FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
BUSAN CAMPUS

Module Description

1	**Module Description**	**M1-M4: Core/Specialization module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Bioprocess and bioreaction technology (3 CH) CLASS: Bioprocess and bio-reaction technology (1 CH) PRACTICAL: Bioprocess and bio-reaction technology (3 CH)	7.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Buchholz	
4	**Content**	Basics of reaction kinetics (micro-heterogenic catalysis, enzyme reactions, enzyme und substrate inhibition; kinetics of growth); biotechnical production process (batch-culture, conti-culture, creation of product); classical methods (fermented food, amino acids, polysaccharides, antibiotics); modern methods (GVO, protein synthesis, immobilization); balance; modelling (model parameter, CO^2 balance, elementary balance); mass transport (models, creations of bubbles, coalescence); reactor models; time of stay; reactors in biotechnology (bubble pillars, stirrer tank); stirring and aeration (stirring organs, power requirement, mixing characteristics); rheology of fermentation solutions; transmission of scale; sterilisation; fermenter environment (measurement and regulation engineering); examples of biotechnical processes.	
5	**Aims of the Module**	The students should understand the application of reaction kinetics to biological processes and the production process of biological products. They should also be able to design bioreactors in light of the mass transport and the mixing behaviour considerations.	
6	**Integration into the Programme**	1^{st} or 2^{nd} semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded written exam (120 minutes) Other requirements: successful completion of practical course	
9	**Calculation of Grade**	Written exam: 100% of module grade	
10	**Language of Instruction**	English	

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FAU Busan

Module Description

1	**Module Description**	**M1-M4: Core/Specialization module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Mechanical process engineering (3 CH) CLASS: Mechanical process engineering (1 CH) PRACTICAL: Mechanical process engineering (3 CH)	7.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Jo	
4	**Content**	An introduction will be given to the identification of chemical systems in MPE and basic mechanical operations and micro processes will be explained. Building on this, the focus will then be placed on physical material changes in life science technology. These include mechanical separation processes, environmental engineering, in particular air, water and soil pollution, and waste treatment. Another part of the module is devoted to mechanical downstream processing in biotechnology. In the classes, students will work independently in small groups to develop special applications. In order to extend knowledge gained in the lecture, students will work on practical tasks and solutions for problems in the field of particle technology. In the practical course students will apply the theory they have learned to authentic problems. Students will also acquire skills, such as using a scientific approach, analyzing and interpreting data and writing a scientific report.	
5	**Aims of the Module**	Students will be taught the basic theoretical principles in the lecture and these will then be applied in the classes and practical courses.	
6	**Integration into the Programme**	1st or 2nd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded written exam (120 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Written exam: 100% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M1-M4: Core/Specialization module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Chemical reaction engineering (3 CH) CLASS: Chemical reaction engineering (1 CH) PRACTICAL: Chemical reaction engineering (3 CH)	7.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Haumann	
4	**Content**	Macro-kinetics (selectivity problem, the influence of mass transfer, simultaneous heat and mass transfer), fluid / fluid reactions (chemical reaction and mass transfer with and without phase boundary layer acceleration factors and hinterland ratio) in reactor selection, non-catalytic gas-solid reactions (borderline cases of porous and non-porous grains, application of the shrinking-core model at the "rate determining step"); single pellet diffusion reactor, parameter estimation, types of chemical reaction apparatus (classification criteria, fluidized bed reactor, fluid / fluid systems); ideal reactors (ideal flow tube: sensitivity, adiabatic reaction, continuous stirred tank: Stability Analysis); real reactors (residence time distribution models, degrees of conversion, single-and multi-dimensional dispersion models) cell models; reaction (concentration and temperature control, complex reactions), fluidized bed reactors (homogeneous and heterogeneous, multi-phase models)	
5	**Aims of the Module**	The students should be familiar with current methods and problems of reactor modelling, design and scale-up so that they are confident of meeting the requirements for completing the Master's thesis in chemical reaction engineering.	
6	**Integration into the Programme**	1st or 2nd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded written examination (120 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Written exam: 100% of the module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M1-M4: Core/Specialization module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Fluid mechanics (3 CH) CLASS: Fluid mechanics (1 CH) PRACTICAL: Fluid mechanics (3 CH)	7.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Delgado	
4	**Content**	Basic differential and integral equations within fluid mechanics (with Tensor spelling); transport phenomena in fluids (molecular considerations of thermal conductivity, diffusion coefficient and viscosity coefficient); dimensional analysis and derivation of the boundary layer equations; similarity solutions for wall bound and free boundary layer flows; other flows of boundary layer character (fully developed, steady, two-dimensional viscous flows); Approximation by Karmann and Pohl Hausen based on the example of the plate boundary layer; boundary layer equations for heat transfer and similarity solutions for thermal boundary layers; Fabric boundary layer and similarity solutions for fabric boundary layers.	
5	**Aims of the Module**	The aim is to provide students with more in-depth knowledge of the fundamentals of fluid mechanics using the example of boundary layer flows. The focus is on the analytical investigation of laminar flow boundary layers, temperature and fabric boundary layers.	
6	**Integration into the Programme**	1st or 2nd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded written examination (120 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Written exam: 100% of the module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M1-M4: Core/Specialization module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Engineering thermodynamics (3 CH) CLASS: Engineering thermodynamics (1 CH) PRACTICAL: Engineering thermodynamics (3 CH)	7.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Fröba	
4	**Content**	Introduction into gas dynamics, flow process, combustion technology, refrigeration engineering, engineering heat transfer	
5	**Aims of the Module**	Students should understand the principles of thermodynamics and be able to apply the learned in different fields of engineering.	
6	**Integration into the Programme**	1st or 2nd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded written exam (120 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Written exam: 100% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M1-M4: Core/Specialization module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Environmental biotechnology (3 CH) CLASS: Environmental biotechnology (1 CH) PRACTICAL: Environmental biotechnology (3 CH)	7.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Breiter	
4	**Content**	1. Introduction to environmental bioprocess engineering (EBPE) 2. Stochiometry and reaction kinetics in (EBPE) 3. Waste water a) Waste water parameters, legal conditions b) Particle separation, pre-treatment… c) Lake systems. Waste water cleaning by plants … d) Carbon elimination • Process with suspended biomass • Biofilm structure • Process with fixed biomass e) N-elimination: Nitrification, Denitrification, Anamox f) P-elimination: Chemical and biological process g) Foam and sludge formation h) Sterilization 4. Anaerobic sludge formation 5. Microbiological soil redevelopment 6. Microbial gas cleaning • Bio-filtering • Bio-washing	
5	**Aims of the Module**	The students should learn how EBPE is based on natural processes, which are then intensified and modified. Students should be able to adapt existing processes to the constantly changing composition and amounts of contaminated environmental media and to the changes in the legal framework. Students should also learn how to develop new biological processes taking into account new scientific knowledge about natural processes.	
6	**Integration into the Programme**	1st - 2nd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded written exam (120 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Written exam: 100% of the module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M5-M9: Elective module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Marine biotechnology (2 CH) CLASS: Marine biotechnology (1 CH) PRACTICAL: Marine biotechnology (3 CH)	5.0 ECTS Credits 2.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Buchholz	
4	**Content**	Seawater (salinity, osmotic pressure, solution chemistry of carbon and nitrogen, temperature, pH); marine habitats and productivities (mutations, light influx); marine organisms (morphology and cell growth, metabolism, biotechnological relevance); screening (procedure and targets); phototrophic biotechnology (photosynthesis, light and dark reactions, pigments, fluorescence); electromagnetic radiation (natural and artificial light sources, light influx, rate of photosynthesis, light use efficiency); cultivation technology (cultivation of micro-algae and cyano-bacteria, sterile technology, scale-up); practical course	
5	**Aims of the Module**	The topics in the marine biotechnology are discussed theoretically and applied practically, using the example of phototrophic microorganisms (algae, cyano-bacteria).	
6	**Integration into the Programme**	1^{st} – 3^{rd} semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Oral exam: 100% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M5-M9: Elective module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Cell Technology (3 CH) CLASS: Cell Technology (1 CH) PRACTICAL: Cell Technology (3 CH)	5.0 ECTS Credits 2.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Lindenberger	
4	**Content**	What is meant by a sterile working environment in cell culture techniques (Equipment, behaviour, safety precautions techniques); relevant culture systems (T-Flask and bioreactor; interactions with the cells, products, and nutrients); production of antibodies with hybridoma cells, insect cells and baculoviruses (biopesticides, recombinant proteins); immobilization (procedure, materials, xenogeneic transplants, immune protection, maximizing the yield of recombinant proteins); establishment of cell lines; characterization of cell cultures (microscopy, trypan blue, MTT, resazurin, EZ4U in CFDA-SE, PJ, FACS, MACS); typical metabolic pathways in cell cultures; needs of cell cultures (nutrients, pO2, adherence, shear stress, buffer systems, pH); medically relevant applications (liver replacement systems, cancer therapy, artificial skin); toxicity and toxicity tests; stem cell procedures and cell differentiation	
5	**Aims of the Module**	The students should understand how to read professional literature critically. Based on 1-3 literature examples per teaching session, it will be shown how unreliable publications in respected journals can be. Furthermore, students learn how to produce the ideal culture system (for example, organ cultures) or how to optimize the yield of a process (e.g. antibodies, recombinant proteins) by identifying the relevant analogies with the living system and how to implement them practically. This includes an in-depth understanding of verifying analysis, biochemistry and material sciences.	
6	**Integration into the Programme**	1st to 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Oral exam: 100% of the grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M5-M9**: **Elective module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Modelling of processes of solid/liquid separation (2 CH) CLASS: Modelling of processes of solid/liquid separation (1 CH) PRACTICAL: Modelling of processes of solid/liquid separation (3 CH)	5.0 ECTS Credits 2.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Dück	
4	**Content**	1. Physical characteristics of phases to be separated - Granulometry 2. Classification and characteristics of mechanical phases of separation 3. Sieving processes 4. Sedimentation processes 5. Centrifuges, cyclones, hydrocyclones 6. Filtration processes; membrane separation 7. Combined methods of phase separation	
5	**Aims of the Module**	Modelling of processes of solid/liquid separation provide the basis for many chemical and biological technologies. In view of this, the aim of this module is to teach students the theoretical fundamentals of these processes. On completion of the module, students will be able to understand and actively apply the basic principles of the physical processes and the functional principles of the apparatus used in these processes. The fundamental mathematical models underlying these processes will be examined, along with the development and application of these models in special apparatus. Students will learn about modern methods of simulation of separation processes, as well as the design of apparatus and equipment including approaches from computer engineering. The main focus of this module is on problems in the fields of environmental engineering and biotechnology.	
6	**Integration into the Programme**	1st - 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes) Other requirements: successful completion of practical course	
9	**Calculation of Grade**	Oral exam: 100% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M5-M9: Elective module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Solvent concepts for catalytic processes (2 CH) CLASS: Solvent concepts for catalytic processes (1 CH) PRACTICAL: Solvent concepts for catalytic processes (3 CH)	5.0 ECTS Credits 2.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Haumann	
4	**Content**	Solvents (polarity, solvation, dissociation, ionization, miscibility, interaction, classification); solvents and catalysis (homogeneous catalysis, liquid-liquid multiphase catalysis); catalysis in organic solvents, water, perfluorinated solvents, supercritical solvents and ionic liquids; multiphase catalysis (catalyst and product separation, extraction, conversion).	
5	**Aims of the Module**	Technical reactions in solution, new developments in the field of technical solvents, application in process engineering of catalytic reactions in liquid-liquid-multiphase systems.	
6	**Integration into the Programme**	1^{st} – 3^{rd} semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Oral exam: 100% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M5-M9: Elective Module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Technical catalysts and adsorbents (2 CH) CLASS: Technical catalysts and adsorbents (1 CH) PRACTICAL: Technical catalysts and adsorbents (3 CH)	5.0 ECTS Credits 2.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Haumann	
4	**Content**	- Catalysis (definition, phenomenon, classification) - Adsorption (processes, equilibria, kinetics) - Homogeneous and heterogeneous catalysis (mechanisms, styles of catalysators, characterization, processes) - Characterization of catalysators (diffraction, optical, chemical, ad- and desorption methods) - Fabrication methods - Technical examples (physical and chemical fundamentals, operational modes, process layout) - Reactor layouts (differential and integral reactors)	
5	**Aims of the Module**	Students should become acquainted with the principles of catalysis and adsorption. They will cover the physical and chemical fundamentals and they will be able to derive solutions for characterizing catalytic reactions and for developing technical process layouts. Students will be introduced to examination methods and to the evaluation of experimental results of catalytic experiments through exercises and practical lab courses.	
6	**Integration into the Programme**	1st to 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes) Other requirements: successful completion of practical course	
9	**Calculation of grade**	Oral exam: 100% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M5-M9: Elective module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Micro-fluid dynamics (2 CH) CLASS: Micro-fluid dynamics (1 CH) PRACTICA: Micro-fluid dynamics (3 CH)	5.0 ECTS Credits 2.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Ertunc	
4	**Content**	In natural and constructed microsystems, unfamiliar physics of the fluid flow have been discovered and utilized. In this course, we provide a theoretical basis for the study of micro-fluid dynamics and show sample studies from the literature, conducted at the Institute of Fluid mechanics (LSTM Erlangen). In the theoretical part, the fluid models for gases and liquids are discussed. The validity of the Navier Stokes equations is questioned by checking the continuum hypothesis. Different regimes of fluid flow are presented based on continuum considerations. Intermolecular, intramolecular, surface as well as dominant particle forces in micro-fluid devices are discussed. An overview of modelling strategies on molecular, meso and macro scales is given. Prominent examples and studies from the literature regarding micro-fluid dynamics are presented.	
5	**Aims of the Module**	Students are expected to understand the multi-scaling and multi-physical nature flow phenomena in microsystems. The dominating forces in those systems will be made familiar to students. They should be able to conduct basic dimensional analysis to classify the flow with respect to the different flow regimes based on the continuum hypothesis. Ultimately, they can decide which forces can be effective under certain gas, liquid and particle laden flows in microsystems and which numerical modelling strategy is appropriate for a given microsystem. Using applied examples from the literature and from our Institute, it is expected that students will be able to bridge the gap between theory and application of the subject matter.	
6	**Integration into the Programme**	1^{st} – 3^{rd} semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes)	
9	**Calculation of Grade**	Oral exam: 100% of module grade	
10	**Language of Instruction**	English	

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FAU Busan

Module Description

1	**Module Description**	**M5-M9**: **Elective module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE: Physics of turbulence and turbulence modelling (2 CH) CLASS: Physics of turbulence and turbulence modelling (1 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Delgado	
4	**Content**	Navier-Stokes equations; statistical description of turbulence (Reynolds equations, turbulent stresses, fluctuations, correlations, probability functions); kinematical description (isotropy, axisymmetry, anisotropy, invariants); turbulence measurements (hot wire anemometry, laser-Doppler anemometry); transport equations (Reynolds stresses, turbulence kinetic energy, turbulence dissipation rate); turbulence closures (energy equation: eddy viscosity, Prandtl-Kolmogorov formula, dissipation rate equation: two-point correlation, Kolmogorov micro-scale); two-equation model of turbulence; wall-bounded flows, free shear flows.	
5	**Aims of the Module**	Students should understand the statistical description of turbulences as well as concepts of turbulence modelling and their applications to the Reynolds transport equations under the assumption of high Reynolds numbers.	
6	**Integration into the Programme**	1st to 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes)	
9	**Calculation of Grade**	Oral exam: 100% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M5-M9: Elective module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE: Applied microbiology (1 CH) CLASS: : Applied microbiology (1 CH) PRACTICAL: : Applied microbiology (2 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Breiter	
4	**Content**	Basic lectures: -DNA, genetic code, transcription, translation -Prokaryotes vs. eukaryotes: differences in genome organization, plasmids -Molecular cloning: Modification of plasmids, importance of E. coli Tutorial (project): Genetic modification of a granulovirus for protein expression -Database search of genome sequences, organization of coding regions etc. -Planning of modification strategy, virtual design of constructs Practical: -Implementation of the molecular cloning strategy	
5	**Aims of the Module**	In this module students will learn about genetic engineering and its application for industrial production as well as recycling/detoxification. This includes basic knowledge about the genetic code, its modification and means of application in industry. Basic as well as advanced cloning techniques and essential components of expression systems will be combined by the students during class for virtual molecular cloning in one actual research project of the department. This is complemented by subsequent testing of the theoretical cloning strategy in the lab. This model is aimed to fit students with knowledge about biotechnology and its adoption for industrial purpose.	
6	**Integration into the Programme**	1st - 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes)	
9	**Calculation of Grade**	Oral exam: 75% of module grade Practical course: 25% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M5-M9: Elective module**	**7.5 ECTS Credits**
2	**Module Components**	LECTURE: Combustion Technology (2CH) CLASS: Combustion Technology (1CH) PRACTICAL: Combustion Technology (3CH)	5.0 ECTS Credits 2.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Zigan	
4	**Content**	Fundamentals, laminar flames, turbulent flames, conservation equations, modeling of combustion systems, pollutant formation, applications. Introduction in numerical simulation of flows with combustion	
5	**Aims of the Module**	Introduction to Combustion Technology supported by practical exercises	
6	**Integration into the Programme**	1st to 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded oral exam (30 minutes) Other requirements: successful completion of the practical course	
9	**Calculation of Grade**	Oral exam: 100% of the grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M10-M12: M5-M9: Elective module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE: Enzyme technology (2 CH) TUTORIAL: Enzyme technology (1 CH) PRACTICAL: Enzyme technology (3 CH)	5.0 ECTS Credits 2.5 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Wandrey	
4	**Content**	Applied enzyme kinetics Applied fermentation kinetics: Highlights from industrial biotransformations , The biogas loop-reactor from lab scale to 300 m^3 scale, Continuous production and application of formate dehydrogenase, Production of chiral alcohols and diols Metabolic engineering Examples: Production of pyruvate and L-valine, Production of L-lysine Downstream processing Examples of low and high molecular weight products	
5	**Aims of the Module**	Students should be aware of how close the field of bioprocess engineering is to chemical processes	
6	**Integration into the Programme**	1^{st} or 3^{nd} semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Graded written exam (120 minutes)	
9	**Calculation of Grade**	Written exam: 100% of module grade	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M10-M12: Supplementary module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE: Food technology (2 CH) CLASS: Food technology (1 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Buchholz	
4	**Content**	Food chemistry; Food microbiology; Quality control; Technology (Heat treatment, Packaging, Drying); Processing (product quality, nutrient content, health value, colour, aroma, texture); additives; enzymes (Enzymology, Immobilisation, ingredients); fermented food (bread dough, wine, beer, cheese); biochemistry, molecular biology and Genetics of microorganisms; genetic engineering and food.	
5	**Aims of the Module**	Introduction to food technology supported by practical exercises. Improvement of biological raw material to consumable food, quality sustainability.	
6	**Integration into the Programme**	1st - 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Written exam	
9	**Calculation of Grade**	Non-graded course achievement	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M10-12: Supplementary module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE: Planning and evaluation of experiments (2 CH) CLASS: Planning and evaluation of experiments (1 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Dück	
4	**Content**	1. Basic mathematical principles of the planning of experiments 2. Organisational considerations in the planning of experiments 3. Fundametals of statistics 4. Typology of errors made in planning experiments 5. Characteristics of reliability in experiments (confidence interval, variance ...) 6. Methods of experiment design and evaluation of results regarding the stochastic dependence (correlation analysis, method of least squares). In addition to the teaching of theory, there will also be an opportunity for students to apply the theory in tasks in the classes and practical lab sessions.	
5	**Aims of the Module**	Students will learn about the rational design of experiments that will also produce conclusive results, taking into account factors such as the economic use of manpower, the lowest use of material and energy, and the least amount of wear and tear of laboratory equipment. Furthermore, students will learn how to test the statistical reliability of research results, i.e. how to determine confidence intervals and the criteria required for statistical reliability. Students should learn how to represent results as mathematical dependencies, so as to enable a quantitative description of experimental data.	
6	**Integration into the Programme**	1st - 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Written exam	
9	**Calculation of Grade**	Non-graded certificate of achievement	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M10-M12: Supplementary module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE: Chemical production processes (2 CH) CLASS: Chemical production processes (1 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Haumann	
4	**Content**	Raw materials (resources, availability, evaluation); crude oil (chemical refinery, hydrotreating, cracking, aromatic); natural gas (synthesis gas, cleaning, application); methanol (synthesis, petrol, olefin, aromatic); plastics (synthesis, polymerization); tensides (production, washing agent); renewable resources (carbohydrates, cellulose, starch, sugar); ammonia (Haber-Bosch process, oxidation, absorption); chlorine (alkali chloride electrolysis, amalgam, membrane method); salts (soda, KCl, phosphates, Solvay method); silicate chemistry; special products (catalyser, chip: endowment, structuring); profitability and evaluation of procedures.	
5	**Aims of the Module**	The students should understand the processes of material changing production. Based on typical products from the chemical industry, students will learn the relation between the physical-chemical principles of the processes, process engineering and design.	
6	**Integration into the Programme**	1st - 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Written Exam	
9	**Calculation of Grade**	Non-graded certificate of achievement	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M10-12: Supplementary module**	**5.0 ECTS credits**
2	**Module Components**	LECTURE: Numerical fluid mechanics (2 CH) CLASS: Numerical fluid mechanics (1 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Prof. Delgado	
4	**Content**	Several grid technology and convergence behaviour; compressible solvents (discretization, methods of resolution, discontinuities, collisions); turbulence-simulation (Kolmogorovian energy cascade, dissipation, Eddy elongation); direct numerical simulation; Large Eddy simulation; Reynolds-averaged Navier-Stokes equation (problem of closing, stress tensor, Models: Eddy viscosity, zero, one and two equation models, Reynolds-tension); High-Performance Computing (efficient utilization, vectorizing, parallelization, disassembling of areas); moving grids; free surfaces; Fluid-Structure Interactions	
5	**Aims of the Module**	Enhancement of basic knowledge of numerical fluid mechanics: compressible fluids, turbulent fluids, high performance calculation, fluid-structure interactions; application of the theory in the classes.	
6	**Integration into the Programme**	1^{st} – 3^{rd} semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Written exam	
9	**Calculation of Grade**	Non-graded certificate of achievement	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M10-M12: Supplementary module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE: Insight into process engineering using optical metrology (2 CH) CLASS: Insight into process engineering using optical metrology (1 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Bräuer	
4	**Content**	The gainful application of optical measurement techniques to *insitu* analyze chemical engineering processes is demonstrated. Therefore the lecture covers different process technologies, • Catalytic chemical vapor deposition for CNTs production • Spray processes for powder generation • Particle production from emulsions • Technical and Engine combustion some fundamental experiments to measure heat and mass transport as well as solubilities and vapor liquid equilibria, • High pressure variable volume view cell • Pendant drop • Mikrofluidics and modern flexible optical measurement techniques based on • Elastic light scattering • Inelastic light scattering • Absorption • Absorption followed by emission	
5	**Aims of the Module**	The optical measurements techniques provide deep insight into the above mentioned processes, which cannot easily be provided without the use of optical *insitu* diagnostics. Therefore the lecture aims to provide a comprehensive understanding of the functioning chains of the treated processes and intends to make the attendees oversee where the use of optical *insitu* measurement techniques is advantageous. The lecture also intends communicating the functioning principles of different optical measurement techniques and the used equipment.	
6	**Integration into the Programme**	1st or 2nd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Written Exam	
9	**Calculation of Grade**	Non-graded certificate of achievement	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M10-M12: Supplementary module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE: Environmental process engineering (2 CH) CLASS: Environmental process engineering (1 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Dr. Breiter	
4	**Content**	1. Introduction to Environmental Process Engineering EPE a) Environment pollution b) Ozone hole c) CO2 issue, coupling 2. Pollution control of air a) Legal framework b) Segregation of dust • electro-static segregation • filtering segregators • liquid segregation processes c) De-sulfurization • quasi-dry and dry processes • REA production of hard plaster d) De-nitrofication, DeNOx • technologies • low and high dust circuits of SCR processes 3. Pollution control of water a) Waste water pararmeters, legal framework b) Detoxification of Redox processes • Cyanide detoxification • Chromate detoxification c) Neutralizing und precipitation • Hydroxide precipitation • Sulfide precipitation • Organosulfide precipitation d) Coagulation • surface charge, zero point of charge • coagulation additives e) liquid-solid separation in EPE	
5	**Aims of the Module**	The students should gain an overview of key environmental issues and understand how environmental process engineering is based on natural processes that are modified. Using this knowledge, students should be able to adapt existing processes to the changeable environment and to develop new processes.	
6	**Integration into the Programme**	1st – 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Written exam	
9	**Calculation of Grade**	Non-graded certificate of achievement	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M13: Supplementary module**	**5.0 ECTS Credits**
2	**Module Components**	LECTURE/EXERCISE: German language course - an insight into science, economy and business culture in Germany and Europe 1 (4 CH) LECTURE/EXERCISE: German language course – an insight into science, economy and business culture in Germany and Europe (4 CH)	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Dietmar Benndorf	
4	**Content**	Basic knowledge of the German language (grammar, vocabulary) with the goal of reaching level A1 of the Common European Framework of Reference for Languages; improvement of skills in reading, listening, writing and speaking; knowledge of society, country and everyday routine matters regarding German and European culture focusing in particular on the economy and business culture.	
5	**Aims of the Module**	The students should gain basic knowledge of German, so that they are able to undertake an internship in Germany or at a German company. Student should also have the opportunity to gain a certificate once they successfully pass an exam at the Goethe Institute. Those students who are the most interested and linguistically strongest will be allowed to continue their study of German in Erlangen during the semester break or in the 3rd and 4th semester.	
6	**Integration into the Programme**	1st and 2nd semesters	
7	**Duration of Module**	2 semesters	
8	**Assessment**	Passing the “Start Deutsch 1” examination at the Goethe Institute	
9	**Calculation of Grade**	Non-graded certificate of achievement	
10	**Language of Instruction**	German	

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Module Description

1	**Module Description**	**M14: Project Course**	**5.0 ECTS Credits**
2	**Module Components**	K: Project Course	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Academic Director FAU Busan	
4	**Content**	Students work on particular technical tasks, such as the technical design of a reactor, as well as broader issues such as heat compounds. Consideration of the steps involved in securing approval, such as site selection and environmental impact testing. Economic aspects such as cost structure, investment and operating costs.	
5	**Aims of the Module**	Students are given the task of configuring a chemical manufacturing plant within a specified period of time using the knowledge acquired during their studies and with the help of publicly available information, such as literature, company brochures, etc.	
6	**Integration into the Programme**	3rd semester	
7	**Prerequisite for Participation**	Successful completion of four specialization modules (Modules M1-M4)	
8	**Duration of Module**	1 semester	
9	**Assessment**	Assessment requirements: completion of the group task within the specified time period, including documentation. Participation in a discussion with the sponsor company.	
10	**Calculation of Grade**	Non-graded certificate of achievement	
11	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M15: Industrial Internship**	**5.0 ECTS Credits**
2	**Module Components**	Industrial Internship	5.0 ECTS Credits
3	**Module Representative (FAU Busan)**	Academic Director FAU Busan	
4	**Content**	The focus during the internship should be more on gaining an overview of the various activities carried out within a company, by participating in working or project groups, and less on learning specific skills. Desirable areas of activity include, for example: chemical production, environmental protection, measurement and control engineering, plant design, construction.	
5	**Aims of the Module**	The aim of the internship is to provide students with practical and professional experience of chemical, process engineering and related industries and give them an insight into the organization and the social structure of a company or institution. Completion of an internship abroad is desirable as it allows students to develop additional cultural competence.	
6	**Integration into the Programme**	1st - 3rd semester	
7	**Duration of Module**	1 semester	
8	**Assessment**	Assessment requirements: certificate from the internship provider detailing the nature and duration of any practical and professional activities undertaken and confirming that the student's performance was satisfactory.	
9	**Calculation of Grade**	Non-graded certificate of achievement	
10	**Language of Instruction**	English	

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Module Description

1	**Module Description**	**M16: Master's Thesis**	**30 ECTS Credits**
2	**Module Components**	AWA: Master's Thesis	30 ECTS **Credits**
3	**Module representative (FAU Busan)**	All lecturers	
4	**Content**	This depends on the topic of the thesis, which may be in any of the following fields: Bioreactor Engineering and bioprocess Engineering, Particle Technology, Chemical Reaction Engineering, Fluid Mechanics and Thermal Processes	
5	**Aims of the Module**	Students work independently on a research task in the field of chemical and bioengineering and produce a report that meets the standards of scientific reporting.	
6	**Integration into the Programme**	4th semester	
7	**Prerequisites for Participation**	Successful fulfilment of all assessment requirements (including passing all examinations) for the modules M1 to M15	
8	**Duration of Module**	1 semester	
9	**Assessment**	Students must complete the research task within the specified time period, including the submission of a written report.	
10	**Calculation of Grade**	With variable weighting, based on practical, written work, presentation	
11	**Language of Instruction**	English	