<u>Appendix 2:</u> Module handbook for Master programme "Mineral Resource and Process Engineering"

Module description "Planning Seminar Mineral Resource Engineering or Process Engineering" (Compulsory field Research-oriented modules)

Module name	Planning Seminar Mineral Resource Engineering or Process Engineering
Short form	
Course type	Planning Seminar Mineral Resource Engineering or Planning Seminar Process Engineering
Semester	Summer semester
Responsible for module**	Mineral Resource Engineering: Prof. Rattmann Process Engineering: Prof. Kreipl
Lecturer(s)**	Prof. Kreipl, Prof. Lenski, Prof. Lotzien, Prof. Daniels, Prof. Paschedag, Prof. Rattmann
Language	English/German
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	RM
Working hours	Total working hours: 300 h of which presence*: 20 h of which self-study: 280 h
Credit points	10 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Mineral Resource Engineering: • Development of team-working skills • Self-organisation and time management • Realistic hands-on experience on how to perform feasibility studies • Engineer-like development of practicable, coherent and thorough plans for all functions and tasks of a mining project Process Engineering • Development of team-working skills • Self-organisation and time management • Realistic hands-on experience on how to plan large-scale process plants • Engineer-like development of practicable coherent and thorough plans for all functions and tasks of a process plant project The module promotes the ability to apply mining engineering knowledge in mine design, including planning and design of mining systems and processes. Economic, ecological and social consequences have to be considered, thus the awareness of their professional and ethical responsibility is raised. The problem-solving attitude and the self-learning attitude are fostered by self-dependent design work. The students intensify their know-how in software application by practical experience (AutoPLAN, Excel, VentSim, MS-Project, etc.). Compiling the project by self-organised teamwork promotes the ability to define, structure, plan and execute a project and to work in teams. The written report and the oral presentation support the ability to communicate the results of their engineering work.
Content	Mineral Resource Engineering: Assisted by tutors, the students prepare in teams a case study for a greenfield mining project. Task description: • 8-week time period, 4-6 students per team • Given information: drilling data, location, geological information • Self-dependent organisation of teamwork, monitoring of progress • Research work to collect needed information and data, engineer-like development of logical assumptions • Planning, design, calculations, description of all functions and tasks of a mining project

	• Preparation of a preliminary bankable feasibility study (written report) • Presentation of the project to a group of expert representatives of the industry and a financial institute. Process Engineering: Supervised and assisted by professors, the students prepare in teams a case study for a project in the field of mechanical, thermal or chemical engineering including engineering and financial aspects. Task description: • Time period: one semester, 3-6 students per team • Given information: background data of the products or starting material; assumed investment costs of plant components • Self-dependent organisation of teamwork, monitoring of progress • Research work to collect needed information and data, engineer-like development of logical assumptions • Planning, design, calculations, description and simulation of all functions and tasks of a process engineering project • Preparation of a preliminary bankable feasibility study including financial aspects (business plan) of the project • Presentation of the project to a group of experts
Required performance for studying/examination, types of examination	Examination performance: written seminar paper
Means used	Coordination talks, Excel, PowerPoint, planning software, Word, MS-Project, own research
Reference literature**	

* Calculated on basis of: 16 weeks per semester; presence proportion may be reduced by blended learning units which would lead to increase of self-study hours.
** At the time these regulations were published; may be subject to change.

Module description "Writing and Publishing Specialist Articles and Conference Papers, Simulation Game" (Compulsory field Research-oriented modules)

Module name	Writing and Publishing Specialist Articles and Conference Papers, Simulation Game
Short form	
Course type	Writing and Publishing Specialist Articles and Conference Papers, Simulation Game
Semester	Winter semester
Responsible for module**	Mineral Resource Engineering: Prof. Rattmann Process Engineering: Prof. Kreipl
Lecturer(s)**	Prof. Kreipl, Prof. Lenski, Prof. Lotzien, Prof. Daniels, Prof. Paschedag, Prof. Rattmann
Language	English/German
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	RM
Working hours	Total working hours: 300 h of which presence*: 20 h of which self-study: 280 h
Credit points	10 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	Practice of Business and Research, Project Work I
Module objectives/learning objectives aimed at	After successful completion of the course students should: • Publish a specialised article according to rules of proven academic practice • Explain engineering matters briefly, understandably, comprehensibly and effectively • Apply stylesheets and guidelines for authors provided by specialist journals The independent writing of a specialist article of the graduate's own choice significantly promotes the application of knowledge acquired during the course of studies. Moreover, it enhances the competence to recognise gaps in one's own knowledge or methodical approach and to derive objectives for the specialist article from that. The discussion of the topic chosen also develops skills of problem-solving intensively and helps to practise the suitable communication of gained insights. The independent exploration of a topic also develops learner autonomy.
Content	Simulation game: Publishing a Specialist Article Based on Practice of Business and Research, Project Work I or II or even a topic of their own choice students will write an article for a specialist journal applying the respective writing guidelines. At the end of the period assigned for the task, the lecturers involved will assess the articles (as a kind of peer review) and provide feedback.
Required performance for studying/examination, types of examination	Examination performance: written seminar paper
Means used	
Reference literature**	

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Module description "Practice of Business and Research, Project Work"
(Compulsory field Research-oriented modules)

Module name	Practice of Business and Research, Project Work
Short form	
Course type	Practice of Business and Research, Project Work
Semester	Summer semester or winter semester
Responsible for module**	Mineral Resource Engineering: Prof. Rattmann Process Engineering: Prof. Kreipl
Lecturer(s)**	Prof. Kreipl, Prof. Lenski, Prof. Lotzien, Prof. Daniels, Prof. Paschedag, Prof. Rattmann
Language	German/English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	RM
Working hours	Total working hours: 300 h of which presence *: 5 h of which self-study: 295 h
Credit points	10 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Students will gain: Insights into the fields of work occupied by mineral resource engineers or process engineers; insights into engineering research activities; independent and structured working on an engineering question under supervision. The module significantly promotes the application of knowledge acquired in the course of studies by the independent exploration of an engineering topic in a professional environment. It also develops the design of concepts, systems and processes. The independent working of the question (supported by the lecturers) enhances the competence to recognise gaps in one's own knowledge or methodical approach and to derive project objectives; this also develops skills of problem-solving intensively and helps to practise the communication of work results in written and oral form as students have to document the project, write a report and present the project work.
Content	Work experience assignment in an industrial company, an engineering office, a laboratory and such as specified in the Guidelines for the Internship (Work Placement).
Required performance for studying/examination, types of examination	Work experience assignment: Certificate of 40 working days and written seminar paper
Means used	To be selected by the student as appropriate for the topic
Reference literature**	To be selected by the student as appropriate for the topic

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Module description "Master's Thesis and Final Oral Examination (Colloquium)"
(Compulsory field Research-oriented modules)

Module name	Master's Thesis and Final Oral Examination (Colloquium)
Short form	
Course type	1. Master's Thesis; 2. Final Oral Examination (Colloquium)
Semester	Summer semester or Winter semester
Responsible for module**	Mineral Resource Engineering: Prof. Rattmann Process Engineering: Prof. Kreipl Prof. Kreipl, Prof. Rattmann
Lecturer(s)**	Professors of the THGA
Language	German or English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	RM
Working hours	Total working hours: 900 h of which presence *: 50 h of which self-study: 850 h
Credit points	Master's Thesis: 27 CP Colloquium: 3 CP
Prerequisites defined in Exam. Regulations	Minimum 60 CP and completed work placement
Recommended prerequisites	
Module objectives/learning objectives aimed at	The graduates have acquired advanced knowledge and understanding of the principles of Mineral Resource and Process Engineering. Thus, they are able to identify engineering research needs and to explore a question deriving from those as the topic of their Master's thesis; this topic need to be worked in a structured manner, developing a solution in a given period of time and presenting it in written form (Master's thesis) and then defending in oral form (colloquium). They have also acquired a deeper understanding and critical assessment of the state of research and are able to implement those skills in their assignment. They can appreciate the learning efforts required to make progress in application-oriented research and are able to make use of state-of-the-art methodology (innovative and technological) to solve issues including methods applied in other disciplines. The graduates have enhanced (and demonstrated) the skill of specifying and working on specialist tasks that are complex and not fully defined or well-known. They have developed the fundamental skills to contribute to the further development of the discipline in research and practice. With their Master's thesis, they present an independent work from the professional and scientific fields of Mineral Resource and Process Engineering. The graduates are able to communicate complex content and scientific-technical problems from the fields of Mineral Resource and Process Engineering logically and coherently in written and oral form to both specialists and non-specialists, in German and a foreign language. They have also acquired the skill to independently create professional and scientific publications and the critically assess those. They can initiate and organise their own learning and thus they are able to pursue lifelong learning.
Content	Analysis of the assignment; development of scientific principles; assessment of different solution options; independent development of a solution relevant to practice based on scientific research findings (own and critical discussion of others); documentation of that in the Master's thesis; presentation of content in colloquium.
Required performance for studying/examination, types of examination	Examination performance: written seminar paper and oral exam
Means used	Computer and software, Internet, reference literature
Reference literature**	THEISEN, M.R.: Wissenschaftliches Arbeiten: Technik – Methodik – Form, Vahlen, 2008; Specialist journals and publications; Internet; currently valid editions of DIN and EN; up-to-date reference literature; Information on Master's thesis and how to write it can be found on the THGA's website: www.THGA-bochum.de.

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Module description "Sustainable Management and Communication"
(Compulsory field Management Skills)

Module name	Sustainable Management and Communication
Short form	
Course type	Sustainable Management and Communication
Semester	Winter semester
Responsible for module**	Prof. Niski
Lecturer(s)**	Prof. Niski
Language	English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points*	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	Business knowledge, proficiency in English
Module objectives/learning objectives aimed at	Learning Outcomes: • Apply scientific knowledge in business administration and methods required to evaluate sustainability concepts and systems • Design, manufacture, and manage processes in an environmentally conducive manner • Analyse engineering and management problems in their social and environmental context • Develop economic, environmental, and social sound sustainable strategies and decisions • Evaluate the impact of products, processes, and activities through life cycle assessment • Develop marketing, communication and PR strategies (co-design) • Demonstrate deep knowledge of conflict management. • Acquire both knowledge and skills that are broad, deep, and necessary to fulfil their professional goals • Effectively contribute to the performance of a group as the group addresses practical business situations, and assume a leadership role as appropriate • Achieve good knowledge about marketing, strategic management and communications • Be knowledgeable about the differences among global economies, institutions, and cultures and will understand the implications these have on global and sustainable management
Content	Academic content: a) Sustainable and strategic management b) Marketing and public relations c) Business planning d) Conflict management e) Human resource management
Required performance for studying/examination, types of examination	Written exam
Means used	Teaching & Learning Methods You will be exposed to a variety of teaching and learning methods that could include: interactive lectures, case studies, seminar presentations and group project work. As this is a Master's level course, we place a significant emphasis on independent, directed, private study that is often conducted in learning sets or groups.

Reference literature**	• David, F.R. (2006): Strategic Management, Concepts and Cases, Upper Saddle River, Pearson Prentice Hall • Kinicki, A., William, B.K. (2009): Management, McGraw-Hill • Kotler, Ph. & Armstrong, G. (2009): Principles of Marketing, 13th ed., Prentice Hall, Pearson • Kotler, Ph. (2008): Marketing Management, 13th ed., Upper Saddle River, Prentice Hall • Kreitner, R. (2009): Principles of Management, South-Western Cengage Learning • Quaddus, M., Siddique, M. (2011): Handbook of Corporate Sustainability: Frameworks, Strategies and Tools • Quick, J.C., Nelson, D. (2013): Principles of Organizational Behavior, 8th ed., South Western Cengage Learning

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Module description "Health and Safety, Environmental Aspects 2" (Compulsory field Management Skills)

Module name	Health and Safety, Environmental Aspects 2
Short form	
Course type	Health and Safety, Environmental Aspects 2
Semester	Winter semester
Responsible for module**	Prof. Sohn
Lecturer(s)**	Prof. Sohn
Language	English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Learning outcomes: The students acquire knowledge on the institutions and persons active in occupational health and safety and in environmental protection, in particular the health and safety officer and the different environmental officers. They learn to recognise and assess risks and to develop state-of-the-art measures. They will be qualified to work as internal advisors and supporters in areas of occupational health and safety and environmental protection. The students learn to appreciate the enormous importance of occupational health and safety (OHS) and environmental protection for sustainable success in business. This module promotes the application of knowledge acquired in OHS and environmental protection as the students apply methods systematically to selected examples and learn to integrate the groups involved. The design of concepts, systems and processes, e.g. regarding the prevention of accidents in the workplace, is promote by the students analysing and discussing case studies from the world of work and transferring their findings to new situations. The module enhances the competence to recognise gaps in one's own knowledge or methodical approach and to derive project objectives; skills of problem-solving are developed as risk-based approaches are practised. The module, using state-of-the-art measures in OHS and environmental protection, advances the competence to recognise the global, economic, ecological and societal context; in particular, the module builds awareness for students' own professional and moral responsibility which is further supported by study trips to selected companies.
Content	Fundamental competences on the specialist topics. At the end of the semester, students will be familiar with the dual occupational health and safety system in Germany and how it is integrated into European law, and they will be able to use relevant regulations to design preventive solutions for processes at work. They will be familiar with the hazard assessment as a fundamental tool to control the company risks of OHS and environmental protection and with the model of how accidents and diseases occur. They will work in groups using examples of own concepts for safety at work.
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	Chalkboard, pin board, projector
Reference literature**	Documents (photos, video clips, descriptions) of practical examples, script/notes, series: Handbücher zum Betriebssicherheitsmanagement

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** At the time these regulations were published; may be subject to change.

Module description "Controlling, Leadership and Corporate Governance" (Compulsory field Management Skills)

Module name	Controlling, Leadership and Corporate Governance
Short form	
Course type	Controlling, Leadership and Corporate Governance
Semester	Winter semester
Responsible for module**	Prof. Niski
Lecturer(s)**	Prof. Niski
Language	English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	After successful completion of the course students should: • Have an overview of key content of controlling, leadership and corporate governance in internationally active companies • Know how controlling is applied in companies and which key performance indicators from controlling can be used in companies • Be familiar with leadership in companies and understand the key principles of leading employees and teams • Know principles of corporate governance (company management) • Know how to develop and implement corporate strategies • Understand which key performance indicators can help to lead a company
Content	• Advanced principles of controlling in companies, use for company performance indicators • Leadership in companies • Corporate governance (developing and implementing company strategy, using key performance indicators to lead a company)
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	PowerPoint presentation, charts, script (Moodle learning platform), own Internet research
Reference literature**	• Hungenberg, Harald; Wulf, Torsten: Grundlagen der Unternehmensführung, Springer Gabler, 2015

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Module description "Sustainable Energy and Raw Materials Supply" (Compulsory field Management Skills)

Module name	Sustainable Energy and Raw Materials Supply
Short form	
Course type	Sustainable Energy and Raw Materials Supply
Semester	Winter semester
Responsible for module**	Dr. Möllerherm
Lecturer(s)**	Dr. Möllerherm
Language	German, English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	After successful completion of the course students should: • Have an overview of the international raw materials industry • Be familiar with the concept of sustainable development • Know the four sources of sustainable raw materials supply and be able to classify them • Know the process chain of primary raw materials supply and be able to optimise this for the purpose of sustainability • Be aware of the opportunities and limits of recycling and circle economy • Know how to substitute materials and classify new materials as resources • Understand and handle the opportunities and limits of material efficiency This module promotes the application of knowledge acquired in the fields of raw materials production and sustainability by analysing process chains of primary raw materials supply with regard to sustainability and efficient use of resources. The module teaches knowledge on the international raw materials industry, the concept of sustainable development four sources of sustainable raw materials supply to build the competence of understanding the global, economic, ecological and societal context. in particular, the module creates awareness for students' own professional and moral responsibility.
Content	• International raw materials industry • Concept of sustainable development • Primary raw materials supply and sustainability • Recycling and circle economy • Substitution as a resource • Material efficiency as a resource
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	PowerPoint presentation, charts, script (Moodle learning platform), own Internet research
Reference literature**	• http://minerals.usgs.gov/minerals/pubs/mcs/ • Lottermoser, B.: Mining Wastes. Springer, 2010. • Richards, J.: Mining, Society and a Sustainable World. Springer, 2010. • Kranert, M.: Einführung in die Kreislaufwirtschaft. Springer, 2016 • Martens, H., Goldmann, D.: Recyclingtechnik. Springer 2016

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Module description "Surface and Underground Mining Equipment"
(Optional compulsory field of major Mineral Resource Engineering)

Module name	Surface and Underground Mining Equipment
Short form	SUME
Course type	Surface and Underground Mining Equipment
Semester	Summer semester
Responsible for module**	Prof. Paschedag
Lecturer(s)**	Prof. Paschedag
Language	English
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Mineral Resource Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP TMP1: 4 CP TMP2: 1 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Knowledge, skills and competences	Graduates of the major Mineral Resource Engineering acquire a comprehensive, detailed, specialised up-to-date knowledge in the fields of equipment and their selection; processes of mineral resource production; planning of projects in mineral resource production; ventilation technology and raw materials production and sustainability. Graduates will be able to apply their knowledge and to develop and design suitable concepts, processes and systems taking framework conditions and restrictions into account. Graduates focus on solving problems and are able to develop relevant solutions. They are also able to review their discipline in the current global, economic, ecological and societal context and to use that for orientation. Graduates are aware of their professional and moral responsibility and act accordingly.
Module objectives/learning objectives aimed at	Learning outcomes: This module comprehensively promotes the application of knowledge acquired in the fields of surface and underground mining equipment by demonstrating their use to students using practical examples. The development of concepts, systems and processes, e.g. on the exploitation of deposits, is strongly advanced by teaching students on the applications of the different machines. The focus on problem-solving is fostered by analysing case studies on selection of equipment. The module provides a detailed view on the use of mining equipment in different countries plus the competence to recognise the current global, economic, ecological and societal context. Likewise, awareness of students' own professional and moral responsibility is built again by using case studies to demonstrate right and wrong decisions and in particular the consequences of wrong actions. The development of concepts, systems and processes, e.g. on the underground exploitation of hard-coal deposits, is strongly advanced by students comprehending relevant cases from the world of work. The focus on problem-solving is promoted by discussing issues from practice for which the students need to find solutions. The content of the module also trains the competence to recognise the current global, economic, ecological and societal context. Likewise, awareness of students' own professional and moral responsibility is built. Surface and underground mining equipment • Be familiar with working principles, functions, limitations, advantages and disadvantages of surface and underground mining equipment. • Be able to select, size and match an appropriate equipment fleet for certain applications in surface or underground mining.

Content	Surface and underground mining equipment • Surface mining equipment: drills, shovels, excavators (BW and hydraulic), draglines, loaders, tramming equipment (trucks, LHD, trains, etc.), conveyors, feeders, stackers, bins, pipelines, etc. • Underground mining equipment: drilling equipment, charging vehicles, LHD, trucks, rock bolting equipment, conveyors, trains, continuous miner, road headers, longwall mining equipment, etc. • Automation and robotics • Maintenance principles and practices – preventative and predictive maintenance • Case studies (assessment)
Required performance for studying/examination, types of examination	Examination performance: 1. Written exam or oral exam 4 CP 2. written seminar paper 1 CP (case studies)
Means used	PowerPoint presentation, charts, script (Moodle learning platform), ~~Mining Simulator~~
Reference literature**	SME Handbook

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Module description "Surface Mine Design"
(Optional compulsory field of major Mineral Resource Engineering)

Module name	Surface Mine Design
Short form	
Course type	Surface Mine Design
Semester	Winter semester
Responsible for module**	Prof. Daniels
Lecturer(s)**	Prof. Daniels
Language	English
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Mineral Resource Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Students should be able: • To select a surface mining method (for a given deposit) • To develop a basic mine design • To set up a mine development plan and mining plan. The module promotes the ability to apply mining engineering knowledge in mine design, including planning and design of mining systems and processes. Economic, ecological and social consequences have to be considered, thus the awareness of their professional and ethical responsibility is raised. The problem-solving-attitude and the self-learning attitude is fostered by self-dependent design work.
Content	• Repetition/update on mining methods and selection of mining method • Planning mining processes • Basic mine design • Calculation of ultimate pit limits • Open pit optimisation • Open pit mine design • Planning and design of mine development, (pay mineral and waste)
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	PowerPoint presentation, charts, script (Moodle learning platform)
Reference literature**	• Society for Mining, Metallurgy, and Exploration: SME Mining Engineering Handbook.2011 • Hustrulid, Kuchta, Martin: Open Pit Mine Planning and Design. CRC Press, 2013

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Module description "Underground Mine Design"
(Optional compulsory field of major Mineral Resource Engineering)

Module name	Underground Mine Design
Short form	
Course type	Underground Mine Design
Semester	Winter semester
Responsible for module**	Prof. Rattmann
Lecturer(s)**	Prof. Rattmann
Language	English
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Mineral Resource Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Students should be able: • To select an underground mining method (for a given deposit) • To develop a basic mine design • To set-up a mine development plan and mining plan
Content	• Repetition/update UG mining methods • Selection mining methods • Determination production rate • Design workings • Planning and design of the mining process (extraction, loading, hauling, hoisting, cycle times, production capacity) • Planning and design: physical mine development • Planning and design: auxiliary processes • Mine development plan, production plan The module develops the ability to apply mining engineering knowledge in mine design, including planning and design of mining systems and processes. Economic, ecological and social consequences have to be considered, thus the awareness of their professional and ethical responsibility is raised. The problem-solving attitude and the self-learning attitude is fostered by self-dependent design work.
Required performance for studying/examination, types of examination	Written exam or oral exam
Means used	PowerPoint presentation, charts, script (Moodle learning platform), Excel applications
Reference literature**	• Society for Mining, Metallurgy, and Exploration: SME Mining Engineering Handbook.2011 • Hustrulid, Bullock: Underground Mining Methods: Engineering Fundamentals and International Case Studies. Society for Mining, Metallurgy, and Exploration, 2001.

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Module description “Mining-induced Ground Movements and their Consequences” (Optional compulsory field of major Mineral Resource Engineering)

Module name	Mining-Induced Ground Movements and their Consequences
Short form	
Course type	Mining-Induced Ground Movements and their Consequences
Semester	Winter semester
Responsible for module**	Prof. Melchers
Lecturer(s)**	Prof. Melchers, Dr. Tansel Dogan
Language	German
Assigned to curriculum as	Optional compulsory module Master’s programme Mineral Resource and Process Engineering, major Mineral Resource Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Students learn about ground movements induced by mining (settlement, lifting, horizontal dislocations, thrusts and faults) and their impact on natural and anthropogenic objects at the surface; they also learn about methods of forecasting ground movements. Thus, awareness of their own professional responsibility is enhanced and they develop the competence to see the results of their own actions in an ecological and societal context. They are able to apply state-of-the-art and innovative methods and tests to solve problems considering the methods taught in other disciplines as well.
Content	Types of ground movements induced by underground mining (classical elements of ground movements); ground movements caused by shaft columns falling away, effective loads; mine water rebound and flooding of mines; types of ground movements induced by surface mining (rise and fall of ground water levels), special cases such as sinkholes and reactivation of faults; forecasting methods of ground movements (analogue, stochastic and currently used methods); impact on the surface including waters, infrastructure and buildings as well as ground water and gas flows/gas paths.
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	Projector, chalkboard, script, exercises and sample exams with answer key, information offered in parts on Moodle learning platform
Reference literature**	KRATZSCH, H.: Bergschadenkunde. Dt. Markscheider-Verein, 1997; Working group 4.6 “Altbergbau” of specialist department Engineering Geology in DGGT: Recommendation “Geotechnisch-markscheiderische Untersuchung und Bewertung von Tagebaurestlöchern, Halden und Kippen des Altbergbaus”, 2009; Recommendation “Geotechnisch-markscheiderische Untersuchung und Bewertung von Altbergbau”, 2004; Germane Gesellschaft für Geotechnik e.V. – DGGT, Germaner Markscheider-Verein e.V. – DMV; currently valid editions of standards DIN and EN; up-to-date reference literature as needed.

* Calculated on basis of: 16 weeks per semester; presence proportion may be reduced by blended learning units which would lead to increase of self-study hours.
** At the time these regulations were published; may be subject to change.

Module description "Mine Planning and Feasibility Studies"
(Optional compulsory field of major Mineral Resource Engineering)

Module name	Mine Planning and Feasibility Studies
Short form	
Course type	Mine Planning and Feasibility Studies
Semester	Summer semester
Responsible for module**	Prof. Rattmann
Lecturer(s)**	Prof. Rattmann, Hr. Plien
Language	English
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Mineral Resource Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Mine planning • To understand basic principles of mine planning • To be competent in long-term, mid-term and short-term mine planning, sequencing and scheduling • To be able to plan a mine (mining method, infrastructure, equipment selection, personnel, etc.) Feasibility studies • To understand importance, scope and content of a feasibility study • To understand the interdependencies between the different tasks of a feasibility study • To be able to develop a project plan for the preparation of a feasibility study Project management • To understand the principles of project management • To understand the concept behind a "Work Break Down" structure • To be familiar with project control mechanisms such as Gantt charts and networks • To understand the use and nature of a "Critical Path" method • To understand the principles of resource allocation and scheduling Financial modelling • To understand the principles of cash flow modelling • To be able to create a cash flow model for a mining project in Excel By practical course work the module fosters the ability to apply mining engineering knowledge in mine planning, feasibility studies, project management and financial modelling. The students gain experience in Excel-programming and MS-Project by practical homework. To define, structure, plan and execute projects is trained using small case studies. By means of interactive workshops (e.g. egg-drop project) the students learn to identify challenges, define objectives and solve problems. Self-dependent analysis of feasibility studies supports the ability of autonomous learning and the ability to understand the economic, ecological and social context of mining projects.

Content	Mine planning • Principles of mine planning • Long-term, mid-term and short-term mine planning, sequencing and scheduling • Planning of mining method, infrastructure, equipment selection, personnel, etc.) Feasibility studies • Introduction, importance of feasibility studies, integration in exploration stage • Scoping study, pre-feasibility study, bankable feasibility study • Content of feasibility studies (preface, general, environment, geology, reserves, mine development plan, mining plan, project plan, processing, surface plant, infrastructure, staffing, marketing, financial modelling, etc.) Project management • Introduction • Project planning • Project scheduling • Project monitoring and controlling Financial modelling • Introduction, introductory example cash-flow model • Cash flow (cash-in (revenues, net smelter return, etc.), cash-out (operational expenditure (Opex), capital expenditure (Capex), government takes, etc.), non-cash items (depreciation), cash surplus • Present value concept (discounting, net present value (NPV), internal rate of return (IRR)) • Financial indicators (NPV, IRR, pay-out time, ultimate cash surplus, maximum exposure, etc.) • Sensitivity analysis
Required performance for studying/examination, types of examination	Examination performance: written exam or oral exam
Means used	PowerPoint presentation, charts, script (Moodle learning platform), own Internet research, MS-Project, Excel
Reference literature**	• Wellmer, F.-W., Dalheimer, M., Wagner, M.: Economic Evaluations in Exploration. Springer 2008 • Hustrulid, Kuchta Martin: Open Pit Mine Planning and Design. CRC Press, Balkema, 2013. • Hustrulid, Bullock: Underground Mining Methods: Engineering Fundamentals and International Case Studies. Society for Mining, Metallurgy, and Exploration, 2001. • Kuster, J., Huber, E., Lippmann, R., Schmid, A., Schneider, E., Witschi, U., Wüst, R.: Project Management Handbook. Springer, 2015. • scripts

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Module description "Mine Ventilation 2"
(Optional compulsory field of major Mineral Resource Engineering)

Module name	Mine Ventilation 2
Short form	
Course type	Mine Ventilation 2
Semester	Winter semester
Responsible for module**	Prof. Rattmann
Lecturer(s)**	Prof. Rattmann, Mr Steffes
Language	English
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Mineral Resource Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP TMP1: 4 CP TMP2: 1 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	After successful completion of the course students should: • Have advanced knowledge in mine ventilation • Be able to calculate and design mine ventilation networks • Be capable to consider mine ventilation requirements in underground mine planning • Be capable to monitor ventilation networks by surveys • Have knowledge of mine gases, associated risks, prediction of inflow and countermeasures • Understand dust generated hazards and their mitigation • Have knowledge in mine climatisation By means of a final mine ventilation project the students learn in small teams to apply their mine ventilation knowledge and to design ventilation systems including tests and validation. The students get familiar with the VentSim software for network calculations. The students have to organize the teamwork themselves and learn how to define, structure, plan and execute the project. They learn to use measurement devices for mine ventilation. The written and oral presentation of their ventilation project fosters the ability to communicate scientific results.
Content	• Introduction • Applied fluid mechanics and thermodynamics • Fan applications in underground mines • Subsurface ventilation systems • Auxiliary ventilation • Air-conditioning • Dust • Mine gas • Mine ventilation network calculations (VentSim-Project, Assessment)
Required performance for studying/examination, types of examination	Examination performance: 1. written exam or oral exam 4 CP 2. written seminar paper 1 CP (Mine Ventilation Project)
Means used	PowerPoint presentation, charts, script (Moodle learning platform), independent Internet research, MS-Project, Excel
Reference literature**	Scripts; Howard L. Hartman,Jan M. Mutmansky,Raja V.: Mine Ventilation and Air Conditioning. Wiley, 1997

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Module description "Software-Based Mineral Deposit and Mine Modelling"
(Optional compulsory field of major Mineral Resource Engineering)

Module name	Software-Based Mineral Deposit and Mine Modelling
Short form	
Course type	Software-Based Mineral Deposit and Mine Modelling
Semester	Summer semester
Responsible for module**	Dr. Dohmen
Lecturer(s)**	Dr. Dohmen
Language	English
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Mineral Resource Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP TMP1: 4 CP TMP2: 1 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	• The students receive a general understanding of computerized/digital mineral deposit modelling/estimation and mine planning techniques using basic computational tools and 3D modelling packages (AutoPLAN) • General competence of 3D digital deposit modelling techniques, interpolation and calculation methods • Basic understanding of public mineral reserve/resource estimation (JORC code) • Basic knowledge of digital mine design modelling, construction and calculation process • In AutoPLAN the students are able to create 3D digital terrain and deposit models out of survey, drilling and other exploration data • Based on the deposit model the students develop a basic design for underground and surface mines with AutoPLAN The students get intensive training in the application of the 3D mine planning software AutoPLAN. They learn how to apply mining engineering knowledge in computer-based mine design. The ability to work in teams is supported by self-dependent group-work. This also encourages the attitude to develop own solutions to solve problems
Content	• Introduction to 3D digital terrain and mineral deposit modelling methods with the use of geostatistical data and interpolation methods • Explanation of standards for public reporting/estimation of minerals exploration results, mineral resource and ore reserves • Overview of the mine design process and techniques for underground and surface mines • Introduction to the deposit and mining modelling software package AutoPLAN • Process to design/plan a mine from drilling data to deposit model and basic mine layout using AutoPLAN (Assessment)
Required performance for studying/examination, types of examination	Examination performance: 1. written exam or oral exam 4 CP 2. written seminar paper 1 CP (mine planning software application)
Means used	PowerPoint presentation, charts, script (Moodle learning platform), AutoPLAN
Reference literature**	• Davis J. (2002): Statistics and data analysis in geology. 3rd ed., 638 p. New York (Wiley) • Clark, I. & Harper, W.V. (2000): Practical Geostatistics 2000.- auf CD, Columbus (Ecosse). • W. Hustrulid, M. Kuchta, R. Martin, Open Pit Mine Planning & Design Volume 1 – Fundamentals, 3rd edition 2013, CRC Press/Balkema • www.jorc.org • www.dhp-gmbh.de • More reference literature provided in lecture

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Module description “Optional compulsory subject” from major Process Engineering (Optional compulsory field of major Mineral Resource Engineering)

Module name	Optional compulsory subject from major Process Engineering
Short form	
Course type	See module descriptions major Process Engineering
Semester	Summer semester or winter semester
Responsible for module**	See module descriptions major Process Engineering
Lecturer(s)**	See module descriptions major Process Engineering
Language	German or English
Assigned to curriculum as	Optional compulsory module from major Mineral Resource Engineering
Forms of teaching/Weekly lessons	See module descriptions major Process Engineering
working hours	See module descriptions major Process Engineering
Credit points	5 CP Study hours required: see module descriptions major Process Engineering
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/Learning objectives aimed at	See module descriptions major Process Engineering
Content	Selecting a module from the optional compulsory field of the major Process Engineering Content see module descriptions major Process Engineering
Required performance for studying/examination, types of examination	See module descriptions major Process Engineering
Means used	See module descriptions major Process Engineering
Reference literature**	See module descriptions major Process Engineering

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Module description "Planning Seminar Mineral Resource Engineering or Process Engineering"
(Compulsory field Research-oriented modules)

Module name	Planning Seminar Mineral Resource Engineering or Process Engineering
Short form	
Course type	Planning Seminar Mineral Resource Engineering or Planning Seminar Process Engineering
Semester	Summer semester
Responsible for module**	Mineral Resource Engineering: Prof. Rattmann Process Engineering: Prof. Kreipl
Lecturer(s)**	Prof. Kreipl, Prof. Lenski, Prof. Lotzien, Prof. Daniels, Prof. Paschedag, Prof. Rattmann
Language	English/German
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	RM
Working hours	Total working hours: 300 h of which presence *: 20 h of which self-study: 280 h
Credit points	10 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Mineral Resource Engineering: • Development of team-working skills • Self-organisation and time management • Realistic hands-on experience on how to perform feasibility studies • Engineer-like development of practicable, coherent and thorough plans for all functions and tasks of a mining project Process Engineering • Development of team-working skills • Self-organisation and time management • Realistic hands-on experience on how to plan large-scale process plants • Engineer-like development of practicable coherent and thorough plans for all functions and tasks of a process plant project The module promotes the ability to apply mining engineering knowledge in mine design, including planning and design of mining systems and processes. Economic, ecological and social consequences have to be considered, thus the awareness of their professional and ethical responsibility is raised. The problem-solving-attitude and the self-learning attitude is fostered by self-dependent design work. The students intensify their know how in software application by practical experience (AutoPLAN, Excel, VentSim, MS-Project, etc.). Compiling the project by self-organised team-work promotes the ability to define, to structure, to plan and to execute a project and to work in teams. The written and oral presentation supports the ability to communicate the results of their engineering work.

Content	Mineral Resource Engineering: Assisted by tutors, the students prepare in teams a case study for a greenfield mining project. Task description: • 8-week time period, 4-6 students per team • Given information: drilling data, location, geological information • Self-dependent organization of teamwork, monitoring of progress • Research work to collect needed information and data, engineer-like development of logical assumptions • Planning, design, calculations, description of all functions and tasks of a mining project • Preparation of a preliminary bankable feasibility study (written report) • Presentation of the project to a group of expert representatives of the industry and a financial institute. Process Engineering: Supervised and assisted by Professors the students prepare in teams a case study for a project in the field of mechanical, thermal or chemical engineering including engineering and financial aspects. Task description: • Time period: one semester, 3-6 students per team • Given information: background data of the products or starting material; assumed investment costs of plant components • Self-dependent organization of teamwork, monitoring of progress • Research work to collect needed information and data, engineer-like development of logical assumptions • Planning, design, calculations, description and simulation of all functions and tasks of a process engineering project • Preparation of a preliminary bankable feasibility study including financial aspects (business plan) of the project • Presentation of the project to a group of experts
Required performance for studying/examination, types of examination	Examination performance: written seminar paper
Means used	Coordination talks, Excel, PowerPoint, planning software, Word, MS-Project, own research
Reference literature**	

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Module description "Writing and Publishing Specialist Articles and Conference Papers, Simulation Game" (Compulsory field Research-oriented modules)

Module name	Writing and Publishing Specialist Articles and Conference Papers, Simulation Game
Short form	
Course type	Writing and Publishing Specialist Articles and Conference Papers, Simulation Game
Semester	Winter semester
Responsible for module**	Mineral Resource Engineering: Prof. Rattmann Process Engineering: Prof. Kreipl
Lecturer(s)**	Prof. Kreipl, Prof. Lenski, Prof. Lotzien, Prof. Daniels, Prof. Paschedag, Prof. Rattmann
Language	English/German
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	RM
Working hours	Total working hours: 300 h of which presence *: 20 h of which self-study: 280 h
Credit points	10 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	Practice of Business and Research, Project Work I
Module objectives/learning objectives aimed at	After successful completion of the course students should: • Publish a specialised article according to rules of proven academic practice • Explain engineering matters briefly, understandably, comprehensibly and effectively • Apply stylesheets and guidelines for authors provided by specialist journals The independent writing of a specialist article of the graduate's own choice significantly promotes the application of knowledge acquired during the course of studies. Moreover, it enhances the competence to recognise gaps in one's own knowledge or methodical approach and to derive objectives for the specialist article from that. The discussion of the topic chosen also develops skills of problem-solving intensively and helps to practise the suitable communication of gained insights. The independent exploration of a topic also develops learner autonomy.
Content	Simulation game: Publishing a Specialist Article Based on Practice of Business and Research, Project Work I or II or even a topic of their own choice students will write an article for a specialist journal applying the respective writing guidelines. At the end of the period assigned for the task, the lecturers involved will assess the articles (as a kind of peer review) and provide feedback.
Required performance for studying/examination, types of examination	Examination performance: written seminar paper
Means used	
Reference literature**	

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Module description "Practice of Business and Research, Project Work" (Compulsory field Research-oriented modules)

Module name	Practice of Business and Research, Project Work
Short form	
Course type	Practice of Business and Research, Project Work
Semester	Summer semester or Winter semester
Responsible for module**	Mineral Resource Engineering: Prof. Rattmann Process Engineering: Prof. Kreipl
Lecturer(s)**	Prof. Kreipl, Prof. Lenski, Prof. Lotzien, Prof. Daniels, Prof. Paschedag, Prof. Rattmann
Language	German/English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	RM
Working hours	Total working hours: 300 h of which presence *: 5 h of which self-study: 295 h
Credit points	10 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Students will gain: Insights into the fields of work occupied by mineral resource engineers or process engineers; insights into engineering research activities; independent and structured working on an engineering question under supervision. The module significantly promotes the application of knowledge acquired in the course of studies by the independent exploration of an engineering topic in a professional environment. It also develops the design of concepts, systems and processes. The independent working of the question (supported by the lecturers) enhances the competence to recognise gaps in one's own knowledge or methodical approach and to derive project objectives; this also develops skills of problem-solving intensively and helps to practise the communication of work results in written and oral form as students have to document the project, write a report and present the project work.
Content	Work experience assignment in an industrial company, an engineering office, a laboratory and such as specified in the Guidelines for the Internship (Work Placement).
Required performance for studying/examination, types of examination	Work experience assignment: Certificate of 40 working days and written seminar paper
Means used	To be selected by the student as appropriate for the topic
Reference literature**	To be selected by the student as appropriate for the topic

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Module description "Master's Thesis and Final Oral Examination (Colloquium)"
(Compulsory field Research-oriented modules)

Module name	Master's Thesis and Final Oral Examination (Colloquium)
Short form	
Course type	1. Master's Thesis; 2. Final Oral Examination (Colloquium)
Semester	Summer semester or winter semester
Responsible for module**	Mineral Resource Engineering: Prof. Rattmann Process Engineering: Prof. Kreipl Prof. Kreipl, Prof. Rattmann
Lecturer(s)**	Professors of the THGA
Language	German or English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	RM
Working hours	Total working hours: 900 h of which presence *: 50 h of which self-study: 850 h
Credit points	Master's Thesis: 27 CP Colloquium: 3 CP
Prerequisites defined in Exam. Regulations	Minimum 60 CP and completed work placement
Recommended prerequisites	
Module objectives/learning objectives aimed at	The graduates have acquired advanced knowledge and understanding of the principles of Mineral Resource and Process Engineering. Thus, they are able to identify engineering research needs and to explore a question deriving from those as the topic of their Master's thesis; this topic need to be worked in a structured manner, developing a solution in a given period of time and presenting it in written form (Master's thesis) and then defending in oral form (colloquium). They have also acquired a deeper understanding and critical assessment of the state of research and are able to implement those skills in their assignment. They can appreciate the learning efforts required to make progress in application-oriented research and are able to make use of state-of-the-art methodology (innovative and technological) to solve issues including methods applied in other disciplines. The graduates have enhanced (and demonstrated) the skill of specifying and working on specialist tasks that are complex and not fully defined or well-known. They have developed the fundamental skills to contribute to the further development of the discipline in research and practice. With their Master's thesis, they present an independent work from the professional and scientific fields of Mineral Resource and Process Engineering. The graduates are able to communicate complex content and scientific-technical problems from the fields of Mineral Resource and Process Engineering logically and coherently in written and oral form to both specialists and non-specialists, in German and a foreign language. They have also acquired the skill to independently create professional and scientific publications and the critically assess those. They can initiate and organise their own learning and thus they are able to pursue lifelong learning.
Content	Analysis of the assignment; development of scientific principles; assessment of different solution options; independent development of a solution relevant to practice based on scientific research findings (own and critical discussion of others); documentation of that in the Master's thesis; presentation of content in colloquium.
Required performance for studying/examination, types of examination	Examination performance: written assignment and oral exam
Means used	Computer and software, Internet, reference literature
Reference literature**	THEISEN, M.R.: Wissenschaftliches Arbeiten: Technik – Methodik – Form, Vahlen, 2008; Specialist journals and publications; Internet; currently valid editions of DIN and EN; up-to-date reference literature; Information on Master's thesis and how to write it can be found on the THGA's website: www.THGA-bochum.de.

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Module description "Sustainable Management and Communication"
(Compulsory field Management Skills)

Module name	Sustainable Management and Communication
Short form	
Course type	Sustainable Management and Communication
Semester	Winter semester
Responsible for module**	Prof. Niski
Lecturer(s)**	Prof. Niski
Language	English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points*	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	Business knowledge, proficiency in English
Module objectives/learning objectives aimed at	Learning outcomes: • Apply scientific knowledge in business administration and methods required to evaluate sustainability concepts and systems • Design, manufacture, and manage processes in an environmentally conducive manner • Analyse engineering and management problems in their social and environmental context • Develop economic, environmental, and social sound sustainable strategies and decisions • Evaluate the impact of products, processes, and activities through life-cycle assessment • Develop marketing, communication and PR strategies (co-design) • Demonstrate deep knowledge of conflict management. • Acquire both knowledge and skills that are broad, deep, and necessary to fulfil their professional goals • Effectively contribute to the performance of a group as the group addresses practical business situations, and assume a leadership role as appropriate • Achieve good knowledge about marketing, strategic management and communications • Be knowledgeable about the differences among global economies, institutions, and cultures and will understand the implications these have on global and sustainable management
Content	Academic content: f) Sustainable and strategic management g) Marketing and public relations h) Business planning i) Conflict management j) Human resource management
Required performance for studying/examination, types of examination	Written exam
Means used	Teaching & learning methods You will be exposed to a variety of teaching and learning methods that could include: interactive lectures, case studies, seminar presentations and group project work. As this is a Master's level course, we place a significant emphasis on independent, directed, private study that is often conducted in learning sets or groups.

Reference literature**	• David, F.R. (2006): Strategic Management, Concepts and Cases, Upper Saddle River, Pearson Prentice Hall • Kinicki, A., William, B.K. (2009): Management, McGraw-Hill • Kotler, Ph. & Armstrong, G. (2009): Principles of Marketing, 13th ed., Prentice Hall, Pearson • Kotler, Ph. (2008): Marketing Management, 13th ed., Upper Saddle River, Prentice Hall • Kreitner, R. (2009): Principles of Management, South-Western Cengage Learning • Quaddus, M., Siddique, M. (2011): Handbook of Corporate Sustainability: Frameworks, Strategies and Tools • Quick, J.C., Nelson, D. (2013): Principles of Organizational Behavior, 8th ed., South Western Cengage Learning

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Module description "Health and Safety, Environmental Aspects 2" (Compulsory field Management Skills)

Module name	Health and Safety, Environmental Aspects 2
Short form	
Course type	Health and Safety, Environmental Aspects 2
Semester	Winter semester
Responsible for module**	Prof. Sohn
Lecturer(s)**	Prof. Sohn
Language	English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	Learning outcomes: The students acquire knowledge on the institutions and persons active in occupational health and safety and in environmental protection, in particular the health and safety officer and the different environmental officers. They learn to recognise and assess risks and to develop state-of-the-art measures. They will be qualified to work as internal advisors and supporters in areas of occupational health and safety and environmental protection. The students learn to appreciate the enormous importance of occupational health and safety (OHS) and environmental protection for sustainable success in business. This module promotes the application of knowledge acquired in OHS and environmental protection as the students apply methods systematically to selected examples and learn to integrate the groups involved. The design of concepts, systems and processes, e.g. regarding the prevention of accidents in the workplace, is promote by the students analysing and discussing case studies from the world of work and transferring their findings to new situations. The module enhances the competence to recognise gaps in one's own knowledge or methodical approach and to derive project objectives; skills of problem-solving are developed as risk-based approaches are practised. The module, using state-of-the-art measures in OHS and environmental protection, advances the competence to recognise the global, economic, ecological and societal context; in particular, the module builds awareness for students' own professional and moral responsibility which is further supported by study trips to selected companies.
Content	Fundamental competences on the specialist topics. At the end of the semester, students will be familiar with the dual occupational health and safety system in Germany and how it is integrated into European law, and they will be able to use relevant regulations to design preventive solutions for processes at work. They will be familiar with the hazard assessment as a fundamental tool to control the company risks of OHS and environmental protection and with the model of how accidents and diseases occur. They will work in groups using examples of own concepts for safety at work.
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	Chalkboard, pin board, projector
Reference literature**	Documents (photos, video clips, descriptions) of practical examples, script/notes, series: Handbücher zum Betriebssicherheitsmanagement

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Module description "Controlling, Leadership and Corporate Governance" (Compulsory field Management Skills)

Module name	Controlling, Leadership and Corporate Governance
Short form	
Course type	Controlling, Leadership and Corporate Governance
Semester	Winter semester
Responsible for module**	Prof. Niski
Lecturer(s)**	Prof. Niski
Language	English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	After successful completion of the course students should: • Have an overview of key content of controlling, leadership and corporate governance in internationally active companies • Know how controlling is applied in companies and which key performance indicators from controlling can be used in companies • Be familiar with leadership in companies and understand the key principles of leading employees and teams • Know principles of corporate governance (company management) • Know how to develop and implement corporate strategies • Understand which key performance indicators can help to lead a company
Content	• Advanced principles of controlling in companies, use for company performance indicators • Leadership in companies • Corporate governance (developing and implementing company strategy, using key performance indicators to lead a company)
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	PowerPoint presentation, charts, script (Moodle learning platform), own Internet research
Reference literature**	• Hungenberg, Harald; Wulf, Torsten: Grundlagen der Unternehmensführung, Springer Gabler, 2015

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Module description "Sustainable Energy and Raw Materials Supply" (Compulsory field Management Skills)

Module name	Sustainable Energy and Raw Materials Supply
Short form	
Course type	Sustainable Energy and Raw Materials Supply
Semester	Winter semester
Responsible for module**	Dr. Möllerherm
Lecturer(s)**	Dr. Möllerherm
Language	German, English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resource and Process Engineering
Forms of teaching/weekly lessons	2 L + 1 E
Working hours	Total working hours: 150 h of which presence *: 50 h of which self-study: 100 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/learning objectives aimed at	After successful completion of the course students should: • Have an overview of the international raw materials industry • Be familiar with the concept of sustainable development • Know the four sources of sustainable raw materials supply and be able to classify them • Know the process chain of primary raw materials supply and be able to optimise this for the purpose of sustainability • Be aware of the opportunities and limits of recycling and circle economy • Know how to substitute materials and classify new materials as resources • Understand and handle the opportunities and limits of material efficiency This module promotes the application of knowledge acquired in the fields of raw materials production and sustainability by analysing process chains of primary raw materials supply with regard to sustainability and efficient use of resources. The module teaches knowledge on the international raw materials industry, the concept of sustainable development four sources of sustainable raw materials supply to build the competence of understanding the global, economic, ecological and societal context. in particular, the module creates awareness for students' own professional and moral responsibility.
Content	• International raw materials industry • Concept of sustainable development • Primary raw materials supply and sustainability • Recycling and circle economy • Substitution as a resource • Material efficiency as a resource
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	PowerPoint presentation, charts, script (Moodle learning platform), own Internet research
Reference literature**	• http://minerals.usgs.gov/minerals/pubs/mcs/ • Lottermoser, B.: Mining Wastes. Springer, 2010. • Richards, J.: Mining, Society and a Sustainable World. Springer, 2010. • Kranert, M.: Einführung in die Kreislaufwirtschaft. Springer, 2016 • Martens, H., Goldmann, D.: Recyclingtechnik. Springer 2016

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Module description “Mechanical Process Engineering 3.1” (Optional compulsory field of major Process Engineering)

Module name	Mechanical Process Engineering 3.1
Short form	
Course type	Processing mineral and secondary raw materials
Semester	Summer semester
Responsible for module**	Prof. Dr. Rainer Lotzien
Lecturer(s)**	Prof. Dr. Rainer Lotzien / Dr. Tansel Dogan
Language	German
Assigned to curriculum as	Optional compulsory module Master’s programme Mineral Resource and Process Engineering, major Process Engineering
Forms of teaching/weekly lessons	2 L + 1 PE
Working hours	Total working hours: 150 h of which presence *: 48 h of which self-study: 102 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	Certificate of attendance required for admission to examination
Recommended prerequisites	
Module objectives/learning objectives aimed at	Students will gain a deeper insight into the procedures and basic operations of processing technology and will be able to apply this knowledge when identifying and solving issues of mineral resource engineering and process engineering. The creation of process sequences and a comprehensive view of the processing technology as well as the creation of process flow schemes are given.
Content	The lecture involves aspects of physics, machining and technology as well as the use to allow a deeper insight into modern sorting methods of processing technology. The lecture deals with processes of refining, floatation, sorting by sinking and swimming, magnetic separation, whirler-type separation, sorting via tailraces and buddles; in each case the respective mineral specifications and areas of application will be looked at, too, as will be economic and environmental aspects.
Required performance for studying/examination, types of examination	Examination performance: written exam, oral exam or written seminar paper
Competences	The module significantly advances and develops the application of knowledge acquired in the fields of Mechanical Process Engineering I and II as well as fundamental knowledge of other key engineering areas. The development of concepts and systems and the students' team-working skills will be fostered by the joint approach and the comprehensive design concerning procedures and process technology; this is further boosted by the defining, structuring and planning of project objectives and developing strategies to solve problems, skills which are taught and practised in simple projects. Students will also learn the use of common software packages (e.g. NIAFLOW-Campus Programm). All in all, this knowledge provides the core competence of an engineer working in processing or process engineering. Thus, gaps in one's own knowledge or methodical approach can be recognised and closed. The communication of work results in written and oral form is trained as well by presenting and discussing them. Reflective, analytical and methodical competences are trained using industrial issues to be discussed under global, economic, ecological and societal aspects. Thus, the students' awareness of their own professional and moral responsibility is developed and/or boosted.
Means used	Projector, chalkboard, tutorial notes /exercises, MPE script
Reference literature**	Presentation materials and script MPE; Lotzien, Rainer, Handbuch Mechanische Verfahrenstechnik I und II, Schubert, Heinrich Wichley-VCH, ISBN 3-527-30577-7; Mechanische Verfahrenstechnik I und II; Stieß, Matthias, Springer Verlag, ISBN 3-540-55852-7 Mineral Processing, Tarjan, Gusztav, Akademiai Kiado, Budapest, ISBN 953052243 8 Vol I and II. SME Mineral Processing Handbook, N.L. Weiss, American Institute of Mining, Metallurgical and Petroleum Engineers, New York, ISBN 0-89520-433-6; Aufbereitung fester mineralischer Rohstoffe, Schubert, Heinrich, VEB Verlag, Leipzig, ISBN 3-342-00152-6 Bd. 1-3 Coal Preparation Technology, D.G. Osborne, Graham Trotman Limited, London ISBN 086010-996-8 Vol 1 und 2. AT Mineral Processing, Bauverlag BV, Gütersloh, ISSN 1434-9302 ERZMETALL World of Metallurgy, GDMB, Clausthal Zellerfeld, ISSN 1613-2394

* Calculated on basis of: 16 weeks per semester; presence proportion may be reduced by blended learning units which would lead to increase of self-study hours.
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Module description "Mechanical Process Engineering 3.2"
(Optional compulsory field of major Process Engineering)

Module name	Mechanical Process Engineering 3.2
Short form	
Course type	Handling Disperse Systems – Bulk Material Technology – Transport, Storage, Bunkering
Semester	Winter semester
Responsible for module**	Prof. Dr. Rainer Lotzien
Lecturer(s)**	Prof. Dr. Rainer Lotzien / Dr. Manuela Kopatschek
Language	German
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Process Engineering
Forms of teaching/weekly lessons	2 L +1 PE
Working hours	Total working hours: 150 h of which presence *: 48 h of which self-study: 102 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	Certificate of attendance required for admission to examination
Recommended prerequisites	
Module objectives/learning objectives aimed at	Students will learn about the basic operations of bulk material mechanics and how to master them; they will be able to design and dimension systems, bunkers and silos for bulk materials. Based on the theoretical context learned on bulk materials, they will be able to develop solutions for the different flow properties (determined in experiments, e.g. Jenike's shear test) of bulk materials in operational use. In practice-focused questions and related experimental tests students will have trained the safe application of their knowledge. New or changed situations and issues will be recognised and expertly dealt with according to the state of technology. The graduates have acquired the necessary competence in topics and methods.
Content	This course continues the courses MPE I and II; the basics, measuring and presentation of particle size distribution and the characteristics of particle systems are expected to be known and will be referred to briefly. The course focuses on the following topics: characterising the flow properties of bulk materials; practical determination of flow properties; stress conditions inside the bulk material; design of bunker and silo systems; continuous conveyors; hydraulic and pneumatic conveying systems; comparison of bulk materials.
Required performance for studying/examination, types of examination	Examination performance: written exam, oral exam or written seminar paper
Means used	Projector, chalkboard, tutorial notes /exercises, MVT-script
Competences	Students will acquire basic knowledge of central issues and theoretical approaches of bulk material mechanics and technology. Thus, the module develops the application of knowledge acquired in the fields of MPE I and II but also of fundamental knowledge of engineering subjects such as fluid mechanics and mechanics as such. The design and development of systems and processed for bulk material mechanics is done - among others - by collaboration in the bulk material lab. By doing so, students are enabled to work out in teams the fundamental design data of relevant systems (as determined in experiments) in simple bulk material projects, including the structuring of problems, definition of objectives and developing problem-solving strategies. Students will also learn the use of common software packages for the treatment of bulk materials and processing technology. This knowledge acquired provides the core competence of an engineer working in processing or process engineering. Thus, gaps in one's own knowledge or methodical approach can be recognised and closed by the students themselves. The communication of work results in written and oral form is trained as well by presenting and discussing them. Reflective, analytical and methodical competences are trained using industrial issues to be discussed under global, economic, ecological and safety-related aspects. Thus, the students' awareness of their own professional and moral responsibility is developed and/or boosted.
Reference literature**	Presentation materials and script; Lotzien, Rainer Pulver und Schüttgut, Schulze D., Springer Verlag, Heidelberg ISBN 3- 540-34082-3 Lagern, Fördern und Dosieren von Schüttgütern, Pahl M.H. Fachbuchverlag Leipzig ISBN 3-343-00842-7; Handbuch Mechanische Verfahrenstechnik I und II, Schubert, Heinrich Wichley-VCH, ISBN 3-527-30577-7; Mechanische Verfahrenstechnik I und II; Stieß, Matthias, Springer Verlag, ISBN 3-540-55852-7.;

	SME Mineral Processing Handbook, N.L. Weiss, American Institute of Mining, Metallurgical and Petroleum Engineers, New York, ISBN 0-89520-433-6 Aufbereitung fester mineralischer Rohstoffe, Schubert, Heinrich, VEB Verlag, Leipzig, ISBN 3-342-00152-6 Bd. 1-3 Journals: AT Mineral Processing, Schüttgut, Chemie-Ingenieur-Technik, Zement-Kalk-Gips, Bulk Solids Handling, Powder Technology, Powder Handling and Processing

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Module description "Thermal Process Engineering 3.1"
(Optional compulsory field of major Process Engineering)

Module name	Thermal Process Engineering 3.1
Short form	
Course type	Energy Efficiency of Plants and Processes
Semester	Winter semester
Responsible for module**	Prof. Dr. Uwe Lenski
Lecturer(s)**	Prof. Dr. Uwe Lenski / TBA
Language	German
Assigned to curriculum as	Optional compulsory module in Master's programme Mineral Resource and Process Engineering, major Process Engineering
Forms of teaching/weekly lessons	2 L + 1 PE
Working hours	Total working hours: 150 h of which presence *: 48 h of which self-study: 102 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	Certificate of attendance required for admission to examination
Recommended prerequisites	
Module objectives/learning objectives aimed at	The module significantly promotes the application of knowledge acquired in the fields of energy efficiency and materials efficiency in technical plants. Working as officials, students will be able to work alone or in teams on requests regarding the optimisation methods introduced and process related offers. Working as project engineers, students will be able to understand the functionality of plants and processes and implement optimisations. The design of concepts, systems and processes e.g. in planning is strongly boosted by students working on practical examples, getting to know the questions of the relevant industries. Working in and leading a team is taught extensively. The module also develops the competence to recognise gaps in one's own knowledge and methodical approach and to derive objectives from that. Communication is practised by presenting results in written and oral form. Learner autonomy is strongly fostered as practical exercises occasionally include computer-based research. The module and its measures convey the competence to see the global, economic, ecological and societal context, and it also raises awareness of one's own professional and moral responsibility. This will be addressed by references in the lectures and exercises, e.g. to recent changes in law.
Content	Students will be able to identify and solve energy-related problems by applying the basic operations. They are able to create the balances of masses and energies. Those can be used to create Sankey diagrams to visualise the context, using where possible eSankey simulations. Students – working as project engineers – will understand the functionality of plants and processes and implement optimisations. In addition to those mentioned above, the topics taught will also include: legal aspects and funding options; energy audits; energy management systems; building envelopes; plant engineering; process heat and cold; CHP plants; waste heat; cross-section technology; optimisation; measuring and control systems; economical efficiency of measures; renewable energies.
Required performance for studying/examination, types of examination	Examination performance: written exam
Means used	Projector, chalkboard, exercises, eSankey software
Reference literature**	M. Blesl und A. Kessler,"Energieeffizienz in der Industrie, Springer Vieweg 2013 Martin Pehnt, Energieeffizienz, Ein Lehr- und Handbuch, Springer Verlag 2011 F. Wosnitza und H. G. Hilgers, Energieeffizienz und Energiemanagement: Ein Überblick heutiger Möglichkeiten und Notwendigkeiten, Springer Verlag 2012

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Module description "Thermal Process Engineering 3.2"
(Optional compulsory field of major Process Engineering)

Module name	Thermal Process Engineering 3.2
Short form	
Course type	Thermal Separation Processes III
Semester	Summer semester
Responsible for module**	Prof. Dr. Uwe Lenski
Lecturer(s)**	Prof. Dr. Uwe Lenski / TBA
Language	German
Assigned to curriculum as	Optional compulsory module in Master's programme Mineral Resource and Process Engineering, major Process Engineering
Forms of teaching/weekly lessons	2 L + 1 PE
Working hours	Total working hours: 150h of which presence *: 48 h of which self-study: 102 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	Certificate of attendance required for admission to examination
Recommended prerequisites	
Module objectives/learning objectives aimed at	The module significantly promotes the application of knowledge acquired when identifying and solving physical and thermodynamic questions applying the fundamental operations. Students will also be enabled to create and solve balances of masses and energies and develop and evaluate drying tests. Working as officials, students will be able to work alone or in teams on requests regarding the separation methods introduced and process related offers. Working as project engineers, students will be able to understand the functionality of plants and processes and implement optimisations. The design of concepts, systems and processes e.g. in planning is strongly boosted by students working on practical examples, getting to know the questions of the relevant industries. Working in and leading a team is taught extensively. The module also develops the competence to recognise gaps in one's own knowledge and methodical approach and to derive objectives from that. Communication is practised by presenting results in written and oral form. Learner autonomy is strongly fostered as practical exercises occasionally include computer-based research. The module and its measures convey the competence to see the global, economic, ecological and societal context, and it also raises awareness of one's own professional and moral responsibility. This will be addressed by references in the lectures and exercises, e.g. to recent changes in law.
Content	Foundations and practical applications of separation processes: extraction, crystallisation, drying
Required performance for studying/examination, types of examination	Examination performance: written exam or oral exam
Means used	Projector, chalkboard, exercises, TVT-script
Reference literature**	Sattler, K.: Thermische Verfahrenstechnik, Grundlagen, Auslegung, Apparate, WILEY-VCH Weilheim 2001; Schönbucher, A.: Thermische Verfahrenstechnik, Springer-Verlag Berlin Heidelberg 2002; Mersmann, A., Kind, M., Stichlmair, J.: Thermische Verfahrenstechnik, Springer-Verlag Berlin Heidelberg 2005; K.Kröll, W.Kast: Trocknungstechnik vol. 1-3, Springer Verlag 1989

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Module description "Chemical Process Engineering 3"
(Optional compulsory field of major Process Engineering)

Module name	Chemical Process Engineering 3
Short form	
Course type	Plant Safety and Scale-up, Industrial Chemistry
Semester	Winter semester
Responsible for module**	Prof. Dr. Andreas Kreipl
Lecturer(s)**	Prof. Dr. Andreas Kreipl/N.N.
Language	German
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Process Engineering
Forms of teaching/weekly lessons	2 L + 1 PE
Working hours	Total working hours: 150 h of which presence *: 48 h of which self-study: 102 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	Certificate of practical exercise required for admission to examination
Recommended prerequisites	
Module objectives/learning objectives aimed at	This module significantly advances the use of knowledge acquired by transferring it to a lab or pilot process of industrial scale in a production facility. Moreover, it will be taught how conduct the safety measurements needed for operating a plant. This knowledge is illustrated by examples of key industrial processes and deepened in the practical exercise. Thus, the students will particularly be able to design and evaluate e.g. scale-up tests and safety measurements. Suitable measures to be sued are, for example, the combination of lab tests and simulation tasks as well as safety measurements using high-energy substances. The design of concepts, systems and processes, e.g. when transferring processes to an industrial scale, is strongly advanced by the students applying the knowledge acquired in the lecture independently in practical experiments; they will evaluate the results comparing them to simulations created with the help of programmes such as CHEMCAD etc. Defining, structuring, planning and working out a project is taught and practised by assigning a case study to the students in which – at the end of the practical exercise – they will work on the transfer of a process to industrial scale. Team work as well as leading a team will be taught in groups during the practical exercise, as each student will be made project leader of a for one experiment. Problem-solving is fostered by asking students to interpret the test results independently and to compare them with the simulation results. Communication of work results is extensively taught and practised as students have to create a case study for one process example. Learner autonomy is promoted by students conducting their own experiments in groups. The creation of a case study and the independent conduction of safety measurements to assess whether the thermal safety of a process or plant is given – these are two components where the module builds the competence to see the global, economic, ecological and societal context. The module also raises awareness of one's own professional and moral responsibility for the environment, employees and resources.
Content	Part 1: Foundations of similarity calculation and dimension analysis; overview of relevant non-dimensional parameters, selected examples from practice, simulation Part 2: Thermal safety of chemical reactions and processes, determination of safety-relevant parameters using DSC and reaction calorimeter, relevant measuring methods, standards, practical conduction and evaluation of measurements Part 3 Overview of key industrial processes in petrochemicals, technical chemistry, polymer chemistry, renewable resources, environmental technology and recycling. In additional to the chemical analysis, the focus lies on the importance for the industry and economy, resource cycles (procurement, recycling and disposal), and environmental aspects such as emissions, water pollution, energy consumption etc.

Required performance for studying/examination, types of examination	Examination performance: written exam or oral exam
Means used	Projector, chalkboard, script, tasks with answer key, information partly present on Moodle learning platform
Reference literature**	Presentation materials and script (possibly) of Prof. Dr. Andreas Kreipl Scale-up: Modellübertragung in der Verfahrenstechnik: Modellübertragung in der Verfahrenstechnik (Zlokarnik/ 1. ed., 2005, Wiley-VCH Verlag); Thermal Safety of Chemical Processes: Risk Assessment and Process Design (Stoessel, 1. ed. 2008, Wiley-VCH Verlag); Praxiswissen der chemischen Verfahrenstechnik: Handbuch für Chemiker und Verfahrensingenieure (Christen, 2. ed., 2010, Springer Verlag); Grundoperationen chemischer Process Engineering (Vauck/Müller, 11. ed., 1999, Wiley-VCH Verlag); Technische Chemie – eine Einführung in die Reaktionstechnik (Fitzer/Fritz/Emig, 5. ed., 2005, Springer-Verlag), Ullmann's Encyclopedia of Industrial Chemistry (published online: 15 JUL 2009, Wiley-VCH Verlag), Technische Chemie (Baerns/Behr/Brehm/Gmehling/Hofmann/Onken/Renken, 1. ed., 2006, Wiley-VCH Verlag), Chemische Technik (Winnacker/Küchler, 5. ed., 2006, Wiley-VCH Verlag), The pilot plant real book (McConville, 2. ed., 2006, Fxm Engineering & Design), Handbook of petrochemical production processes (Meyer, 2005, McGraw-Hill Handbooks), Hydrocarbon Process Safety (Jones, 2003, Whittles Publishing), etc.

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Module description "Simulation 3"
(Optional compulsory field of major Process Engineering)

Module name	Simulation 3
Short form	
Course type	Simulation 3
Semester	Summer semester
Responsible for module**	Prof. Dr. Andreas Kreipl
Lecturer(s)**	Prof. Dr. Andreas Kreipl/N.N.
Language	English
Assigned to curriculum as	Compulsory module Master's programme Mineral Resources and Process Engineering, major Process Engineering
Forms of teaching/weekly lessons	2 L + 1 PE
Working hours	Total working hours: 150 h of which presence *: 48 h of which self-study: 102 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	Certificate of attendance required for admission to examination
Recommended prerequisites	
Module objectives/learning objectives aimed at	The module significantly promotes the application of knowledge acquired in working with simulation programmes such as CHEMCAD and POLYMATH allowing students independent simulation of procedures of process engineering. Students will also be able to use simulation for process optimisation and to evaluate and interpret the results of the simulations. For this purpose, case studies on different processes are simulated by the students and the impact of the changes in process parameters on the process are analysed and evaluated. The design of concepts, systems and processes is strongly advanced by the students creating their own process flow charts and integrating the results of the simulations into the development of processes. Students are extensively taught in the use of software packages such as POLYMATH and CHEMCAD. Defining, structuring, planning and working out a project is taught and practised by the students simulating processes in a team. Problem-solving is fostered by asking students to compare the simulation results with the results gained in the practical exercise. This also promotes learner autonomy. The optimisation of process parameters and the impact on resource efficiency deriving from those – these are two components where the module builds the competence to see the global, economic, ecological and societal context.
Content	Simulation of process-engineering systems using CHEMCAD, Aspen HYSYS or similar programmes involving practical examples and sensitivity analyses
Required performance for studying/examination, types of examination	Examination performance: written exam or oral exam or written seminar paper
Means used	Projector, chalkboard, script, exercises with answer key, information partly presented on the Moodle learning platform, computer in the simulation lab of THGA
Reference literature**	Presentation materials and script of Prof. Dr. Andreas Kreipl http://www.chemstations.eu/

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Module description "Analytics and Environmental Analytics"
(Optional compulsory field of major Process Engineering)

Module name	Analytics and Environmental Analytics
Short form	
Course type	Analytics and Environmental Analytics
Semester	Winter semester
Responsible for module**	Prof. Dr. Andreas Kreipl
Lecturer(s)**	Prof. Dr. Andreas Kreipl/N.N.
Language	German
Assigned to curriculum as	Optional compulsory module Master's programme Mineral Resource and Process Engineering, major Process Engineering
Forms of teaching/weekly lessons	1 L+2 PE
Working hours	Total working hours: 150 h of which presence *: 48 h of which self-study: 102 h
Credit points	5 CP
Prerequisites defined in Exam. Regulations	Certificate of practical exercise required for admission to examination
Recommended prerequisites	
Module objectives/learning objectives aimed at	The students will independently develop methods for GC and HPLC; they will learn to assess chromatographic and spectroscopic methods and apply those to analyse procedures of process engineering as well to examine hazardous substances in samples e.g. of waste water. Moreover, students will receive an introduction into the validation and quality assurance of relevant methods, procedures and directives. This knowledge is acquired in lectures and practical exercises and deepened later in an analytical simulation game. The students will be enabled to develop methods e.g. for GC and HPLC and to evaluate chromatograms. Measures used here are the supervised development of methods for GC and HPLC as well as the application of methods to independently find solutions for analytical problems. Developing analytical methods, e.g. to examine procedures in process-engineering, is strongly boosted by students developing methods under supervision which will then be applied in the practical exercise Chemical Process Engineering 3. In addition, the students will be trained to use software packages to control GC and HPLC devices. The module intensively trains the use of analytical tools and processes, in particular GC and HPLC, by instructed method development and independent evaluation of chromatograms and spectres. Problem-solving skills are fostered by applying the methods derived in another practical exercise. The monitoring of waste water samples serves as an example. Communicating results in written and oral form is extensively practised as the students need to create one example of a validation report. Learner autonomy is boosted by students work in groups on a complex question where the solution can only be found by applying a combination of the methods learned. With its focus on quality assurance and environmental analytics the module builds the competence to see the global, economic, ecological and societal context.
Content	Methodenentwicklung für GC und HPLC, Auswertung chromatographischer und spektroskopischer Messungen (GC, HPLC, GC-MS, MS, NMR, ICP-OES, etc.), Validierung und Qualitätssicherung in der analytischen Chemie, Umweltanalytik, praxisbezogene Erstellung und Auswertung von Prozess- und Qualitätskontrollen, Planspiel Analytik
Required performance for studying/examination, types of examination	Examination performance: written exam or oral exam and written term paper
Means used	Projector, chalkboard, script, exercises with answer key, information partly presented on the Moodle learning platform
Reference literature**	Presentation materials and script of Prof. Dr. Andreas Kreipl; HPLC richtig optimiert: Ein Handbuch für Praktiker: (Kromidas, 1. ed., 2006, Wiley-VCH Verlag); Der HPLC-Experte: Möglichkeiten und Grenzen der modernen HPLC (Kromidas, 1. ed., 2014, Wiley-VCH Verlag); Prozessanalytik: Strategien und Fallbeispiele aus der industriellen Praxis (Kessler, 1. ed., 2006, Wiley-VCH Verlag); GC für Anwender (Gruber/ Klein, 1. ed., 1994, Wiley-VCH Verlag); Chromatogramme richtig integrieren und bewerten: Ein Praxishandbuch für die HPLC und GC (Kromidas/ Kuss, 1. ed., 2008, Wiley-VCH Verlag); Instrumentelle Analytische Chemie: Verfahren, Anwendungen, Qualitätssicherung (Cammann, 1. ed., 2010, Spektrum Verlag); GMP-/FDA-Anforderungen an die Qualitätssicherung: Qualitätssicherungssystem, GMP-Compliance, Lieferantenqualifizierung, GMP-relevante Verträge (Amborn/ Bakhschai/ Engelhard/ Hösch, 2016, Editio Cantor Verlag); Handbuch Validierung in der Analytik (Kromidas, 1. ed., 2011, Wiley-VCH Verlag); etc.

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Module description “Optional Compulsory Subject from Major Mineral Resource Engineering” (Optional compulsory field of major Process Engineering)

Module name	Optional Compulsory Subject from Major Mineral Resource Engineering
Short form	
Course type	See module descriptions major Mineral Resource Engineering
Semester	Summer semester or winter semester
Responsible for module**	See module descriptions major Mineral Resource Engineering
Lecturer(s)**	See module descriptions major Mineral Resource Engineering
Language	German or English
Assigned to curriculum as	Optional compulsory module major Process Engineering
Forms of teaching/Weekly lessons	See module descriptions major Mineral Resource Engineering
working hours	See module descriptions major Mineral Resource Engineering
Credit points	5 CP Study hours required: see module descriptions major Process Engineering
Prerequisites defined in Exam. Regulations	
Recommended prerequisites	
Module objectives/Learning objectives aimed at	See module descriptions major Mineral Resource Engineering
Content	Selecting a module from the optional compulsory field of the major Mineral Resource Engineering Content see module descriptions major Mineral Resource Engineering
Required performance for studying/examination, types of examination	See module descriptions major Mineral Resource Engineering
Means used	See module descriptions major Mineral Resource Engineering
Reference literature**	See module descriptions major Mineral Resource Engineering

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