Course Package

Process Technology

Name module	Process Technology – 2A
Educational programme	MSc Chemical Engineering
Period	First block of second semester (block 2A)
Study load	15 ECTS
Coordinator	C. C. Diepenmaat

Process Technology			
block 1A	**block 1B**	**block 2A**	**block 2B**
		Turbulent Combustion **201700218** (5 EC)	
		Process Equipment Design **201300155** (5 EC)	
		Electives: (1 of the 5 EC or 2 of the 2,5 EC)	
		Bionanotechnology - 193400111 (5EC)	
		Process Dynamics & Control - 201800324 (2,5 EC)	
		Chem. Process Analysis - 201800328 (2,5 EC)	
		Scaling-up in Chem. Eng. - 201800329 (2,5 EC)	
		Electrochemical Engineering - 201800326 (2,5 EC)	

Required preliminary knowledge: Thermodynamics, Fluid Dynamics, Heat and Mass Transfer, Reaction Engineering, Separations Technology, Mathematic (among others statistics for Chemical Process Analysis), Basic fluid flow theory, Transport Phenomena and Heat Transfer on bachelor level, Intro in Reaction Engineering, Intro Separation Technology, Basic (molecular) biology, Organic chemistry, Electrochemistry and/or Electrochemistry: Fundamentals & Techniques.

Please note: choose 5 ECTS worth of electives for the normal workload.

201700218 - Turbulent Combustion

The course targets the student to know about numerical modelling approaches of transport in turbulent flows, and how to use them in a commercially available CFD code. The student will know about, and how to analyse, turbulent flows with chemical reactions by means of models and numerical simulation. The student will be able to handle modeling off chemical reaction described by mechanisms with many elementary reactions. He will know how use and understand turbulent flow models in a RaNS and LES approach.. The student will learn how to characterize the regime of turbulent combustion on basis of dimensionless numbers such as Reynolds, Lewis, Prandtl, Schmidt and Karlovitz numbers.This knowledge will enable the student to solve numerically turbulent transport problems in for example the process industry or power generation industry.The course treats the transport in the turbulent flow of gaseous fluids composed of multiple species, by means of diffusion, convection or chemical reaction.

Turbulence has a large effect on both convective transport and chemical reaction. The course intends to give an overview of the major processes, and a description by means of transport equations is presented. Numerical tools (Computational Fluid Dynamics) are used for product optimization and analysis. In the course several assignments in the use of numerical models for chemical reaction, turbulent convection and mixing and combustion will be given. The course will be finalized by means of a computer assignment using a CFD package made available to the students for use on their lap top computer. A practical case with application on a combustion problem will be worked out. The marking will be done on basis of the assignment reports and an oral exam.

201300155 - Process Equipment Design

An industrial process consists mainly of a reactor, separation equipment (for instance distillation), heat exchangers and pumps/compressors. This course starts with lectures to discuss the design in general, and the design of various types of unit operation in detail. Also the mechanical aspects are discussed.

Topics of the different lectures:

- design methodology in general,
- equipment for momentum transport (pumps, fans, compressors),
- equipment for heat transfer, with and without phase transition,
- equipment for mass transfer: focus on distillation.
- mechanical design aspects of process equipment.

The course is finalized with a group design assignment of three types of unit operations for momentum, heat and mass transfer from an industrial scale process. Each team (in general of 3 to 4 students) delivers a report with the results of the design calculations. At the exam two teams will present their results. Before the exam the team reports are exchanged to give the team the opportunity to study the other design. The students are asked during the final exam to compare and discuss the two different designs and to come up with a final concept. Finally, the mark is based on the group effort: the report + presentation and an individual mark for the oral exam about the design and redesign of the used process equipment part.

Electives: (1 of the 5 EC or 2 of the 2,5 EC)

193400111 - Bionanotechnology

Bionanotechnology is a field of research and applications that sits at the interface between nanotechnology on the one hand and life sciences on the other.

This course includes:

- An introduction into the field of bionanotechnology field
- Basics of nanobiology, including structure and function of DNA/RNA, DNA supercoiling, chromatin structure, structure and function of proteins, lipids, membranes, molecular motors, biological cells
- (Biological) nanoparticles, including gene therapy and DNA nanoparticles, inorganica and iron oxide nanoparticles, quantum dots, the unfamiliar world at the nanoscale, molecular interactions, Brownian motion, and diffusion
- Methods and techniques to study biology at the nanoscale, including fluorescence microscopy and other fluorescence-based technoniques, nanoscopy methods, scanning probe microscopy (AFM), single molecule force spectroscopy, elasticity mapping, optical tweezers, magnetic tweezers.

- Writing of a comprehensive essay on the applications of nanobiotechnology, based on a short literature study.

201800324 - Process Dynamics and Control

Part	Subjects of lecture/tutorial	Book chapter	Contents
1. dynamic process modeling	1. introduction 2. modeling	1, 2 3, 4	- Context model design - basic control scheme design - behavioral model design
2. IO-model behavior	3. process in operating point 4. process behavior	7, 6 5.1-3 5.4 10	- linearization - laplace transform - input-output again - examples
3. Controlled process behavior	5. PID behavior 6. PID in frequency domain	32.1-2 32.5 9 32.3-5	- closed-loop behavior - PID-controller tuning - Bode-plot of transfer function - PID-controller tuning

201800328 - Chemical Process Analysis

This course intends to provide an understanding of how experiments on a chemical process should be designed, so that data collection will lead to statistically meaningful conclusions in an efficient and effective way. A methodology for the optimization of the parameters in a chemical process or of a chemical product will be developed, and analytical strategies for continuous monitoring of the status of a chemical process, product, or instrument will be elaborated. Chemometric data analysis concepts including pattern recognition and multivariate analysis will be discussed in the context of a chemical process or product performance characterization and process model selection, verification, and validation. The concept of statistical process control will be explained. The obtained knowledge and skills will be practiced by applying them to real (industrial) cases.

201800329 - Scaling-up in Chemical Engineering

Introduction to scale-up (rationale, problems); Scale-up Problem Analysis (identification of relevant parameters); Dimensional Analysis for deriving dimensionless numbers for scale-up, Examples (analysis, deriving scale-up criteria, process similarity, pitfalls, and successes), Case study (in class) and working on a new scale-up problem (in groups of 2 persons or individual)

Course structure: Lectures; individual written exam (pi-theorem), case studies (in class), group or individual assignment (small report + presentation)

201800326 - **Electrochemical Engineering**

The student should be able to understand and make suggestions for the improvement of electrochemical processes on the basis of thermodynamics, kinetics, and physical transport phenomena