techniques • Production and Purification of Anti-IL-8 with CHO-DP12, ATCC CRL124451 **Skills:** • Handling of mammalian tissue cultures • Assembling and operation of animal cell culture bioreactors for therapeutic protein production • Separation and purification of monoclonal antibodies **Expertise:** • Design and realization of recombinant protein production using an eukaryotic expression system • Presentation and discussion of experimental results comprising the relevant scientific literature • Preparation of a written assignment
Content:	• One Week Introductory Lab-Course: "Basic Tissue Culture Techniques" • Team Project: "Protein Factory" Project Objectives: Production and purification of monoclonal antibodies (Anti IL-8) with CHO-DP12, ATCC CRL12445
Assessment:	Project report
Media:	Slides, papers
Literature:	Primary literature as announced in class

Degree Programme:	M. Sc. Biotechnology and Process Engineering
Title of Module:	Project Theory: Chemical Process Engineering / Green Engineering
Abbreviation:	CPET
Title of Class:	**Computer Aided Process Engineering (CAPE)**
Semester:	2
Responsible for Module:	Prof. Dr.-Ing. Claus Werninger
Lecturer:	Prof. Dr.-Ing. Claus Werninger
Language:	English
Assignment to Programme:	M. Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Lecture and Computer Laboratory / 2 & 2 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Participation in Lecture Advanced Theory of Process Engineering
Study Goals:	**Knowledge:** • Learn about heuristic and rigorous design rules to design single equipment and processes • Obtain basic knowledge on the importance of thermodynamic modelling for material property and thermodynamic state modelling **Skills:** • Learn to select appropriate path of reaction and separation for a process • Apply state-of-the-art software for computer aided process engineering (CAPE) **Expertise:** • Integrate CAPE calculations into a design process • Validate results from calculation with operational data • Use CAPE in redesign existing processes
Content:	➢ Fundamentals of Process Design – Structure and Synthesis ➢ Chemical Reaction Schemes, Equilibrium and Reactor Design ➢ Design of Separation Sequence and Technology ➢ Process Analysis
Assessment:	Written or oral exam
Media:	Lecture Notes, Slides, Board, E-Learning, CAPE software
Literature:	➢ Seider, Seader, Lewin: Process Design Principles, JOHN WILEY & SONS ➢ Turton, Baille, Whiting, Shaelwitz: Analysis, Synthesis, and Design of Chemical Processes PRENTICE HALL ➢ Biegler, Grossmann, Westerberg: Systematic Methods of Chemical Process Design PRENTICE HALL ➢ Douglas: Conceptual Design of Chemical Processes, McGRAW-HILL ➢ Schuler: Prozesssimulation, WILEY – VCH

	➢ Smith: Chemical Process Design and Integration JOHN WILEY & SONS ➢ Blass: Entwicklung verfahrenstechnischer Prozesse, SPRINGER

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Project Theory: Chemical Process Engineering / Green Engineering
Abbreviation:	GET
Title of Class:	**Green Engineering**
Semester:	2
Responsible for Module:	Prof. Dr. rer. nat. Jens Born
Lecturer:	Prof. Dr. rer. nat. Jens Born
Language:	English
Assignment to Programme:	M. Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Seminar / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Participation in Lecture Advanced Theory of Process Engineering
Study Goals / Skills:	➢ Knowledge of approaches and methodologies for evaluating and improving the environmental performance of chemical processes and products ➢ Design a process path with (almost) optimal parameters of energy and material consumption ➢ Evaluate design alternatives under the constraint of sustainability ➢ Apply renewable resources
Content:	➢ Introduction to environmental issues and risk concepts ➢ Evaluation and improvement of environmental performance of chemical processes (Evaluating fates, exposures, and performance during process synthesis, green chemistry methods,) ➢ Unit operations and pollution prevention ➢ Process integration and environmental performance of a flow sheet based on life cycle concepts ➢ Renewable resources – sustainable handling and processing strategies
Assessment:	Written report and oral presentation
Media:	Blackboard, overhead, presentation
Literature:	➢ Allen, Shonnard: Green Engineering, PRENTICE HALL ➢ Seider, Seader, Lewin: Process Design Principles, JOHN WILEY & SONS ➢ Turton, Baille, Whiting, Shaelwitz: Analysis, Synthesis, and Design of Chemical Processes PRENTICE HALL ➢ Biegler, Grossmann, Westerberg: Systematic Methods of Chemical Process Design PRENTICE HALL ➢ Douglas: Conceptual Design of Chemical Processes, McGRAW-HILL Schuler: Prozesssimulation, WILEY – VCH

	➢ Smith: Chemical Process Design and Integration, JOHN WILEY & SONS ➢ Blass: Entwicklung verfahrenstechnischer Prozesse, SPRINGER

Degree Programme:	M. Sc. Biotechnology and Process Engineering
Title of Module:	Team Project: Chemical Process Engineering / Green Engineering
Abbreviation:	CPETP
Title of Class:	**Chemical Process Engineering / Green Engineering**
Semester:	2
Responsible for Module:	Prof. Dr.-Ing. Claus Werninger
Lecturer:	Prof. Dr. rer. nat. Jens Born Prof. Dr.-Ing. Claus Werninger
Language:	English
Assignment to Programme:	M. Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Project / 8 h per week
Workload:	Study time in class: 120 h Study time at home: 240 h
Credits:	12
Requirements:	Participation in Lecture Advanced Theory of Process Engineering
Study Goals:	**Knowledge:** • Acquire specific knowledge according to the project topic **Skills:** • Apply scientific methods based on sustainability issues to match the principles of Green Engineering • Increase proficiency with CAPE software • Set-up operational plans for group members • Arrange group work into working packages • Communicate on milestones with group members and supervisor **Expertise:** • Project Management Principles • Estimate the benefits of CAPE for research and design
Content:	A group of 2 – 4 students will work out a process design of a new process or an alternative to an existing process comprising basic layout of equipment and simulation of the process. An important aspect of the project work is the research on operational, kinetic and material data from literature or from experiment. Costs of process erection and operation are to be estimated by simple means. Appropriate hours in class will be spent to discuss problems in team with or without the professor. Results are to be presented orally by contributions from each team member and as a written report of the team.
Assessment:	Written report and oral presentation
Media:	Board, Overhead, presentation, CAPE software, E-Learning
Literature:	➢ Allen, Shonnard: Green Engineering PRENTICE HALL ➢ Seider, Seader, Lewin: Process Design Principles JOHN WILEY & SONS ➢ Turton, Baille, Whiting, Shaelwitz: Analysis, Synthesis, and Design of Chemical Processes

	PRENTICE HALL ➢ Biegler, Grossmann, Westerberg: Systematic Methods of Chemical Process Design PRENTICE HALL ➢ Douglas: Conceptual Design of Chemical Processes McGRAW-HILL ➢ Schuler: Prozesssimulation, WILEY – VCH ➢ Smith: Chemical Process Design and Integration JOHN WILEY & SONS ➢ Blass: Entwicklung verfahrenstechnischer Prozesse SPRINGER

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Project Theory: Separation Technology 1
Abbreviation:	AST-PT
Title of Class:	**Separation Technology 1**
Semester:	2
Responsible for Module:	Prof. Dr. Werner Baumeister
Lecturer:	Prof. Dr. Werner Baumeister
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Lecture and Exercise / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6 in combination is AST II
Requirements:	Knowledge of fundamental aspects of Down Stream Processing
Study Goals / Skills:	The goal of this lecture is to provide students with ***knowledge*** of the fundamental principles and techniques of preparative chromatographic separations. Students should gain the ***ability to calculate*** spatial and temporal distributions of components in discrete space and discrete/continuous time models of chromatographic separation processes and to analyse single component and overlapping multicomponent chromatographic bands. Students should gain ***competence*** to analyse and evaluate chromatographic separation processes by using simple mathematical models of chromatography.
Content:	1. Physicochemical Basis of Chromatography 2. Mathematical Description of Chromatography 3. Discrete Space Discrete Time Model 4. Discrete Space Continuous Time Model 5. Spatial Distribution of Components 6. Temporal Distribution of Components 7. Properties of Distribution Functions 8. Evaluation of Experimental Distribution Data 9. Overlapping Components: Mixture Distributions 10. Deconvolution of Overlapping Components
Assessment:	Written or oral exam
Media:	Blackboard, computer, overhead projector, beamer
Literature:	• G. Guiochon, B. Lin: Modeling for preparative chromatography, Academic Press, Amsterdam, 1st ed., 2003 • G. Guiochon et al.: Fundamentals of preparative and nonlinear chromatography, Elsevier Academic Press, Amsterdam, 2nd ed., 2006 • Henner Schmidt-Traub (ed.): Preparative Chromatography, Wiley-VCH, Weinheim, 2nd ed., 2012

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Project Theory: Separation Technology 2
Abbreviation:	AST-PT
Title of Class:	**Separation Technology 2**
Semester:	2
Responsible for Module:	Prof. Dr.-Ing. Wolfgang F. Hess
Lecturer:	Prof. Dr.-Ing. Wolfgang F. Hess
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Lecture, Laboratory and Exercise / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6 in combination AST I
Requirements:	Knowledge of fundamental aspects of Particle Technology or Down Stream Processing
Study Goals / Skills:	Within *Separation Technology 2 (Project Theory)* the students will obtain knowledge of the theoretical basics of filtration / disintegration and practise methods to solve technical tasks together with computer aided modelling.
Content:	1. Separation techniques for biological dispersions, filtration by differential pressure, filtration resistances, incompressible/compressible cakes 2. Disintegration of cells: - chemical, biological, mechanical methods, - energetic comparison of different methods 3. Scale-up Methods - Dimensional analysis - Specific Process Parameters
Assessment:	Written or oral exam
Media:	Blackboard, computer, overhead projector, beamer
Literature:	➢ Rushton et al.: Solid-Liquid Filtration and Separation Technology WILEY-VCH, Weinheim 2000 ➢ A.T. Jackson: Process Engineering in Biotechnology OPEN UNIVERSITY PRESS, Milton Keynes 1990

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Team Project: Separation Technology
Abbreviation:	AST-TPPE
Title of Class:	**Separation Technology**
Semester:	2
Responsible for Module:	Prof. Dr.-Ing. Wolfgang F. Hess
Lecturer:	Prof. Dr.-Ing. Wolfgang F. Hess
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Project: Laboratory, Exercise / 4 and 4 h per week (maximum class size: 2 groups with 8 students)
Workload:	Study time in class: 120 h Study time at home: 240 h
Credits:	12
Requirements:	Knowledge of fundamental aspects of Particle Technology or Down Stream Processing
Study Goals / Skills:	Participating in *Team Project in Separation Technology* the students will obtain practical experience in filtration and disintegration processes and in solving technical tasks regarding process engineering problems in general. They will be able to determine relevant data by experiment using this data needed for effective process design.
Content:	1. Filtration of biological dispersions by differential pressure experimental evaluation of filtration resistances 2. Disintegration of cells by mechanical methods, experimental comparison of different methods 3. Scale-up Methods
Assessment:	Project report and oral presentation
Media:	Blackboard, overhead projector, beamer, personal computers equipped with MATLAB and several toolboxes (e.g. PDE, Optimization, Curve Fitting)
Literature:	➢ Rushton et al.: Solid-Liquid Filtration and Separation Technology WILEY-VCH, Weinheim 2000 ➢ A.T. Jackson: Process Engineering in Biotechnology OPEN UNIVERSITY PRESS, Milton Keynes 1990

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Project Theory: Food Biotechnology and Processing 1
Abbreviation:	FBP I
Title of Class:	**Food Biotechnology and Processing 1**
Semester:	2
Responsible for Module:	Prof. Dr. Birte Nicolai
Lecturer:	Prof. Dr. Birte Nicolai
Language:	English
Assignment to Programme:	M. Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Seminar / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6 in combination is FBP II
Requirements:	Knowledge of fundamental aspects of fermentation, processing and analytical methods
Study Goals	**Knowledge:** • Learn about food biotechnological production methods • Understand processes during food fermentation • Learn about process parameters and analytical methods **Skills:** • Increase proficiency about food fermentations • Set-up process conditions for food production • Assess foods according to their analytical parameters **Expertise:** • Independent study of content • Self-organization
Content:	During this seminar students learn the theoretical background of food biotechnology and processing. This is either done by presentation and by self-studies of the given literature.
Assessment:	Written or oral exam
Media:	Slides, blackboard, literature
Literature:	• Doyle, M.P.; Beuchat, L.R.: Food Microbiology – Fundamentals and Frontiers, ASM Press Washington • Lee, B.H. (1996): Fundamentals of Food Biotechnology, VCH Publishers New York • Primary literature as announced in class

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Project Theory: Food Biotechnology and Processing 2
Abbreviation:	FBP II
Title of Class:	**Food Biotechnology and Processing 2**
Semester:	2
Responsible for Module:	Prof. Dr. Birte Nicolai
Lecturer:	Prof. Dr. Birte Nicolai
Language:	English
Assignment to Programme:	M. Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Seminar / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6 in combination with FBP I
Requirements:	Knowledge of fundamental aspects of fermentation, processing and analytical methods
Study Goals	**Knowledge:** • Extend knowledge on preparation, presentation and interpretation of scientific results • Extend knowledge on work with scientific literature **Skills:** • Improve presentation skills • Communication and project follow-up with the group and the supervisor **Expertise:** • Analytical thinking
Content:	Accompanying seminar for team project “Food Biotechnology and Processing”. Students will prepare the team project and present the results to the group. Finally the group will discuss the results against the background of current literature to further develop the project.
Assessment:	Oral presentation or oral exam
Media:	Slides, blackboard
Literature:	Primary literature as announced in class

Title of Module:	Team Project: Food Biotechnology and Processing
Abbreviation:	FBP P
Title of Class:	**Food Biotechnology and Processing (Team Project)**
Semester:	2
Responsible for Module:	Prof. Dr. Birte Nicolai
Lecturer:	Prof. Dr. Birte Nicolai
Language:	English
Assignment to Programme:	M. Sc. Biotechnology and Process Engineering Optional Compulsory Class, Semester 2
Class Type / Hours:	Project / 8 h per week
Workload:	Study time in class: 120 h Study time at home: 240 h
Credits:	12
Requirements:	Knowledge of fundamental aspects of fermentation, processing and analytical methods
Study Goals	**Knowledge:** • Acquire specific knowledge according to the project topic **Skills:** • Increase proficiency with analytical methods and production equipment • Set-up plans for the experimental test design • Arrange group work **Expertise:** • Project Management principles • Analytical thinking
Content:	Students will be introduced to industrial food production by visiting food producing plants and doing food productions in a pilot plant. They will familiarize with the relevant process parameters and analytical methods. Based on the learning, they will work on a current scientific problem in food biotechnology.
Assessment:	Project report
Media:	Slides, blackboard, pilot plant equipment
Literature:	Primary literature as announced in class

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Course – Professional Leadership and Rhetoric
Abbreviation:	EC-PLR
Title of Class:	**Professional Leadership and Rhetoric**
Semester:	1
Responsible for Module:	Ralf Gorath
Lecturer:	Ralf Gorath
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 1
Class Type / Hours:	Lecture / 4 h per week – class size: minimum 7, maximum 20
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals:	**Knowledge:** • Acquire basic knowledge of HRM in academic views • Acquire basic knowledge of rhetorics • Acquire basic knowledge of verbal and non-verbal communication **Skills:** • Achieve and increase competence in speech • Use "Active Listening" in personal management • Perform "Coaching" as an active element of leadership • Convincing interaction with employees and peers **Expertise:** • Competence in rhetoric – basics, metaphors and style • Competence in human resources management • Competence in structured communication
Content:	Personnel Management in academic views Motivation and responsibility in HRM Rhetorical craftsmanship – basics, metaphors, analogies, style Active listening in practical management Structured communication as a tool for effective interaction Corporate communication culture Formal authority and informal power Praise and criticism in critical evaluation Personnel recruiting and -development - and costs Team development and coaching
Assessment:	Written exam or homework assignment or presentation
Media:	Board and presentation
Literature:	• Paul Watzlawick: Human communication / Menschliche Kommunikation – Formen, Störungen, Paradoxien. Huber, Bern 1969 [12. unveränderte Aufl. 2011], ISBN 3456834578 • Friedemann Schulz-von-Thun: Miteinander reden: Kommunikation für Führungskräfte. Rowohlt, Reinbek 2000/2003, ISBN 3-499-61531-2 • Ronald H. Carpenter – Choosing powerful words – Allyn and Bacon 1999, ISBN 0-205-27124-3 • Peter Ditko – In Bildern reden – Econ 1998, ISBN 3430121140

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Course – Identification and evaluation of relevant literature for scientific projects
Abbreviation:	EC-IEL
Title of Class:	**Identification and evaluation of relevant literature for scientific projects**
Semester:	1
Responsible for Module:	Prof. Dr. Detlef Goelling
Lecturer:	Prof. Dr. Detlef Goelling
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 1
Class Type / Hours:	Lecture / 2 h per week
Workload:	Study time in class: 30 h Study time at home: 60 h
Credits:	3
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals:	**Knowledge:** • Acquire knowledge for scientific literature research **Skills:** • Increase scientific background for project work and for writing project report or thesis • Increase project management skills • Evaluation of scientific background for projects **Expertise:** • Definition of scientific status on project relevant topics • Efficient and reliable literature research
Content:	Each student will be assigned a scientific topic. Then, students carry out a literature search according to their assignment. Finally, they document their findings in a written report.
Assessment:	Project report
Media:	Blackboard, overhead projector, beamer, World Wide Web
Literature:	Medline

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Course – Quality systems in food industry
Abbreviation:	EC-QSFI
Title of Class:	**Quality systems in food industry**
Semester:	1
Responsible for Module:	Prof. Dr. Birte Nicolai
Lecturer:	Prof. Dr. Birte Nicolai
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Elective course, Semester 1
Class Type / Hours:	Seminar / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals:	**Knowledge:** • Learn about quality management systems, quality solving techniques and the specific requirements of the food industry **Skills:** • Apply quality solving techniques • Understand framework in food industry • Arrange group work • Improve presentation skills **Expertise:** • Quality management principles
Content:	1.) General terms and definitions 2.) Historical development of quality management 3.) Framework in food industry 4.) Quality management and assurance standards 5.) Crisis management
Assessment:	Oral presentation
Media:	Slides, videos, blackboard, case study, management training game
Literature:	▸ Doeg, C.: Crisis Management in the Food and Drinks Industry: A Practical Approach, Springer New York ▸ Quality Management standards ▸ Primary literature as announced in class

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Course – First-Time Manager
Abbreviation:	EC-FTM
Title of Class:	**First-Time Manager**
Semester:	1
Responsible for Module:	Prof. Dr. Birte Nicolai
Lecturer:	Prof. Dr. Birte Nicolai
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Elective course, Semester 1
Class Type / Hours:	Seminar / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals:	**Knowledge:** • Understand the role of a manager / leader • Learn about the theoretical background and the practical application of management/ leadership elements **Skills:** • Apply management / leadership skills • Arrange group work • Improve presentation skills **Expertise:** • Management / leadership principles • Interpersonal and communication skills
Content:	1.) Management /Leadership 2.) Winning hearts and minds 3.) Leading change 4.) Appraisals 5.) Coaching 6.) Problem solving and diagnostic techniques 7.) Presentation skills
Assessment:	Oral presentation or project report
Media:	Slides, videos, blackboard, management training game, role-playing
Literature:	• Kotter, J.P.: Leading Change, Harvard Business Review Press Boston • Kotter, J.P.: Our Iceberg is Melting, Palgrave Macmillan London • Nahavandi, A.: The Art and Science of Leadership, Prentice Hall, New Jersey • Bass, B.M. and Bass, R.: The Bass Handbook of leadership: Theory, Research and Managerial Applications, Free Press New York • Primary literature as announced in class

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Course – Bioanalysis
Abbreviation:	EC-BA
Title of Class:	**Bioanalysis**
Semester:	1
Responsible for Module:	Dipl.-Biol. Uwe Krüger
Lecturer:	Dipl.-Biol. Uwe Krüger
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 1 or 2
Class Type / Hours:	Lecture / 4 h per week (blocked as 8 h every other week)
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals:	**Knowledge:** • Learn about the variety of biological (physicochemical) parameters and appropriate detectors **Skills:** • Apply knowledge in selecting, evaluating and using various physicochemical detectors and devices to provide relevant information on living matter **Expertise:** • Gain expertise in addressing bioanalytical tasks from molecular to macroscopic scale
Content:	The course focusses on problems how to define analytic tasks by matching physicochemical footprints of life with the appropriate detector equipment at various scales and how to derive the desired information from a dataset. In this context students will discuss on taking appropriate samples and also on some data conditioning and statistics. Furthermore, a glimpse on chemometrics has to be included.
Assessment:	Oral presentation
Media:	Laboratory equipment, board, slides, handouts
Literature:	Will be provided according to specific experiments

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Course – Fluid Flow in Process Equipment
Abbreviation:	EC-FFPE
Title of Class:	**Fluid Flow in Process Equipment**
Semester:	2
Responsible for Module:	Prof. Dr.-Ing. Claus Werninger
Lecturer:	Prof. Dr.-Ing. Claus Werninger
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Compulsory Class, Semester 2
Class Type / Hours:	Lecture / 2 h per week
Workload:	Study time in class: 30 h Study time at home: 60 h
Credits:	3
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals:	**Knowledge:** • Fundamentals of (fluid) multiphase flow • Get familiar with equipment to generate disperse phase **Skills:** • Design process equipment in terms of phase motion and phase contact time **Expertise:** • Propose appropriate equipment design for given multiphase reaction or separation problem
Content:	1. (Fluid) Particles: Generation and Motion 2. Interaction of phases in multiphase flow 3. Equipment design: Nozzles, Trays, Packings
Assessment:	Homework assignment or project report
Media:	Board, slides
Literature:	As anounced in class

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Courses - Design, Economy and Sustainability in Chemical Engineering
Abbreviation:	DES
Title of Class:	**Design, Economy and Sustainability in Chemical Engineering**
Semester:	2
Responsible for Module:	Prof. Dr. rer. nat. Jens Born
Lecturer:	Prof. Dr. rer. nat. Jens Born
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Elective Course, Semester 2
Class Type / Hours:	Workshop / 4 h per week
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Registered Student to M.Sc. BPE or on request
Study Goals / Skills:	Basic knowledge and skills to design chemical processes with a holistic view under economic and ecologic constraints
Content:	1. Design concepts, principles and constraints 2. Product design - needs, ideas, selection methods, skills and tools 3. Plant design Process and flow sheet development Cost estimation and profitability Basic principles of green chemistry and green engineering Optimum design and design strategies Software instruments
Assessment:	Project report or oral presentation
Media:	Board, Slides, CAPE software
Literature:	➢ M. Peters, K. Timmerhaus: Plant Design and Economics for Chemical Engineers McGRAW-HILL ➢ E. L. Cussler, G. D. Moggridge: Chemical Product Design CAMBRIDGE UNIVERSITY PRESS

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Courses – Disintegration of Particles and Cells
Abbreviation:	EC-DisInt
Title of Class:	**Disintegration of Particles and Cells**
Subtitle:	Using Stirred Media Mills in Down Stream Processing
Semester:	1
Responsible for Module:	Prof. Dr.-Ing. Wolfgang F. Hess
Lecturer:	Prof. Dr.-Ing. Wolfgang F. Hess
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Elective Class, Semester 1
Class Type / Hours:	Lecture, Workshop and Laboratory / 4 h per week (maximum class size: 15)
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Knowledge of fundamental aspects of Particle technology and Down Stream Processing
Study Goals / Skills:	On the basis of the latest scientific literature students will obtain knowledge of measuring techniques within the field of Particle Technology. Theory will be accomplished by practical experience in the lab. Students will be able to evaluate the results according to their real sense and practical use.
Content:	1. Basics of the physics of disintegration of particles and cells down to nano scale 2. Definition and measuring techniques for evaluation of the destruction effect 3. Scale up of comminution processes in ball mills 4. Incremental and cumulative processes 5. Practising laboratory experiments and evaluation of the processes
Assessment:	Homework assignment or written project report and oral presentation
Media:	Scientific papers, computer, overhead projector, beamer
Literature:	➢ A.T. Jackson: Process Engineering in Biotechnology OPEN UNIVERSITY PRESS, Milton Keynes ➢ Current scientific papers as supplied by the lecturer

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	Elective Courses – Particles and Cells Measuring Techniques
Abbreviation:	EC-PartM
Title of Class:	**Particles and Cells Measuring Techniques**
Subtitle:	Measuring Particle Size Distributions and Evaluation
Semester:	1
Responsible for Module:	Prof. Dr.-Ing. Wolfgang F. Hess
Lecturer:	Prof. Dr.-Ing. Wolfgang F. Hess
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering Elective Class, Semester 1
Class Type / Hours:	Lecture, Workshop and Laboratory / 4 h per week (maximum class size: 15 students)
Workload:	Study time in class: 60 h Study time at home: 120 h
Credits:	6
Requirements:	Knowledge of fundamental aspects of Particle Technology and Down Stream Processing
Study Goals / Skills:	On the basis of the latest scientific literature the students will obtain knowledge of measuring techniques within the field of Particle Technology and Down Stream Processing. Theory will be accomplished by practical experience in the lab. Students will be able to evaluate the results according to their real sense and practical use. The students will reach the competence to measure, evaluate and explain product properties regarding to Particle Technology, e.g. the particle size distribution, and to Down Stream Processing, e.g. disintegration of cells.
Content:	1. Basics of the representation and evaluation of particle size distributions. 2. Basics of the physical measuring techniques measuring particles and cells in dispersions down to nano scale 3. Separation techniques in biotechnology and process engineering 4. Incremental and cumulative processes 5. State-of-the-art optical analyser techniques: Dispersion of laser light, dynamical dispersion 6. Comparability and reliability of the results to be used in process control and quality management
Assessment:	Homework assignment or project report and oral presentation
Media:	Scientific papers, computer, overhead projector, beamer
Literature:	➢ A. Zhong, Lin Wang: Characterization of Nanophase Materials WILEY-VCH, Weinheim ➢ Brian H. Kaye: Characterization of Powders and Aerosols WILEY-VCH, Weinheim

Degree Programme:	M.Sc. Biotechnology and Process Engineering
Title of Module:	**Master-Thesis**
Abbreviation:	MA
Semester:	3
Responsible for Module:	Prof. Dr.-Ing. Claus Werninger
Lecturer:	Students will be supervised by one professor of their choice.
Language:	English
Assignment to Programme:	M.Sc. Biotechnology and Process Engineering, Compulsory, Semester 3
Class Type / Hours:	n. a.
Workload:	900 h
Credits:	30
Requirements:	See Study Regulations (Prüfungs- and Studienordnung)
Study Goals:	The student works independently on a problem preferably related to the field of biotechnology and process engineering. He or she uses scientific methods acquired during his participation in this programme. The student is capable to manipulate, discuss and display the data he or she collected for his/her work.
Content:	according to individual problem description
Assessment:	Written report, oral presentation and defence (60 min.) Assessment of all contributions will be accomplished by the supervising professor and one of his/her colleagues.
Media:	n. a.
Literature:	n. a.