Data:	PPDMPR. MA. Nr. 3620 / Examination number: 40318	Version: 25.01.2024	Start Year: WiSe 2019
Module Name:	**Project - Process Design Mineral Processing / Recycling**		
(English):			
Responsible:	Peuker, Urs Alexander / Prof. Dr.-Ing.		
Lecturer(s):	Mitarbeiter des Institutes MVT/AT		
Institute(s):	Institute of Mechanical Process Engineering and Mineral Processing		
Duration:	1 Semester(s)		
Competencies:	The project work aims at the dimensioning one process step of a mineral processing or recycling plant. On the basis of lab scale test (e.g. Bond grindability, filtration resistance) the students work out a basic engineering of a unit operation within a processing plant of a given ore type / recycling question. The students learn to select the right lab scale tests, which provide the material and process data to quantify the individual processing steps. They learn the balancing of the material flows as well as of the auxiliary streams (e.g. process water).		
Contents:	Seminar: • Introduction into project related theory • Example of a case study • Selection of lab scale tests / using standard parameters (e.g. VDI guidelines) • Documentation Project: • Selection of lab tests • Lab work: determination of individual parameters • Selection of apparatus / dimensioning of process step • Presentation of flow sheet.		
Literature:	Selected papers and textbook chapters for individual project topic (to be announced in the first week) VDI guidelines and international standards		
Types of Teaching:	S1 (WS): process design mineral processing / recycling / Seminar (2 SWS) S1 (WS): project process design mineral processing / recycling / Practical Application (8 SWS)		
Pre-requisites:	**Recommendations:** Conception of Process Equipment, 2023-08-31 Training in Particle Technology, 2022-09-15		
Frequency:	yearly in the winter semester		
Requirements for Credit Points:	For the award of credit points it is necessary to pass the module exam. The module exam contains: AP*: Report (basic Engineering - process layout and applied engineering tools) AP*: Presentation (determination of key parameters using engineering tools) AP*: Presentation (process layout) * In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.		
Credit Points:	5		
Grade:	The Grade is generated from the examination result(s) with the following weights (w):		

	AP*: Report (basic Engineering - process layout and applied engineering tools) [w: 2] AP*: Presentation (determination of key parameters using engineering tools) [w: 1] AP*: Presentation (process layout) [w: 1] * In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.
Workload:	The workload is 150h.

Data:	TPT. MA. Nr. / Examination number: 40316	Version: 05.03.2024	Start Year: WiSe 2022
Module Name:	**Training in Particle Technology**		
(English):			
Responsible:	Peuker, Urs Alexander / Prof. Dr.-Ing.		
Lecturer(s):	Mitarbeiter des Institutes MVT/AT Peuker, Urs Alexander / Prof. Dr.-Ing.		
Institute(s):	Institute of Mechanical Process Engineering and Mineral Processing		
Duration:	1 Semester(s)		
Competencies:	This module is designed to introduce or review the core principles of particle technology. It utilizes specialized exercises aimed at honing scientific and technological skills in calculating particle size distributions and understanding fundamental micro-processes. Furthermore, the module introduces the physical principles governing mechanical micro-processes. Through a series of exercises and case studies, students will learn to apply these fundamental approaches in describing and designing process equipment on a level of conceptional engineering.		
Contents:	Particle characterization Particle size distribution Mixing of particle size distributions Separation of particle size distributions (classification) Micro processes in particle technology • Particles in flow-fields (i.e. sedimentation) • Flow through porous media • Particle-particle interactions (e.g. van-der-Waals-forces, electrostatic interactions, DLVO-theory, capillary forces) • Breakage laws (i.e. breakage energy) Selected case studies form the fields: • Filtration • Sedimentation • Agglomeration • Classification • Comminution • And others		
Literature:	M. Stieß: Mechanische Verfahrenstechnik 1 - Partikeltechnologie, Springer-Verlag, Berlin, Heidelberg, 2009 H. Schubert: Handbuch der Mechanischen Verfahrenstechnik, Wiley-VCH, Weinheim, 2003 selected scientific papers		
Types of Teaching:	S1 (WS): Recall of fundamentals - (lecture also digital available every semester - provided as screencasts) / Lectures (1 SWS) S1 (WS): Application of fundamentals - case studies - corresponding excercise to apply the theoretical equations and solutions / Exercises (2 SWS)		
Pre-requisites:			
Frequency:	yearly in the winter semester		
Requirements for Credit Points:	For the award of credit points it is necessary to pass the module exam. The module exam contains: KA: written exam [120 min] PVL: test (midterm) The PVL is integrated in the lecture / excercise in the midterm of the lecture series.		

	PVL have to be satisfied before the examination.
Credit Points:	4
Grade:	The Grade is generated from the examination result(s) with the following weights (w): KA: written exam [w: 1]
Workload:	The workload is 120h.

Data:	RESMGT. MA. Nr. 2082 / Examination number: 62407	Version: 31.05.2018	Start Year: WiSe 2016
Module Name:	**Resource Management**		
(English):			
Responsible:	Glöser-Chahoud, Simon / Prof.		
Lecturer(s):	Glöser-Chahoud, Simon / Prof.		
Institute(s):	Corporate Sustainability and Environmental Management		
Duration:	1 Semester(s)		
Competencies:	Students • explain the resource related corporate management tasks, structure these, • use selected tools and methods and • explain the interplay between resource management and related tasks such as operations and supply chain management.		
Contents:	The course deals with the field of resource management from a industrial perspective. This comprises resource related management tasks, methods and tools to solve these and how they are embedded within functions and processes of companies. Thereby the focus lies on repetition factors mineral raw materials and energy carriers, renewable raw materials and energy carriers as well as secondary raw materials and energy carriers.		
Literature:	Bausch (2009): Handbook Utility Management, Springer Thiede (2012): Energy Efficiency in Manufacturing Systems, Springer Thonemann (2015): Operations Management, Pearson Vrat (2014): Materials Management, Springer Wagner, Enzler (2006) Material Flow Management, Physica		
Types of Teaching:	S1 (WS): Lectures (2 SWS) S1 (WS): Exercises (2 SWS)		
Pre-requisites:			
Frequency:	yearly in the winter semester		
Requirements for Credit Points:	For the award of credit points it is necessary to pass the module exam. The module exam contains: AP*: Case study with oral presentation KA* [90 min] * In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.		
Credit Points:	6		
Grade:	The Grade is generated from the examination result(s) with the following weights (w): AP*: Case study with oral presentation [w: 1] KA* [w: 4] * In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.		
Workload:	The workload is 180h. It is the result of 60h attendance and 120h self-studies.		

Data:	Examination number: 40319	Version: 18.01.2019	Start Year: WiSe 2019
Module Name:	**Practice of Secondary Raw Materials**		
(English):	Practice of Secondary Raw Materials		
Responsible:	Peuker, Urs Alexander / Prof. Dr.-Ing.		
Lecturer(s):	Mitarbeiter des Institutes MVT/AT Peuker, Urs Alexander / Prof. Dr.-Ing.		
Institute(s):	Institute of Mechanical Process Engineering and Mineral Processing		
Duration:	1 Semester(s)		
Competencies:	The students acquire knowledge about typical actual challenges as well as about technical setups and approaches in recycling industry. They are able to connect theoretical knowledge on unit operations to the technical operation of recycling plants. Furthermore the students become familiar with the balancing and business models in secondary raw materials business.		
Contents:	The aim is the teaching of practical insight into secondary raw materials technology and its industrial application. Several established processes for secondary raw materials are introduced by (guest) lectures. This introduction contains the specialties of the material sources and properties, the process design and potential alternatives as well as the key technological components. The lecture also involves demonstration of technology by site visits of recycling plants. (guest) lectures: introduction in several recycling processes, e.g. battery recycling (acid lead battery, lithium-ion battery), aluminium scrap, construction waste, metallurgical waste, WEEE, automotive recycling.		
Literature:	Martens, H. und Goldmann, D.: Recyclingtechnik Scientific publications		
Types of Teaching:	S1 (WS): Lectures (1 SWS) S1 (WS): Seminar (1 SWS) S1 (WS): 4-6 Site visits to relevant production plants connected to course content / Excursion (3 SWS)		
Pre-requisites:	**Mandatory:** course restricted to students of EMerald program or Students of Bachelor Engineering Fach Verfahrenstechnik und Chemieingenieurwesen		
Frequency:	yearly in the winter semester		
Requirements for Credit Points:	For the award of credit points it is necessary to pass the module exam. The module exam contains: AP: Report		
Credit Points:	4		
Grade:	The Grade is generated from the examination result(s) with the following weights (w): AP: Report [w: 1]		
Workload:	The workload is 120h.		

Data:	RecSRM. MA. Nr. / Examination number: 40326	Version: 24.07.2023	Start Year: WiSe
Module Name:	**Recycling – Secondary Raw Materials**		
(English):	Recycling – Secondary Raw Materials		
Responsible:	Peuker, Urs Alexander / Prof. Dr.-Ing. Charitos, Alexandros / Prof.		
Lecturer(s):	Peuker, Urs Alexander / Prof. Dr.-Ing. Charitos, Alexandros / Prof.		
Institute(s):	Institute of Mechanical Process Engineering and Mineral Processing Institute of Nonferrous Metallurgy and Purest Materials		
Duration:	1 Semester(s)		
Competencies:	The students will be able to link the applied module to the engineering and scientific fundamentals they have learned during their education. They will get an overview on selected process designs in the recycling of secondary raw materials. They will be able to analyze and understand the individual process steps of mechanical and metallurgical recycling. They will be aware of the interlink between mechanical and metallurgical recycling approaches. Finally, they be able to apply this knowledge to describe technical issues quantitatively.		
Contents:	There is a theoretical introduction into different quantitative methods / process steps, which are relevant in recycling, e.g. • Waste regulation • Logistics / quality control • Shredding • Mechanical sorting (magnetic, electrostatic, eddy current, density, sensor based, ...) • Metallurgical • Emissions Building on the microprocesses of particle technology (c.f. Training in Particle Technology) and fundamental knowledge in chemistry and thermodynamics, various technical process and related apparatus or machine technology of recycling technology are introduced including: • Battery recycling • ELV recycling • Plastics recycling • Non-ferrous metal recycling • Aluminum recycling • Tin recycling • Slag recycling • 1-2 additional topics		
Literature:	H. Martens, D. Goldmann, Recyclingtechnik, Springer, Berlin, 2016 H. Schubert: Handbuch der Mechanischen Verfahrenstechnik, Wiley-VCH, Weinheim, 2003 Selected scientific papers		
Types of Teaching:	S1 (WS): Lectures (3 SWS) S1 (WS): Seminar (1 SWS)		
Pre-requisites:	**Recommendations:** Training in Particle Technology, 2022-09-15 Grundlagen der Mechanischen Verfahrenstechnik, 2020-04-06 Mechanische Verfahrenstechnik, 2020-04-07		
Frequency:	yearly in the winter semester		

Requirements for Credit Points:	For the award of credit points it is necessary to pass the module exam. The module exam contains: in examination variant 0: MP/KA (KA if 8 students or more) [MP minimum 20 min / KA 150 min] PVL: report or in examination variant 1: MP [20 to 30 min] PVL: report Examination variant 1 provided for "TUBAF digital" PVL have to be satisfied before the examination.
Credit Points:	6
Grade:	The Grade is generated from the examination result(s) with the following weights (w): in examination variant 0: MP/KA [w: 1] or in examination variant 1: MP [w: 1]
Workload:	The workload is 180h. It is the result of 60h attendance and 120h self-studies. The latter includes the preparation and follow-up of the lecture course, the preparation and follow-up of the seminar including reporting, as well as the preparation for the written exam.

Data:	SSSE. MA. Nr. 3653 / Examination number: 43112	Version: 24.09.2018	Start Year: WiSe 2018
Module Name:	**Selective Separation of Strategic Elements**		
(English):			
Responsible:	Bräuer, Andreas / Prof. Dr.-Ing.		
Lecturer(s):	Haseneder, Roland / Dr. rer. nat.		
Institute(s):	Institute of Thermal, Environmental and Natural Products Process Engineering		
Duration:	1 Semester(s)		
Competencies:	On completion of the course the student shall be able to explain membrane technology and the different applications like extraction and membrane assisted processes regarding the separation of value products. Focus is put on strategic elements. They can use their physico-chemical knowledge on membrane separation, development of hybrid operation systems and the influences for practical applications and are familiar with the methods and problems related to separation devices. Due to the seminar the students will be able to dicuss the current literature on the topic.		
Contents:	• membranes, modules, hybrid processes • driving forces, transport resistances • structures, materials • mass transfer • module construction • MF, UF, NF, RO • standard applications • scaling, fouling effects • special applications: mine water treatment, leaching solutions, resourcerecovery • internship to membrane processes		
Literature:	Heinrich Strathmann: Introduction to Membrane Science and Technology, Wiley-VCH, 2011 Anil K. Pabby, Syed S.H. Rizvi, Ana Maria Sastre Requena: Handbook of Membrane Separations, CRC-Press 2008		
Types of Teaching:	S1 (WS): Lectures (2 SWS) S1 (WS): Seminar (1 SWS) S1 (WS): Practical Application (1 SWS)		
Pre-requisites:			
Frequency:	yearly in the winter semester		
Requirements for Credit Points:	For the award of credit points it is necessary to pass the module exam. The module exam contains: KA [90 min]		
Credit Points:	5		
Grade:	The Grade is generated from the examination result(s) with the following weights (w): KA [w: 1]		
Workload:	The workload is 150h. It is the result of 60h attendance and 90h self-studies.		

Data:	SSMP MA. / Examination number: 51119	Version: 13.11.2018	Start Year: SoSe 2019
Module Name:	**Simulation of Sustainable Metallurgical Process**		
(English):			
Responsible:	Stelter, Michael / Prof. Dr.-Ing. Reuter, Markus / Prof. Dr.		
Lecturer(s):	Reuter, Markus / Prof. Dr.		
Institute(s):	Institute of Nonferrous Metallurgy and Purest Materials		
Duration:	1 Semester(s)		
Competencies:	1. Simulation of reactor types • modelling and simulation of hydro- and pyrometallurgical reactors for primary and secondary resources and determination of mass and energy balances as well as minerals processing • determination of ecological and economic footprint of reactors 2. Modelling of processing flowsheets • develop processing flowsheets for non-ferrous metal containing resources • modelling and simulation of hydro- and pyrometallurgical processing plants for primary and secondary non-ferrous resources as well as minerals processing • determination of mass and energy balances of the complete flowsheet and determine optimal processing routes • determination of ecological and economic footprint of complete flowsheets 3. Methods and tools • use of simulation tools such as HSC Sim 9.0, FACTSAGE etc. and environmental software tools such as GaBi to evaluate different processing options • create process designs and communicate results to a client and/or stakeholders e.g. NGOs		
Contents:	Reactor types in process metallurgy and minerals processing (e.g. TSL, Kaldo, flash smelting, QSL, flotation cells etc.) will be compared using simulation cases, evaluated and optimised for metal and minor metal recovery. The environmental footprint as also the economic performance of each reactor type will be compared with each other to establish best options for reactor flotation types as a function of feed types. The student will understand minerals processing and metallurgical reactor technology better and also be in a better position to create more sustainable industry and society. Process design cases will be performed by the students to optimally process different feed types. By using a wider range of reactor types the student will be able to simulate complete flowsheets, provide mass and energy balances at the same time also determine the environmental footprint as well as economic analysis. This course will also examine the impact of product design on the recycling of various end-of-life products such as mobile phones etc. Thus, not only will natural resources be processed in the simulated systems but also materials from the “urban mine”. Therefore, this course will also use this rigorous simulation basis to critically discuss environmental legislation as well as communicate		

	these results to all stakeholders. The course takes place as a 2 week block course in September.
Literature:	• E. Worrell, M.A. Reuter (2014): Handbook of Recycling, Elsevier BV, Amsterdam, 595p. (ISBN 978-0-12-396459-5). • M.A. Reuter, R. Matusewicz, A. van Schaik (2015): Lead, Zinc and their Minor Elements: Enablers of a Circular Economy World of Metallurgy – ERZMETALL 68 (3), 132-146. • M.A. Reuter, A. van Schaik, J. Gediga (2015): Simulation-based design for resource efficiency of metal production and recycling systems, Cases: Copper production and recycling, eWaste (LED Lamps), Nickel pig iron, International Journal of Life Cycle Assessment, 20(5), 671-693. • M.A. Reuter, I. Kojo (2014): Copper: A Key Enabler of Resource Efficiency, World of Metallurgy – ERZMETALL 67 (1), 46-53 (Summary of plenary lecture Copper 2013). • S. Creedy, A. Glinin, R. Matusewicz, S. Hughes, M.A. Reuter (2013): Outotec® Ausmelt Technology for Treating Zinc Residues, World of Metallurgy – ERZMETALL, 66(4), 230-235. • M.A.H. Shuva, M.A. Rhamdhani, G. Brooks, S. Masood, M.A. Reuter (2016): Thermodynamics data of valuable elements relevant to e-waste processing through primary and secondary copper production - a review, J. Cleaner Production, 131, 795-809. • M.A. Reuter (2016): Digitalizing the Circular Economy - Circular Economy Engineering defined by the metallurgical Internet of Things-, 2016 TMS EPD Distinguished Lecture, USA, Metallurgical Transactions B, 47(6), 3194-3220 (http://link.springer.com/article/10.1007/s11663-016-0735-5). • I. Rönnlund, M.A. Reuter, S. Horn, J. Aho, M. Päällysaho, L. Ylimäki, T. Pursula (2016): Sustainability indicator framework implemented in the metallurgical industry: Part 1-A comprehensive view and benchmark & Implementation of sustainability indicator framework in the metallurgical industry: Part 2-A case study from the copper industry, International Journal of Life Cycle Assessment, 21(10), 1473-1500 & 21(12), 1719-1748.
Types of Teaching:	S1 (SS): Block course / Lectures (1 SWS) S1 (SS): Block course / Seminar (2 SWS) S1 (SS): Block course / Practical Application (2 SWS)
Pre-requisites:	**Recommendations:** Basic thermodynamic, thermodynamic and kinetic knowledge in process metallurgy
Frequency:	yearly in the summer semester
Requirements for Credit Points:	For the award of credit points it is necessary to pass the module exam. The module exam contains: AP: Report of simulation The student should solve a case/example and hand in the computer file as a document.
Credit Points:	6
Grade:	The Grade is generated from the examination result(s) with the following weights (w): AP: Report of simulation [w: 1]
Workload:	The workload is 180h. It is the result of 75h attendance and 105h self-studies.

Data:	MINLI. BA.HPT.Nr / Examination number: 33208	Version: 28.01.2020	Start Year: WiSe 2016
Module Name:	**Mineral Liberation Analysis (MLA) of Mineral Resources**		
(English):			
Responsible:	Schulz, Bernhard / Prof. Dr.		
Lecturer(s):	Schulz, Bernhard / Prof. Dr.		
Institute(s):	Institute of Mineralogy		
Duration:	1 Semester(s)		
Competencies:	Bewertung von Erzen und Aufbereitungsprodukten aus der automatisierten Liberierungsanalyse (Mineral Liberation Analysis, MLA) mit Rasterelektronenmikroskop (REM). Aufsetzen und Spezifizierung von automatisierten Messungen mit REM. Numerische und graphische Auswertung von Datenbank-Files der automatisierten Analysen mit REM. Evaluation of metal ores and processed metal ores by automated mineral liberation analysis (MLA) by Scanning Electron Microscope (SEM). Set-up and speciation of automated measurements by SEM. Numerical and graphical assessment of databas files produced from automated SEM measurements.		
Contents:	Methodik der automatisierten REM-Analyse, Auswerte-Programme, Daten-Extraktion, Interpretation, Verfassen von Berichten an Aufbereitungsingenieure. Methods of automated SEM analysis, evaluation software, data extraction, interpretation, writing of reports for mineral processing engineers.		
Literature:	Gu, Y. (2003). Automated Scanning Electron Microscope Based Mineral Liberation Analysis. Journal of Minerals and Materials Characterization & Engineering, vol. 2, no. 1: 33–41.; Fandrich, R., Gu, Y., Burrows, D. & Moeller, K. (2007). Modern SEM-based mineral liberation analysis. International Journal of Mineral Processing, 84, 310-320.		
Types of Teaching:	S1 (WS): Mineral Liberation Analysis (MLA) of Mineral Resources - Präsentation von Verfahren der automatisierten Mineral Liberation Analysis (MLA) mit Rasterelektronenmikroskop. Teilnehmer bearbeiten Daten mit eigenen Laptops. Presentation of methods of Mineral Liberation Analysis (MLA) by Scanning Electron Microscope (SEM). Participants evaluate data by using their own Laptops. / Exercises (2 SWS)		
Pre-requisites:	**Recommendations:** Knowledge of analytical methods based on electron beam intruments		
Frequency:	each semester		
Requirements for Credit Points:	For the award of credit points it is necessary to pass the module exam. The module exam contains: AP: Report with protocol on the evaluation of a Mineral Liberation Analysis by Scanning Electron Microscope (SEM)		
Credit Points:	3		
Grade:	The Grade is generated from the examination result(s) with the following weights (w): AP: Report with protocol on the evaluation of a Mineral Liberation Analysis by Scanning Electron Microscope (SEM) [w: 1]		
Workload:	The workload is 90h. It is the result of 30h attendance and 60h self-studies. Der Zeitaufwand beträgt 60 h und setzt sich zusammen aus 30 h Präsenzzeit und 30 h Selbststudium. Letzteres umfasst die Anfertigung		

	des Berichts mit Protokoll. Expenditure of time is 60 hrs. This is composed of 30 hrs presence in class and 30 hrs homework, including preparation of report with protocol.