Public Announcement

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S. 1 - 57		Telefone:	80-99087

Examination Regulations* for the Master's Degree Programme "Metallurgical Engineering" of the Rheinisch-Westälische Technische Hochschule Aachen (RWTH Aachen University)

27.09.2010

Based on section 2, subsection 4 of the Act on Universities in the State of North Rhine-Westphalia (*Gesetz über die Hochschulen des Landes Nordrhein-Westfalen*, abbr. HG) from 31 October 2006 (published in the *Gesetz- und Verordnungsblatt* of the State of North Rhine-Westfalia, p. 474), most recently amended by section 2 of the Act on the Development of Universities of Applied Sciences in the State of North Rhine-Westfalia (*Gesetzes zum Ausbau der Fachhochschulen in Nordrhein-Westfalen*) from 8 October 2009 (published in the *Gesetz- und Verordnungsblatt* of the State of North Rhine-Westphalia 2009, p. 516) (published in the *Gesetz- und Verordnungsblatt* of the State of North Rhine-Westphalia, p. 255), the *Rheinisch-Westälische Technische Hochschule Aachen* (RWTH Aachen University) decrees the following Regulations:

* Note: This is a translation of the German regulations. In case of doubt, the German wording is binding.

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I. General

1. Area of application and Master's degree

(1) These Examination Regulations apply to the Master's degree programme "Metallurgical Engineering".

(2) The Faculty of Geo Resources and Materials Engineering awards the degree Master of Science RWTH Aachen University (M. Sc. RWTH) upon successful completion of the Master's programme.

2. Programme objective and language

(1) In the Master's programme "Metallurgical Engineering", the knowledge acquired in the Bachelor's programme is widened and deepened in such a way as to give graduates the ability to manage complex problems and independently conduct scientific work.

(2) The programme is a consecutive Master's programme.

(3) The programme is taught in the English language.

(4) The Master's thesis is to be written in the English language.

3. Admission requirements

(1) The requirements for admission are a recognised first degree establishing the candidate's academic qualification for the Master's Programme. Academic qualifications are recognised if they have been approved by an authorised state agency of the country in which the university is located or if they have been accredited in a state-approved process.

(2) Applicants with an academic qualification within the meaning of subsection 1 must have the requisite knowledge in the subjects listed below to successfully complete a Master's programme in Metallurgical Engineering. All subjects in parts 1a and 1b below should have been covered in the degree programme referred to in subsection 1 within a framework of 60 *Semesterwochenstunden* (semester periods per week, abbr. SWS).

Part 1 approx. 60 *SWS*	a)	Mathematics
		Physics
		Inorganic Chemistry
		Physical Chemistry
	b)	Mechanics
		Machine Components
		Electrical Engineering
		Crystallography
Part 2		Principles of Engineering Sciences

(3) The Examination Board may impose conditions on admission, requiring applicants to demonstrate certain knowledge prior to registering for the Master's thesis. The Exami-

nation Board determines the nature and scope of these conditions for each case separately based on the course content of the degree programme previously completed.

(4) Applicants who did not earn their degree qualification in an English-language institution or whose native language is not English must be able to demonstrate sufficient command of the English language to pursue an English-language degree programme. The following proof is recognised:

a) Test of English as Foreign Language (TOEFL) “Internet-based” Test (iBT) with a score of at least 80 points, or
b) TOEFL “Paper-based“ Test (PBT) with a score of at least 550 points, or
c) IELTS Test with a score of at least 6.0
d) Cambridge Test – Certificate in Advanced English (CAE)

(5) The Examination Board decides whether the admission requirements are fulfilled in consultation with the student office, or in the case of international applicants in consultation with the International Office.

(6) The current version of the guidelines for the admission of international applicants wishing to study at RWTH Aachen University (*Ausländerrichtlinien*) is applicable.

(7) All applicants, whether they have previously completed a Master’s programme at RWTH Aachen University or studied at other universities, must apply to the Examination Board to have their completed or other academic achievements recognised prior to enrolment in or transfer to this degree programme to qualify for enrolment or transfer.

4. Standard period of study, scope and credit points

(1) The standard period of study applicable to the course programme including the time required for the Master's thesis is four semesters (two years). The study programme can only be started in the winter semester and is planned accordingly.

(2) The course has a modular structure. Each module aims to impart and develop knowledge and competence in certain subject areas, which are assessed by means of examination or other form of appraisal. Depending on the area of specialisation, the course consists of 14-15 modules, including the Master’s thesis module. All modules and module segments are defined in the Module Catalogue by area of specialisation (see Appendix 2).

(3) The performance in the individual modules is assessed according to section 9 and weighted with credit points in the module segment grade. The segment grades are used to calculate an overall grade as specified in section 9. Credits points are not simply assigned in proportion to course hours. They also reflect the time necessary for preparation, revision, and examination (self-study). One credit point represents an estimated workload of 30 hours. As a rule, a semester amounts to 30 credit points. The Master’s degree programme, therefore, amounts to a total of 120 credit points.

(4) The course programme, including the Master’s thesis, amounts to 61 SWS (contact time in semester periods per week). One SWS equals one 45-minute period a week for the duration of a semester. The number of semester periods per week applies purely to lectures and tutorials. In addition, students are expected to spend time preparing and revising. In accordance with subsection 3, this time is accounted for in the corresponding number of credit points assigned.

(5) RWTH Aachen University guarantees that it is possible to complete the courses it offers within the standard time applicable, and that in particular the modules required to obtain a degree, the corresponding examinations and the Master's thesis can be completed for the defined scope within the set deadlines.

5. Registration and admission to modules

(1) The modules for the Master's degree programme "Metallurgical Engineering" are open to participation by students enrolled in or admitted as cross-registered students to this degree programme, as well as other students and guest students of RWTH Aachen University. Students are required to register through a modular registration procedure for each module. The registration deadline and procedure are announced in good time in the CAMPUS information system.

(2) Should it be necessary to limit the number of students for a module (e.g. to achieve academic targets, because of the teaching method used for a module, for research purposes, or because of the number of teaching and support staff available), it will be effected in accordance with section 59, subsection 2 of the HG (Act on Universities in the State of North Rhine-Westphalia). Students who are required to attend a module within the scope of their degree programme take precedence (semester-specific compulsory or core elective examinations). The allocation of remaining places is made in the following order: non-semester-specific compulsory or core elective examinations, optional examinations (section 6, subsection 1), voluntary supplementary examinations (in accordance with section 8, subsection 1) and free admission (subsection 1).

6. Examinations and examination deadlines

(1) The total Master's examination consists of the examinations for the individual modules and the Master's thesis. The examinations take place and the Master's thesis is written during the course of the programme and must be completed within the standard time applicable. Students must be registered for examinations. The modules in the curriculum are divided into compulsory, core elective and optional modules. Compulsory modules are mandatory. Core elective modules are modules students must select from a prescribed list. In addition, students may be presented with a choice of optional modules from which they can freely select. The optional modules are not the same as the supplementary modules referred to in section 8. Supplementary modules are modules that are not part of the curriculum. They are attended by students on a voluntary basis.

(2) It is essential to register in order to attend a module. Students who register for compulsory modules are automatically registered for the corresponding examination. The subsequent registration is automatically dated 1 December for the winter semester and 1 June for the summer semester of the same year. Students are not automatically registered for examinations in the case of core elective, optional or supplementary modules. Section 5, subsection 1 remains in force.

(3) Students must attend modules on the dates stipulated in the curriculum. Exact registration and deregistration procedures are announced in the CAMPUS information system. A registration for an examination is also an implicit registration for a potential resit. Section 5, subsection 3 remains unaffected.

(4) The Examination Board will ensure that in each examination period there is opportunity to take examinations in the course subjects associated with the Master's examination

of that semester. There will be at least two examinations a year for each course subject; examinations will be announced at the start of lectures.

5) The statutory maternity protection period, the duration of parental leave or leave for the care and upbringing of children within the meaning of section 25, subsection 5 of the German Federal Education and Training Assistance Act (*Bundesausbildungsförderungsgesetz*), as well as the care of spouses, civil partners, relatives of direct lineage or first-degree in-laws are taken into account.

(6) Should a candidate prove on the basis of a medical certificate that he or she is unable to take an examination in its entirety or in part in the designated form due to prolonged or permanent physical impairment or chronic illness, the chairperson of the Examination Board will allow the candidate to produce equivalent proof of performance in a different form. In the case of obligatory practical training or obligatory study periods abroad, which even with support of the university cannot be justified because of the impairment, alternative proof of academic achievement will be permitted.

(7) Students on leave are not entitled to obtain any course certificates or take any examinations at RWTH Aachen University. This does not apply to resits of failed examinations or to certificates (progress reports) for study periods or practical semesters abroad. Nor does it apply if leave of absence is taken for the care and upbringing of children within the meaning of section 25, subsection 5 of the German Federal Education and Training Assistance Act (*Bundesausbildungsförderungsgesetz*), or the care of spouses, civil partners, relatives of direct lineage or first-degree in-laws.

7. Examination types

(1) As a rule examinations are either written or oral. However, examinations can also take the form of a presentation, report, or assignment, a written paper or progress check on a student research project, or a colloquium. Within the scope of the module students may be required to submit proof of participation or performance. Proof of participation or performance may be defined as an admission requirement for further examination in a module. Proof of performance can take the same forms as examinations. Proof of participation certifies active participation in a module.

(2) The final form for an alternative form of examination and any permitted aids will be announced at the start of a module, but no later than four weeks before the examination date. Section 13, subsection 5 remains unaffected. Examination dates and the names of examiners must be announced in the CAMPUS information system no later than the middle of May and November respectively. The weighting of the individual examinations in the overall examination grade for a module will also be announced.

(3) In **oral examinations**, candidates must demonstrate a coherent understanding of the concepts of the subject and be able to place specific problems into context. Oral examinations also establish whether candidates have a broad basic knowledge. Oral examinations are conducted by several examiners (*Kollegialprüfung*) or by one examiner in the presence of a competent assessor. Candidates are examined either individually or in a group comprising no more than four candidates. Each candidate will normally be examined in a subject or subject area by one examiner only. Prior to assessment in accordance with section 9, subsection 1, the examiner must consult the assessor. The essential topics and results of an oral examination are recorded in the minutes of the examination. Following the examination, the candidate is notified of the grade obtained. An oral examination should take between fifteen and thirty minutes per candidate. In the case of complementary oral examinations in accordance with section 13, subsection 2, assessment by an examiner is sufficient. In the case of group exami-

nations, examiners should make sure that candidates are allowed the same time as those examined individually.

(4) Students who want to take the same examination at a later date, can be admitted to the examination as auditors, provided that there is enough space and the candidate does not object. Admission does not extend to the consultation and announcement of the examination results.

(5) In **written examinations**, candidates must be able to demonstrate an ability to identify a problem and find ways of solving it in a limited time and with limited aids, using the established methods of the discipline. The duration of written examinations for segment 1 (basic subjects) is three hours. The duration of written examinations in segment 2 is at least 60 minutes, or as follows, depending on the number of credit points applicable to the respective module:

up to 3 credit points	at most 90 minutes
up to 6 credit points	at most 120 minutes
more than 6 credit points	at most 180 minutes

Reading time, which is supplementary to examination time, may be applicable. Exact durations are specified in the Module Catalogue.

(6) Written examinations may also include multiple choice questions. Please refer to section 9, subsections 2 and 3 for assessment details.

(7) Every written examination must be assessed by an examiner. If a written examination is assessed by two examiners in accordance with section 13, subsection 4, the grade awarded is the arithmetic mean of the individual evaluations. The individual examiners may delegate the preliminary marking of examination papers to qualified scientific coworkers with a relevant Master's degree or a comparable or higher qualification. In the case of complementary oral examinations in accordance with section 13, subsection 2, assessment by one examiner is sufficient.

(8) A **Presentation** is a talk of between 10 and 30 minutes, in which students should demonstrate their ability to elaborate a scientific topic within the context of the discipline and present the results orally.

(9) A **Report** is a talk of between 10 and 30 minutes based on a written work. in which students should demonstrate their ability to elaborate a scientific topic within the context of the discipline and present the results orally.

(10) In the case of a **written assignment** students are expected complete a task on the subject of the module and propose suitable solutions, using the relevant literature and appropriate aids where necessary. The applicable aids are announced together with the task. Section 7, subsection 7, sentence 2 applies accordingly.

(11) The objective of **written papers or progress checks**, which are handed out, supervised and assessed during the semester, is to gradually prepare students for subsequent examinations. Students are entitled to credit up to 10% of supervised semester papers or practice tests for a module to a final examination in a subsequent examination period. It is not obligatory to pass these papers or practice tests to successfully complete the module. The lecturer will announce the exact criteria for attaining bonus points at the beginning of the semester, but no later than the date of the first course in the CAMPUS system.

(12) In the case of a **student research project** students are expected to carry out a task in the field of the Master’s degree programme. Students are normally expected to com-

plete the task within one semester. The Master's thesis guidelines in section 16, subsections 2-4 of the Examination Regulations apply to the student research project.

(13) Examinations referred to in subsections 8-10 may also be taken as a group examination, provided that it is possible to separately assess each group member's individual performance.

(14) In the **colloquium** students are expected to demonstrate a coherent understanding of the concepts of the discipline and an ability to put specific problems into this context. Students may start a colloquium with a presentation as referred to in subsection 8.

(15) During **practical training** students are expected to learn to work independently on experiments, assess measurement data and present scientific results. Examinations during practical training are designed to assess a student's expertise, skills and quality of scientific work. If practical training is carried out in small groups, the individual student's performance is assessed.

(16) Examinations can also be taken in the form of e-tests. E-tests are multimedia-supported examinations normally developed by two examiners. They may consist of, for example, open questions, completion exercises or matching exercises. To implement multimedia-supported examination questions it is necessary to ensure that the electronic data is uniquely identifiable and can be unmistakably and irrefutably attributed to the student. The examination must be taken in the presence of a competent professional (minute taker) within the meaning of section 11. The examination process must be documented, including the names of the minute takers, the participating students, the start and end time of the examination and any unusual occurrences. Students must be granted access to the multimedia examination in accordance with section 21.

8. Supplementary course modules

(1) Candidates may opt to take examinations in additional, freely-selectable modules referred to as supplementary modules.

(2) At the candidate's request, the examination result for these modules can be printed on the certificate, but will not be included in the calculation of the overall grade.

9. Assessment of examinations and grading

(1) The individual examination grades are determined by the respective examiner. The following grading system is used:

1 = Very good	An excellent performance;
2 = Good	A performance well above average requirements;
3 = Satisfactory	A performance which fulfils all normal requirements;
4 = Sufficient	A performance which meets the requirements despite some weaknesses;
5 = Failed	A performance which due to considerable weaknesses does not meet the requirements.

Grades may be raised or lowered by three decimal points, to produce more differentiated intermediate grades. The grades 0.7, 4.3, 4.7 and 5.3 are excluded. Ungraded examinations are awarded a "pass" or a "fail".

(2) Multiple Choice is an examination format, having several pre-formulated answers to a question from which one is to be chosen. The criteria for assessment must be given on the examination sheet and announced fourteen days before the examination on the notice board or the CAMPUS information system. An examination consisting only of multiple-choice questions is regarded as passed, if

a) 60% of questions are answered correctly, or
b) the number of questions answered correctly is not more than 22% lower than the average examination results of the candidates who took the examination.

(3) A candidate who has answered at least the minimum number of questions correctly, thus passing the examination, will be graded as follows:

- very good, for answering at least 75% more questions correctly
- good, for answering between 50% and 75% more questions correctly
- satisfactory, for answering between 25% and 50% more questions correctly
- sufficient, for answering up to 25% more questions correctly

(4) If an examination contains multiple-choice as well as other types of questions, the multiple-choice questions will be assessed in accordance with subsections 2 and 3. The other questions are assessed according to the standard applicable procedure. The grade is calculated from the weighted results of both parts of the examination. The weighting is based on the number of questions for each examination question type.

(5) An examination is only graded if the candidate is registered for the corresponding degree programme at the time of the examination or performance appraisal. Examination results must be announced within six weeks, however, no later than ten days before the date of a relevant resit. The grades are automatically e-mailed to the RWTH Aachen University students' e-mail contact addresses via the CAMPUS information system and announced on the notice board. Students can retrieve their current list of grades in the CAMPUS information system.

(6) An examination is deemed to have been passed, if the grade is at least "sufficient" (4.0). If an examination consists of more than one part, the grade is calculated based on the results of the individual parts. However, each individual part must be graded at least "sufficient" (4.0) or passed. Subsection 7 applies mutatis mutandis to the grades. The weighting of the individual parts is specified in the Module Catalogue (see appendix).

(7) A module is deemed to have been passed, if the grade for all corresponding examinations is at least "sufficient" (4.0) and all other corresponding credit points (e.g. participation and course certificates) have been earned. Credit points are attributed to modules in accordance with the Module Catalogue (see appendix).

(8) The overall grade is based on the module grades and the grade of the Master's thesis. The individual module grades, weighted with the corresponding number of credit points, are used to calculate the segment grades. To calculate the overall grade the individual module segments are weighted with different factors as follows:

Module segment 1 (basic subjects)	Factor 0.45
Module segment 2 (subjects-specific specialisation)	Factor 0.20
Module segment 3 (other achievements)	Factor 0.35

Module segment 1 covers basic subjects, module segment 2 covers subject-specific specialisation, and module segment 3 covers the Master's thesis as well as all other achievements (supplementary subject, practical training, and student research project).

The following overall pass grades apply to the Master's examination:

An average grade up to 1.5	= Very good
An average grade between 1.6 and 2.5	= Good
An average grade between 2.6 and 3.5	= Satisfactory
An average grade between 3.6 and 4.0	= Sufficient

The lowest of the weighted module grades for the three module segments will be disregarded at a student's request submitted to and approved by the Examination Board, provided that all module examinations were passed within the standard time applicable to the programme.

(9) When calculating the grades and the overall grade, only the first decimal place is taken into account. All further decimal places are dropped without rounding.

(10) Instead of the overall grade "very good" according to subsection 7, the overall grade "with distinction" will be awarded if the Master's thesis is graded 1.0 and the weighted average of all other grades is not less than 1.3.

10. Examination Board

(1) The Faculty of Geo Resources and Materials Engineering will set up an Examination Board responsible for the organisation of the examinations and duties assigned to it in the present regulations. The Examination Board will consist of a chairperson, a deputy, and five more members with the right to vote. The chairperson, the deputy, and two more members are elected from the professors, one board member is elected from the scientific staff, and two board members are elected from the students. Substitutes are elected for the members of the Examination Board. The term of office is three years for the professorial and scientific staff members, and one year for the student members. Re-elections are allowed.

(2) The Examination Board constitutes a public authority (*Behörde*) for the purpose of German administrative procedural law (*Verwaltungsverfahrens- and Verwaltungsprozessrecht*).

(3) The Examination Board will ensure that the Examination Regulations are observed and that examinations are duly conducted. In particular, the Examination Board is responsible for appeals against decisions on examination procedures. In addition, the Examination Board must report regularly, at least once a year, to the faculty about the development of examinations and study durations. The Board provides suggestions for reform of the Examination Regulations and the curriculum, and discloses the grades and overall grades awarded. The Examination Board may delegate the execution of its regular tasks to its chairperson. This does not apply to decisions on appeals or the report to the faculty.

(4) The Examination Board has a quorum if, in addition to the chairperson or the deputy, there are two more professors with a vote or their substitutes, and at least two more members with a vote or their substitutes present. The Board decides by simple majority. In the event of a tie, the chairperson has the casting vote. The student members of the Examination Board do not take part in accrediting former study achievements and examination results.

(5) The members of the Examination Board have the right to be present at examinations.

(6) The meetings of the Examination Board are not open to the public. The members of the Examination Board and their substitutes will observe confidentiality concerning their office. Members who are not civil servants or public sector employees will be bound to confidentiality by the chairperson of the Examination Board.

(7) The Examination Board will have the administrative support of the central examination office (*Zentrales Prüfungsamt – ZPA*) to fulfil its tasks.

11. Examiners and assessors

(1) The chairperson of the Examination Board appoints the examiners, who in turn appoint the assessors. The appointments must be put on record. Only those examiners who have passed at least the same or a comparable final examination and taught independently in the respective module during the study period preceding the examination may be appointed, unless imperative reasons necessitate an exception. Only those assessors who have at least the same or a comparable degree may be appointed.

(2) Examiners must be independent in their conduct of examinations. Section 10, subsection 6, sentence 2 applies accordingly. This also applies to assessors.

(3) The candidate may suggest examiners for the Master's thesis, the student research project, and the written and oral examinations. Where possible, the candidate's suggestions will be taken into account. However, the suggestions do not constitute an entitlement.

(4) The chairperson of the Examination Board will ensure that candidates are notified of the names of examiners on time, but no later than the middle of May and November respectively. Notifications posted on the notice board or in Campus are sufficient.

12. Crediting previous study periods, course work and examination results, and upgrading to senior semesters

(1) Studies, successfully or unsuccessfully completed courses and examination results in an equivalent degree programme at another university in Germany are officially accredited. Studies, successfully or unsuccessfully completed courses and examination results in other degree programmes or at other universities or at state or state-recognised universities of cooperative education (*Berufsakademien*) in Germany are transferable, provided that they are equivalent. Credits earned at universities outside Germany are transferable on request when equivalency has been established. On request, the university may also accredit other skills and qualifications to a degree programme on the basis of the records submitted.

(2) Equivalency of achievements is deemed to exist, when the content, scope and requirements of study periods, course work and examination results substantially correspond to those set forth in the Master’s degree programme "Metallurgical Engineer-

ing". However, this will not be based on a skeletal comparison but rather on an overall review and evaluation. When determining the equivalency of study periods, course work and examination results from outside the Federal Republic of Germany, the equivalency agreements approved by the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (*Kultusministerkonferenz*) and agreements under university partnerships must be observed. If there is any doubt regarding equivalence, the Central Office for Foreign Education (*Zentralstelle für ausländisches Bildungswesen*) may be consulted.

(3) The Examination Board is responsible for accreditation pursuant to subsections 1 and 2. As a rule, a representative of the subject concerned is consulted before a decision on equivalency is taken.

(4) Should course work and examination results be accredited, the grades – in so far as the grading systems are comparable – will be recognised and used to calculate the overall grade. Should grading systems not be comparable, the entry "recognised" will be included in the record and identified accordingly in the student's *Zeugnis* (official certificate documenting academic performance).

(5) When the requirements set forth in subsections 1 and 2 have been satisfied, studies, course work and examination results achieved within the ambit of German law will be accredited ex officio. The student will submit the documentation necessary for accreditation.

13. Re-taking examinations, the Master's thesis and expiry of the right to take examinations

(1) Failed examinations may be re-taken twice, a failed Master's thesis once. The topic of the Master's thesis may be changed provided that the candidate did not make use of this option when writing his or her first Master's thesis.

(2) Should a candidate be given the grade "failed" (5.0) for a second resit examination and the grade was not determined on the basis of an attempt to cheat, a default, or a withdrawal without good reason in accordance with section 14, subsection 2, he or she must be given the opportunity to take a complementary oral examination before the grade "failed" is assigned. Section 7, subsection 3 applies mutatis mutandis to the complementary oral examination. The complementary oral examination can only result in the grade "sufficient" (4.0) or the grade "failed" (5.0).

(3) Students must apply to repeat a Master's thesis no later than three semesters after the unsuccessful first attempt. Section 8, subsection 3 of the Law on Tuition and University Fees (*Studienbeitrags- und Hochschulabgabengesetz*) applies mutatis mutandis to this deadline. Candidates who do not meet this deadline will lose the right to be examined, unless they cannot be held responsible for the transgression.

(4) Written and oral examinations intended to conclude a degree programme in accordance with a curriculum, and resit examinations, where definitive failure precludes the completion of the degree programme, must be graded by at least two examiners. Section 7, subsection 7, remains unaffected.

(5) Examiners may conduct resit examinations either orally or in written form. Students will be informed via the notice board at least two weeks prior to the resit examinations whether they will be oral or written.

(6) If an examination consists of several parts, students are only required to resit the part they fail. However, if there is a close correlation or chronological connection between the examinations, or if it concerns, for example, a written and an oral part of one examination, the whole examination must be re-taken.

(7) A student has definitely failed a module when the examinations that still need to be passed can no longer be repeated.

(8) A student has definitely failed a Master's examination when the examinations that need to be passed for a module can no longer be repeated, or when the second Master's thesis is graded or assessed as "failed".

14. Cancellation, defaulting, withdrawal, deception, breach of regulations

(1) Candidates may cancel their registration for an examination once for every examination without giving reasons up to one week before the examination date. The cancellation of an examination also constitutes a registration for the following examination.

(2) An examination will be marked as "failed" (5.0) if the candidate fails to appear on the day of an examination without good reason or if he or she withdraws from the examination without good reason after the examination has started. The same is applies if a candidate fails to complete a written examination within the allotted time, in which case the candidate forfeits his or her right to take a complementary oral examination. In this case, the last sentence in subsection 1 applies.

(3) Reasons justifying a withdrawal or defaulting have to be reported in writing to the Examination Board and substantiated without delay. In the event of illness, the candidate will be required to submit a medical certificate. The chairperson of the Examination Board may, in individual cases, require the submission of a certificate from a medical examiner designated by the Board. The Examination Board will notify the candidate in writing if it refuses to accept the reasons submitted. Any grades that have already been earned will be recognised. In this case, the last sentence in subsection 1 applies.

(4) In the case of written examinations – with the exception of proctored examinations – the candidate must affirm in lieu of oath that the examination was taken by him or her without any inadmissible outside help.

(5) Candidates who try to influence the results of an examination through deception, e.g. by using inadmissible aids, will receive the grade "failed" (5.0) for the examination concerned. Any deception identified by the respective examiner or proctor will be put on record. The respective examiner or proctor may bar any candidate from continuing an examination who, despite a warning, disrupts the orderly conduct of the examination. In such cases, the candidate will receive the grade "failed" (5.0). A record will be made of the reasons for barring the candidate from the examination. In the case of repeated or other serious cases of deception, the candidate may be barred from taking further examinations.

(6) Candidates must be notified of a negative decision, and the reasons for it, and any legal remedies available to them, in writing and without delay.

II. Master’s examination and Master’s thesis

15. Method and scope of the Master’s examination

(1) The Master's examination consists of:

1. the examinations and other work listed in the Module Catalogue in Appendix 2
2. the Master’s thesis, including the Master’s colloquiums.

(2) The order of modules, examinations and other proofs of performance should be in line with the curriculum. Examinations and other proofs of performance are completed during the course of the programme. The topic of the Master’s thesis cannot be provided until the student research project, the 10-week practical training (or the second experimental student research project) are accounted for, and a further 66 credit points have been obtained.

(3) The content of the examinations and other proofs of performance are determined by the content of the corresponding modules in accordance with the Module Catalogue.

16. Master’s thesis

(1) The Master’s thesis is a dissertation written by the candidate. It should demonstrate that the candidate is capable of conducting independent work on a problem under guidance within a specified period of time under application of scientific methods.

(2) The Master’s thesis may be assigned and supervised by any professor researching and teaching at RWTH Aachen University at the Faculty of Geo Resources and Materials Engineering or in the section Metallurgy and Materials Technology. Contract lecturers and members of the scientific staff may participate in the supervision. In exceptional cases, the Master's thesis may be conducted outside the Faculty, or outside RWTH Aachen University, provided that the Examination Board agrees and it is supervised by one of the persons named in the first sentence.

(3) Upon special request, the chairperson of the Examination Board can arrange to have a topic for the Master's thesis assigned to the candidate by the designated deadline. The candidate will be given an opportunity to propose a topic.

(4) The Master’s thesis is written in the English language.

(5) The chairperson of the Examination Board will notify the candidate of the deadline for submission. The date of issue and the topic are put on record.

(6) As a rule, candidates have six months to complete their Master’s thesis. The written work should not exceed 80 pages, excluding appendices. The topic and nature of the assigned task must be such that the Master's thesis can be completed within the specified period with an input equivalent to six months full-time work. In consultation with the supervisor and the departmental or faculty study counselling service, the thesis may be completed part-time within a maximum period of twelve months. A request to this effect must be submitted to and approved by the Examination Board. The topic may only be changed once, and only within the first month of the time allocated. As an exception for individual cases, the Examination Board may extend the completion time by up to six weeks, upon receipt of an application in which the candidate cites reasons endorsed by the supervisor that would justify an extension.

(7) The candidate will present the results of the Master's thesis as a final presentation in a Master's colloquium. Section 7, subsection 14 applies mutatis mutandis to the presentation.

17. Submission and assessment of the Master's thesis

(1) An original copy of the Master's thesis must be submitted to the Examination Board by the specified deadline. In coordination with the examiners, the Examination Board will fix the date and place for the colloquium in good time, so that the colloquium can be held within four weeks after submission. The date of submission will be put on record. If the Master's thesis is not submitted on time, it will be marked as "failed" (5.0). The Master's thesis will only be assessed if the candidate is registered for the degree programme at the time of submission.

(2) The examiner should be the person who assigned the topic of the Master's thesis. The thesis often represents the final examination. It is always evaluated, with the grade substantiated in writing, by two examiners in accordance with section 9, subsection 1. The grade of the thesis is the arithmetic mean of the individual grades given in accordance with section 9, subsection 1, provided that the difference between the grades is not more than 2.0. If the difference is more than 2.0, or if one examiner assesses the thesis as failed while the other examiner gives a better grade, the chairperson of the Examination Board will appoint a third examiner to assess the Master's thesis, who will determine the grade within four weeks, taking the other two grades into account.

(3) The grade should be announced within eight weeks of the date of submission, except where section 2, subsection 4 is applicable. The Examination Board has the right to appoint other examiners if the grade is not announced on time.

(4) The written Master's thesis is awarded 27 credit points. The colloquium is graded and included in the grade of the Master's thesis with a weighting of 3 credit points.

18. Pass requirements

Candidates will be deemed to have passed the Master's examination, when they have passed all required modules and obtained at least the grade "sufficient" (4.0) for the Master's thesis. The Master's degree programme is concluded once the Master's examination has been passed.

III. FINAL PROVISIONS

19. Report (*Zeugnis*), degree certificate and attestations

(1) A candidate who has passed the Master's examination will receive a *Zeugnis* (official report documenting academic performance) listing the results, no later than three months after the final examination. The report lists the modules and the Master's thesis with corresponding grades and credit points as well as the overall grade. The report also lists the topic of the Master's thesis and any supplementary modules. The overall grade is given in words and as a number with one decimal place. The report is signed by the chairperson of the Examination Board.

(2) The report bears the date on which the final examination or thesis was completed.

(3) This report is issued in German and English.

(4) Together with the report, the candidate will be issued a Master's degree certificate in German and English, with the same date as the report, certifying the Master's degree awarded. The Master's degree certificate is signed by the dean of the Faculty and the chairperson of the Examination Board.

(5) Together with the report, the degree holder will also be issued a Diploma Supplement in German and English. The Diploma Supplement also includes an ECTS (European Credit Transfer System) grading scale.

(6) If a candidate has ultimately failed the Master's examination, the chairperson of the Examination Board will notify him or her in writing, including information on any legal remedies available.

(7) Students who leave the university without a degree may request a certificate stating their complete study and examination performances. This certificate is issued in German and English.

20. Invalidity of the Master's examination, annulment of the Master's degree

(1) Should it become known after the Master's degree certificate has been issued that the candidate cheated during an examination, the Examination Board may retroactively adjust the grades for those examinations during which the candidate cheated and declare the entire Master's examination or parts thereof as failed.

(2) Should it become known after the Master's degree certificate has been issued that certain examination requirements were not fulfilled, without any fraudulent intent on the part of the candidate, the defect will be remedied by the candidate's successful completion of the examination. Should the candidate have deliberately secured wrongful admission, the Examination Board will decide on the legal consequences in accordance with German administrative procedural law of the State of North Rhine-Westphalia (*Verwaltungsverfahrensgesetz*).

(3) Prior to any decision, the person in question will be given an opportunity to state his or her case.

(4) The incorrect report will be withdrawn and, where applicable, a new report will be issued. Decisions pursuant to subsection 1 and subsection 2, sentence 2, may be taken only for a period of five years after the issue date of the report.

(5) Should the candidate's entire Master's examination be declared a fail, the Faculty will annul the Master's degree and withdraw the diploma.

21. Access to the examination records

(1) After having been informed of their grades, candidates must be given the opportunity to inspect the corrected papers or written examinations. Candidates will be informed of the time and place for inspection during the examination, but no later than with the announcement of their grade. Students must be given at least fifteen minutes inspection time.

(2) After completion of the examination process, and in so far as subsection 1 does not apply, candidates will be given the opportunity to inspect the written examinations and

relevant examiners' assessments and examination protocols upon their application.

(3) The application must be submitted to the chairperson of the Examination Board within one month of the report being issued. The chairperson of the Examination Board will determine the time and location of the inspection.

22. Entry into force, publication and transitional provisions

(1) These Examination Regulations will enter into force on the day after their publication. They will be published in the Official Announcements (*Amtliche Bekanntmachungen*) of RWTH Aachen University.

(2) These Examination Regulations apply to all students newly enrolled in the Master's degree programme in Metallurgical Engineering during or after the 2010/2011 winter semester.

(3) Students enrolled before the 2010/11 winter semester may switch to these Examination Regulations on request. They may continue to study under the previous Examination Regulations dated 26.08.2008 for a maximum of two years after entry into force of these Examination Regulations. After this two-year period, students will automatically switch to these Examination Regulations.

Drawn up pursuant to the resolution adopted by the Faculty Council of the Faculty of Georesources and Materials Engineneering on 23.06.2010.

The Rector
of RWTH Aachen University

Aachen, 27.09.2010 sgd. Schmachtenberg

Appendix 1

Catalogue of modules

This catalogue of modules represents the status quo according the day of publication of these examination regulations. Changes, which are not related to examination types are announced here: http://muw.iehk.rwth-aachen.de/.

Area of specialization „Process Technology of Metals“

Module segment 1:

Thermochemistry (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
- Chemical equilibrium - Phase diagrams - Properties of mixtures - Statistical thermodynamic - Rate of chemical reactions - Elastic properties - Properties of surfaces				The students get to know the basics of thermochemistry, enabling them to evaluate the thermodynamic and kinetic properties of materials to select or develop suitable materials for different processes and requirements.		
Prerequisites				**Grading**		
				Written exam (180 min). Furthermore, the exam grade can be improved by taking part in a 30 min optional learning progress check. Accomplishes the student 80 % of the points of this check, the exam grade will improve by one grade step (hence e.g. from 3.7 to 3.3), with an accomplishment of 90 %, the exam grade will improve by two grade steps hence e.g. from 3.7 to 3.0). This improvement is valid for all exams written within one year after the learning progress test and provided that the written exam is graded with 4.0 or better. A better grade than 1.0 is not possible.		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam(180 min)		7.5
Exercise		2		Progress Check		0.5

Physical Metallurgy (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Microstructure; atomic structure of solids; crystal defects; alloys; diffusion; mechanical properties; recovery, recrystallization, grain growth; solidification; solid state phase transformations; physical properties				The students will get familiar with the physical fundaments of material science. The students will be enabled to study more specialized and fundamental topics of material science. They will learn to use the concepts and methods in material science independently and will practice this in exercises accompanying the lecture. The students will deepen their understanding of the learnt contents during these exercises.		
Prerequisites				**Grading**		
				Written exam(180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Process Metallurgy and Recycling (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/29	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Non-ferrous metallurgy: -Basics of nonferrous metallurgy, Economical significance, primary and secondary raw material, global material management. -Metallurgical processes of Copper: Pyrometallurgy: flash smelting; Converter metallurgy and direct production; Recycling and pyrometallurgical Refining; Refining electrolysis and casting -Metallurgical processes of Aluminum: Bauxite to Al-Hydroxide; Al-Hydroxide to Metal; Recycling, melt treatment and casting. -Metallurgical processes of Zinc : Hydrometallurgy; Extraction electrolysis and hydrometallurgical Recycling; Pyrometallurgy; pyrometallurgical refining of lead and zinc -Metallurgical processes of Titanium: Sorel-process, Kroll-process, remelting Iron and steel: -Introduction, historical review; -preparation of ore, production of coke; -thermodynamic, heterogeneous equilibrium, kinetics; -reduction technology, production of Iron; -production of steel; -secondary metallurgy; -casting and solidification -slag in the production of Iron and steel -recycling of the steel scrapes -environment protection and sustainability				Non-ferrous Metallurgy: The students should become capable to understand the material flow, the primary and secondary processing route, the necessary aggregate with parameters of process and the chemical reaction in the metallurgical process of Copper, Aluminum, Zinc, Lead and Titanium, as well as the consideration of the problem of environment and location and especially energy requirements. Iron and steel: The students should know the most important properties of the production of Iron and steel. They should be able to describe the plant specific relationship between the aggregates of process, the thermo-chemical properties of each middle-production and the kinetically process procedure.		
Prerequisites				**Grading**		
				Written exam (180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Fabrication Technology of Metals (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	6	8	2	SS 2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
a);c) -Introduction to basics: plasticity, plastomechanics, boundary conditions and heat transport, solution methods -Technology and solving methods of bulk-forming: forging, extrusion, bar extrusion, drawing, rolling -Technology and solving methods of sheet forming: forming of sheet metal, tribology, deep-drawing, -stretch-forming, flow forming b);d) -Physical and technological basics: metallic melts, supercooling, nucleation, casting-, feeding- and gating techniques -Molding and casting technology: high-pressure-die-casting, die-casting sand-casting as well as molding materials and applicable rapid-prototyping techniques -Casting materials (cast iron, aluminum- and magnesium alloys): metallurgy, casting properties, micro-structure and its properties as well as the relationship between them -Simulation of foundry processes: heat-balance in casting and mould, flow and convection -Aspects of economic and ecological challenges in foundry technology				a); c): Knowledge: The students know the basic technologies of metal forming as well as selected solution methods. Comprehension: The students understand the coherences between essential process and material parameters. Application: The basic equations of the elemental theory for analysis and interpretation of basic processes of metal forming can be applied. b); d): Knowledge: The students possess an overview and know the basics of foundry technology. Comprehension: The students understand the connection between process technology, casting materials and their simulation. Application: The students are enabled to meet technology based decisions on complex foundry processes and materials.		
Prerequisites				**Grading**		
				Written exam (180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Process Control Engineering (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1 & 2	2	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
a), b) measuring methods, processing and validation of measuring data, distribution functions, error analysis, physical measuring principles (temperature, flow, level, mechanical quantities..), industrial instrumentation c), d) - process control systems - communication systems - modeling techniques - modeling plants, products, processes, - control engineering discrete control, hybrid control, hierarchical control schema, control languages, (CFC, SFC, StateCharts..) formal methods				a), b)ability to- apply measuring methods, - handle measured data , - evaluate measuring information; basic knowledge of - main physical measuring principles - requirements in industrial instrumentation c), d)ability to- analyze basic control problems- construct hierarchical control solutions- handle industrial control languages- work with structural models of plants and processes; basic knowledge of - industrial control systems - requirements in industrial control		
Prerequisites				**Grading**		
				50 % Exam I (90 min) 50 % Exam II (90 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture I		2		Exam I (90 min)		4
Exercise I		1				
Lecture II		2		Exam II (90 min)		4
Exercise II		1				

Transport Phenomena (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1 & 2	2	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
a)Fundamentals of heat transfer and mass transport. General equations of conduction, convection and radiation, 1st law of thermodynamics, systems, system boundaries, Fouriers law, Fouriers differential equation, one dimensional steady state heat conduction, transient heat conduction, numerical methods for heat conduction problems, fundamentals of convective heat transfer, similarity theory, Buckingham theorem, heat radiation, radiation exchange, gas radiation b), c)Fundamentals of the fluid flow mechanics (momentum transport), Fluid, Newtons shear stress approach, fundamentals of the rheology, hydrostatics, aerostatics, hydrodynamics, frictionless and friction-afflicted flows, Bernoulli, momentum law, tube flow, dimensionless numbers, Navier-Stokes-equations				a)The students are trained to classify the kinds of energy- and mass-transport in technical systems and to examine this with numerical and analytical methods quantitatively. They can derive the mathematical model equations from the balance equations. In the lecture and the supplementary exercises examples are preferred from the field of the material engineering (Industrial Furnace Technology, Metallurgy) b), c)The students are trained to classify the types of flows and to analyze the basic equations analytically. In the lecture and the supplementary exercises examples are preferred from the field of the material engineering (Industrial Furnace Technology, Metallurgy)		
Prerequisites				**Grading**		
				50 % Exam I (90 min) 50 % Exam II (90 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture I		2		Exam I (90 min)		4
Exercise I		1				
Lecture II		2		Exam II (90 min)		4
Exercise II		1				

Module segment 2:

Melt Treatment and Continuous Casting (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	4	4	2	SS 2009	English

CONTENTWISE INFORMATION	
Content	**Educational objectives**
Most important processes and operations for the production of iron and steel -Details of preparation of raw materials (sintering, pelletising, coke-making) -Special topics of production of hot metal and sponge iron (blast furnace, smelting and direct reduction), -Steel making (basic oxygen furnace, electric arc furnace), special topics -Melt treatment (ladle and vacuum metallurgy) -Continuous Casting Technology	The students will be enabled to apply metallurgical processes and to decide about the most suitable aggregates for modern iron- and steelmaking. The students will be capable to dimension the production processes of different steel types based on thermodynamic and reaction kinetic principles, types of aggregates, operation practices and other boundary conditions.
Prerequisites	**Grading**
	Written exam (60 min) , admission only after successfully passing of the practice experiments

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
Lecture	2	Exam (60 min)	3
Exercise	1	Practical course	1
Practical course	1		

Unit Operations in Nonferrous Metallurgy (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	5	5	2	SS 2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Reaction-metallurgy of the most important processes for winning/refining of non ferrous metals: Rotary kiln, fluidized bed reactor, metal/slag interactions in converters, aluminothermic reduction, bath melting operations (ISA-smelt, TBRC, QSL), gas purging, leaching, solvent extraction and electrolysis, separation techniques, each with - Process determining mechanism and parameters - Thermochemical fundamentals - Principles of equipment design and scale up - Methods for product-assessment - Environmental issues - Process examples				The students become capable to define criteria for the selection of suitable reactors and to conduct a benchmark study of competing processes including design, development and analysis.		
Prerequisites				**Grading**		
				Written exam (60 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		2		Exam (60 min)		4
Exercise		1		Practical course		1
Practical course		2				

Casting Processes and Casting Alloys (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1	4	4	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Casting Processes and Casting Alloys: Basic of solidification; nucleation and grain growth, metallurgy of foundry alloys; sand casting, core making, permanent mould casting; Aluminium, Magnesium and Steel alloys; Cast iron; Simulation and Modelling of casting processes.				The students will know the metal-physical basis for the most important characteristics of solidification of castings and of casting processes under theoretical and hands on aspects. The students will be enabled to identify the relevant relations especially between material properties and process parameters. The knowledge of cast alloys and their processing principles will be deepened by lab experiments and tutorial examinations.		
Prerequisites				**Grading**		
				Written exam (60 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		2		Exam (60 min)		3
Exercise		1		Practical course		1
Practical course		1				

Fundamentals and Solving Methods in Metal Forming (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1	4	4	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
- Basics of plastomechanics, stress and deformation states, yield law, differential equations for elementary theory, boundary conditions -Elementary theory for basic metal forming processes -Similarity theorem and modeling techniques, basics of FEM				Knowledge: The students know the possibilities and boundaries of solving methods in metal forming including FEM and similarity theory. Understanding: The students have a detailed understanding of plastomechanics. Application and Analysis: The students are able to analyze the basic processes in metal forming, to choose an adequate solving method and to derive the elementary coherences to describe and estimate certain metal forming processes.		
Prerequisites				**Grading**		
				Written exam (60 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		2		Exam (60 min)		3
Exercise		1		Practical course		1
Practical course		1				

Industrial Furnaces (Study Major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1	4	4	2	WS 2008/09	English

CONTENTWISE INFORMATION	
Content	**Educational objectives**
- Introduction to Industrial Furnaces - Melting Furnaces - Electric Arc Furnace Technology - Induction Melting Furnaces - Al-Melting Furnaces - Resistance Heating Furnaces - Reheating Furnaces - Fundamentals of Fuels and Combustion - Burners - Energy Balance of Industrial Furnaces - Efficiency, Air Preheating - Furnaces for the Production of Semi-Final Steel Products - Heat Treatment Furnaces - Batch and Continuous Furnaces - Annealing under pure H2-atmospheres - Furnaces for the Heat Treatment of Al	The students are supposed to be put in the situation to understand the unit operations which are carried out in industrial furnaces. They are supposed to classify furnaces and to be able to evaluate furnaces (energy balance, efficiency, heat losses). Ultimately they are supposed to be in the situation to select the suitable furnace type for a heat treatment task.
Prerequisites	**Grading**
	Written exam (60 min)

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
Lecture	2	Exam (60 min)	4
Exercise	2		

Module segment 3:

Complementary course						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1		3	1	WS 2010/2011	
CONTENTWISE INFORMATION						
Prerequisites				**Grading**		
				Certification		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Certification		3

Internship						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		10	1	WS 2010/2011	

CONTENTWISE INFORMATION	
Content	**Educational objectives**
- Fabrication and processing of materials - Business procedures	The internship provides the students an insight into the chosen occupational field; delivers a first guide for a future professional life and an impression of the social relations in industry. The possibility to get to know industrial processes enables a deeper understanding of and motivation for their studies.
Prerequisites	**Grading**
	Certification

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
		Presentation	10

Student Research Project						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Selected task within a research and development project, theoretically or experimentally, including independent information sourcing, structuring of the topic, and exposition of the investigations, presentation and defence of the thesis.				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor.		
Prerequisites				**Grading**		
for Master Thesis				Written thesis		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Written thesis		8

Experimental Student Research Project						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		10	2	WS 2008/2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
- Experimental Research Skills				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor within a Experimental Student Research Project.		
Prerequisites				**Grading**		
for Master Thesis				80% Experimental Student Reasearch Project 20% Colloquium		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Written thesis		8
				Colloquium		2

Master Thesis						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
4	1		30	1	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Selected task within a research and development project, theoretically or experimentally, including independent information sourcing, structuring of the topic, exposition of the investigations, presentation and defense of the thesis.				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor.		
Prerequisites				**Grading**		
• Complementary Course • Student Research Project • Internship OR Experimental Student Research Project • 66 additional Credit Points				Written thesis 90% Colloquium 10 %		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Master thesis		27
				Colloquium		3

Area of specialization „Physical Metallurgy and Materials“

Module segment 1:

Thermochemistry (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
- Chemical equilibrium - Phase diagrams - Properties of mixtures - Statistical thermodynamic - Rate of chemical reactions - Elastic properties - Properties of surfaces				The students get to know the basics of thermochemistry, enabling them to evaluate the thermodynamic and kinetic properties of materials to select or develop suitable materials for different processes and requirements.		
Prerequisites				**Grading**		
				Written exam (180 min). Furthermore, the exam grade can be improved by taking part in a 30 min optional learning progress check. Accomplishes the student 80 % of the points of this check, the exam grade will improve by one grade step (hence e.g. from 3.7 to 3.3), with an accomplishment of 90 %, the exam grade will improve by two grade steps hence e.g. from 3.7 to 3.0). This improvement is valid for all exams written within one year after the learning progress test and provided that the written exam is graded with 4.0 or better. A better grade than 1.0 is not possible.		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		7.5
Exercise		2		Progress check		0.5

Physical Metallurgy (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Microstructure; atomic structure of solids; crystal defects; alloys; diffusion; mechanical properties; recovery, recrystallization, grain growth; solidification; solid state phase transformations; physical properties				The students will get familiar with the physical fundaments of material science. The students will be enabled to study more specialized and fundamental topics of material science. They will learn to use the concepts and methods in material science independently and will practice this in exercises accompanying the lecture. The students will deepen their understanding of the learnt contents during these exercises.		
Prerequisites				**Grading**		
				Written exam (180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Process Metallurgy and Recycling (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/29	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Non-ferrous metallurgy: -Basics of nonferrous metallurgy, Economical significance, primary and secondary raw material, global material management. -Metallurgical processes of Copper: Pyrometallurgy: flash smelting; Converter metallurgy and direct production; Recycling and pyrometallurgical Refining; Refining electrolysis and casting -Metallurgical processes of Aluminum: Bauxite to Al-Hydroxide; Al-Hydroxide to Metal; Recycling, melt treatment and casting. -Metallurgical processes of Zinc : Hydrometallurgy; Extraction electrolysis and hydrometallurgical Recycling; Pyrometallurgy; pyrometallurgical refining of lead and zinc -Metallurgical processes of Titanium: Sorel-process, Kroll-process, remelting Iron and steel: -Introduction, historical review; -preparation of ore, production of coke; -thermodynamic, heterogeneous equilibrium, kinetics; -reduction technology, production of Iron; -production of steel; -secondary metallurgy; -casting and solidification -slag in the production of Iron and steel -recycling of the steel scrapes -environment protection and sustainability				Non-ferrous Metallurgy: The students should become capable to understand the material flow, the primary and secondary processing route, the necessary aggregate with parameters of process and the chemical reaction in the metallurgical process of Copper, Aluminum, Zinc, Lead and Titanium, as well as the consideration of the problem of environment and location and especially energy requirements. Iron and steel: The students should know the most important properties of the production of Iron and steel. They should be able to describe the plant specific relationship between the aggregates of process, the thermo-chemical properties of each middle-production and the kinetically process procedure..		
Prerequisites				**Grading**		
				Written exam (180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Fabrication Technology of Metals (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	6	8	2	SS 2009	English

CONTENTWISE INFORMATION	
Content	**Educational objectives**
a);c) -Introduction to basics: plasticity, plastomechanics, boundary conditions and heat transport, solution methods -Technology and solving methods of bulk-forming: forging, extrusion, bar extrusion, drawing, rolling -Technology and solving methods of sheet forming: forming of sheet metal, tribology, deep-drawing, -stretch-forming, flow forming b);d) -Physical and technological basics: metallic melts, supercooling, nucleation, casting-, feeding- and gating techniques -Molding and casting technology: high-pressure-die-casting, die-casting sand-casting as well as molding materials and applicable rapid-prototyping techniques -Casting materials (cast iron, aluminum- and magnesium alloys): metallurgy, casting properties, micro-structure and its properties as well as the relationship between them -Simulation of foundry processes: heat-balance in casting and mould, flow and convection -Aspects of economic and ecological challenges in foundry technology	a); c): Knowledge: The students know the basic technologies of metal forming as well as selected solution methods. Comprehension: The students understand the coherences between essential process and material parameters. Application: The basic equations of the elemental theory for analysis and interpretation of basic processes of metal forming can be applied. b); d): Knowledge: The students possess an overview and know the basics of foundry technology. Comprehension: The students understand the connection between process technology, casting materials and their simulation. Application: The students are enabled to meet technology based decisions on complex foundry processes and materials.
Prerequisites	**Grading**
	Written exam(180 min)

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
Lecture	4	Exam (180 min)	8
Exercise	2		

Metallic Materials (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	6	8	2	SS 2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Physical properties of metallic materials; substitutional and interstitial solid solution; selected binary and ternary systems; Choice of materials, steel groups: unalloyed mild steels, structural steels, soft magnetic steels, stainless steels, aluminum, titanium and magnesium alloys, copper base alloys, super alloys, high melting metals, hard materials and compounds of hard materials; magnetic materials; design of composite materials phase transformation: precipitation and aging, pearlite, bainite, martensite; heat treatment of steels; steel processing: continuous casting, hot rolling, cold rolling, annealing, surface treatment; development of microstructure.				Students are proficient in the metal-physical phenomena and their different possibilities for systematic influence on metals properties. Further on, students manage the transfer of the learned theories on practical applications of metallic materials. For selected examples, students are capable of analyzing the development of microstructure through process chain.		
Prerequisites				**Grading**		
				Written exam (180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Mineral Materials (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English

CONTENTWISE INFORMATION	
Content	**Educational objectives**
a) Glass: Thermodynamic functions of a glass, the glass transition, random network versus cluster hypothesis of the glass structure, viscosity (VFT, Angell, and Gibb-Adam plot), crystallization and nucleation. Ionic versus covalent bonds, hybrid bonds, anion-cation packing, Dietzel field strength, electronegativity, short-range order building blocks of oxide glasses; optical and spectral properties; thermal expansion, thermal stresses, strength and fracture mechanics of a material having no internal microstructure b) Ceramics: Definitions of ceramics, chemical composition and interatomic bonding; sintering phenomena; introduction to brittle fracture; ceramics in application: high-temperature properties: refractories, insulating materials, ceramics in automotives and energy technology; electrical and electronic properties, ion conductivity, super conductors, NTC, PTC, medical properties. c) Crystallography of Mineral Materials: Basic systematic crystal chemistry: Chemical and topological classification; fundamental structure types. Structure and chemical bonding. Principles of structure-property relations in inorganic solids (mechanical, electrical, magnetic, thermal properties etc.). Structural defects and structural phase transitions and their influence on macroscopic properties. Crystal chemical tailoring of materials properties (doping, substitution etc.); Selected examples of technically important materials (e.g. perovskites, spinells, semiconductors, oxide- and non-oxide ceramics, ultrahard materials, refractories etc.) d) 'Glass': Calculation of viscosity by Lakatos factors, derivation of VFT parameters from experiments, set-up of Angell and Gibbs-Adam plot; determination of the crystallization time law from crystallite geometry; design of a full-fledged industrial cooling programme e) 'Ceramics': Microstructural evolution during sintering; thermal expansion; thermal shock; lambda probe, SOFC, linings of gas turbines; corrosion in liquids and gasses, active and passive oxidation; dental and bone implants. f) like c)	a) Lecture: The students conceive 'glass' as a special aggregate state of matter and know how to describe it in terms of thermodynamic, structural, and kinetic categories. They understand the meaning of chemical bonds in oxide systems, and are able to derive the short-range order entities of the glass structures. They gain an overview over spectral, optical, and thermo-mechanical properties of industrial glasses. b) Lecture: The students understand the chemical and physico-chemical properties of ceramic materials; they know about the most important structure-property relations such as brittle behavior, thermal properties; ion and super conductivity, piezo effect, medical behavior; they know what kind of material is used for what purposes and recognize advantages and disadvantages. c) Lecture: The students acquire a basic understanding of the building principles of crystal structures in terms of chemical bonding and structural topology. This includes an overview over the most important structure types and of structure-property relations in inorganic (non-metallic) engineering materials. d) Exercise: The students know to derive the viscosity-temperature function from the chemical composition of a glass, to determine working and cooling range. They are able to derive the crystallization curve for a given glass. They know how to influence the color of a glass. They know how to set up a cooling programme for an industrial product. e) Exercise: The students know about fundamentals of sintering behavior and are able to give qualitative estimates on the microstructural evolution during densification; they are able to estimate the stress-failure behavior of ceramics by means of Griffith- Equation. f) Exercise: The students will learn 'hands-on' how to understand, draw and interpret crystal structures both qualitatively (identify structure type, identify coordination, describe polyhedral linkage etc.) and quantitatively (derive bond-lengths and -angles, discuss bond-strength and derive structure related properties).
Prerequisites	**Grading**
	Written exam (180 min); 60 min for each sub-topic

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
Lecture	4	Exam (180 min)	8
Exercise	2		

Module segment 2:

Advanced Physical Metallurgy (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	4	4	2	SS 2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Thermodynamics of interfaces, grain boundary migration, grain growth in polycrystals, grain boundary engineering				The students gain a deeper understanding and are trained in quantitative description of the phenomena and the processes in condensed matter. They can apply the thermodynamic and kinetic basics of internal interfaces and junctions in polycrystalline materials.		
Prerequisites				**Grading**		
				Oral exam (30min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		2		Oral exam		4
Exercise		2				

Introduction to Texture Analysis (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1	3	3	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Introduction (Motivation, introduction to the principal concepts of texture analysis, diffraction for texture analysis); Fundamentals (definitions, orientation, misorientation, orientation spaces); Measurements of macrotexture (X-ray diffraction, neutron diffraction, pole figures, ODF-analysis, typical textures); Measurements of microtexture (TEM-based techniques, Kikuchi-patterns, SEM-EBSD, OIM, orientation mapping); other techniques; application examples.				Students become familiar with the basics of texture analysis. By a comprehensive coverage of the theory and practice, students learn about different texture techniques now available. A discussion of applications of texture analysis in research and industry enables students to verify their knowledge.		
Prerequisites				**Grading**		
				Written exam (60 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		2		Exam (60min)		3
Exercise		1				

Micromechanics of Materials (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	4	4	2	SS 2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Introduction to mechanics of lattice defects (dislocations, interfaces etc.); Introduction to collective lattice defect behaviour (micro bands, shear bands, orange peel, interface mechanics, basics of yield surface, strain percolation, 'Ridging') Grain mechanics and polycrystal mechanics (Taylor-Bishop-Hill, theory of poly crystals, Eshelby Theory). Interface and surface mechanics (grain boundary mechanics) Mechanics of layered structures (polymer coatings on metals). Mechanics of biocompatible materials Mechanics of biological materials (bone, Chitin, collagen, cellulose)				The lecture enables students to understand micromechanics in terms of mechanisms based on lattice defects which are valid for certain conditions. The students are able to apply their knowledge to basic as well as more advanced engineering problems.		
Prerequisites				**Grading**		
				Written exam (60 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		3		Exam (60min)		4
Exercise		1				

Comprehensive Physical Metallurgy Lab (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2 & 3	2	10	10	2	SS 2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
a,b) Solidification with respect to phase diagram Al-Zn ; microstructure and concentration distribution in a cast bronze after solidification and homogenization; tensile tests of Cu single and polycrystals; hardening of Al alloys; recrystallization; texture measurements c) Presentation about a study integrated thesis or master thesis d) Changing topics of Physical Metallurgy and Materials Science				a,b) The students are enabled to carry out metallographic sample preparation independently. They can conduct experiments on their own with respect to the topics presented during the physical lab. They can interpret and discuss results obtained from own experiments. c,d) The students will improve their presentation skills and will learn how to become familiar with a new topic that was not covered in lectures.		
Prerequisites				**Grading**		
				Certification		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Exercise		3		Presentation (Seminar I)		1
Practical course		7		Presentation (Seminar II)		1
				Practical course		8

Module segment 3:

Complementary course						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1		3	1	WS 2010/2011	
CONTENTWISE INFORMATION						
Prerequisites				**Grading**		
				Certification		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Certification		3

Internship						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		10	1	WS 2010/11	
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
- Fabrication and processing of materials - Business procedures				The internship provides the students an insight into the chosen occupational field; delivers a first guide for a future professional life and an impression of the social relations in industry. The possibility to get to know industrial processes enables a deeper understanding of and motivation for their studies.		
Prerequisites				**Grading**		
				Certification		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Presentation		10

Student Research Project						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Selected task within a research and development project, theoretically or experimentally, including independent information sourcing, structuring of the topic, and exposition of the investigations, presentation and defense of the thesis.				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor.		
Prerequisites				**Grading**		
for Master Thesis				Written thesis		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Written thesis		8

Experimental Student Research Project						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		10	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
- Experimental Research Skills				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor within a Experimental Student Research Project.		
Prerequisites				**Grading**		
for Master Thesis				80% Experimental Student Research Project 20% Colloquium		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Experimental Student Research Project		8
				Colloquium		2

Master Thesis						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
4	1		30	1	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Selected task within a research and development project, theoretically or experimentally, including independent information sourcing, structuring of the topic, exposition of the investigations, presentation and defense of the thesis.				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor.		
Prerequisites				**Grading**		
• Complementary Course • Student Research Project • Internship OR Experimental Student Research Project • 66 additional Credit Points				Written thesis 90% Colloquium 10 %		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Master thesis		27
				Colloquium		3

Area of specialization „Materials Science of Steels“

Module segment 1:

Thermochemistry (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
- Chemical equilibrium - Phase diagrams - Properties of mixtures - Statistical thermodynamic - Rate of chemical reactions - Elastic properties - Properties of surfaces				The students get to know the basics of thermochemistry, enabling them to evaluate the thermodynamic and kinetic properties of materials to select or develop suitable materials for different processes and requirements.		
Prerequisites				**Grading**		
				Written exam (180 min). Furthermore, the exam grade can be improved by taking part in a 30 min optional learning progress check. Accomplishes the student 80 % of the points of this check, the exam grade will improve by one grade step (hence e.g. from 3.7 to 3.3), with an accomplishment of 90 %, the exam grade will improve by two grade steps hence e.g. from 3.7 to 3.0). This improvement is valid for all exams written within one year after the learning progress test and provided that the written exam is graded with 4.0 or better. A better grade than 1.0 is not possible.		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		7.5
Exercise		2		Progress Check		0.5

Physical Metallurgy (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Microstructure; atomic structure of solids; crystal defects; alloys; diffusion; mechanical properties; recovery, recrystallization, grain growth; solidification; solid state phase transformations; physical properties				The students will get familiar with the physical fundaments of material science. The students will be enabled to study more specialized and fundamental topics of material science. They will learn to use the concepts and methods in material science independently and will practice this in exercises accompanying the lecture. The students will deepen their understanding of the learnt contents during these exercises.		
Prerequisites				**Grading**		
				Written exam (180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Process Metallurgy and Recycling (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Non-ferrous metallurgy: -Basics of nonferrous metallurgy, Economical significance, primary and secondary raw material, global material management. -Metallurgical processes of Copper: Pyrometallurgy: flash smelting; Converter metallurgy and direct production; Recycling and pyrometallurgical Refining; Refining electrolysis and casting -Metallurgical processes of Aluminum: Bauxite to Al-Hydroxide; Al-Hydroxide to Metal; Recycling, melt treatment and casting. -Metallurgical processes of Zinc : Hydrometallurgy; Extraction electrolysis and hydrometallurgical Recycling; Pyrometallurgy; pyrometallurgical refining of lead and zinc -Metallurgical processes of Titanium: Sorel-process, Kroll-process, remelting Iron and steel: -Introduction, historical review; -preparation of ore, production of coke; -thermodynamic, heterogeneous equilibrium, kinetics; -reduction technology, production of Iron; -production of steel; -secondary metallurgy; -casting and solidification -slag in the production of Iron and steel -recycling of the steel scrapes -environment protection and sustainability				Non-ferrous Metallurgy: The students should become capable to understand the material flow, the primary and secondary processing route, the necessary aggregate with parameters of process and the chemical reaction in the metallurgical process of Copper, Aluminum, Zinc, Lead and Titanium, as well as the consideration of the problem of environment and location and especially energy requirements. Iron and steel: The students should know the most important properties of the production of Iron and steel. They should be able to describe the plant specific relationship between the aggregates of process, the thermo-chemical properties of each middle-production and the kinetically process procedure.		
Prerequisites				**Grading**		
				Written exam (180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Fabrication Technology of Metals (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	6	8	2	SS 2009	English

CONTENTWISE INFORMATION	
Content	**Educational objectives**
a);c) -Introduction to basics: plasticity, plastomechanics, boundary conditions and heat transport, solution methods -Technology and solving methods of bulk-forming: forging, extrusion, bar extrusion, drawing, rolling -Technology and solving methods of sheet forming: forming of sheet metal, tribology, deep-drawing, -stretch-forming, flow forming b);d) -Physical and technological basics: metallic melts, supercooling, nucleation, casting-, feeding- and gating techniques -Molding and casting technology: high-pressure-die-casting, die-casting sand-casting as well as molding materials and applicable rapid-prototyping techniques -Casting materials (cast iron, aluminum- and magnesium alloys): metallurgy, casting properties, micro-structure and its properties as well as the relationship between them -Simulation of foundry processes: heat-balance in casting and mould, flow and convection -Aspects of economic and ecological challenges in foundry technology	a); c): Knowledge: The students know the basic technologies of metal forming as well as selected solution methods. Comprehension: The students understand the coherences between essential process and material parameters. Application: The basic equations of the elemental theory for analysis and interpretation of basic processes of metal forming can be applied. b); d): Knowledge: The students possess an overview and know the basics of foundry technology. Comprehension: The students understand the connection between process technology, casting materials and their simulation. Application: The students are enabled to meet technology based decisions on complex foundry processes and materials.
Prerequisites	**Grading**
	Written exam (180 min)

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
Lecture	4	Exam (180 min)	8
Exercise	2		

Metallic Materials (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	6	8	2	SS 2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Physical properties of metallic materials; substitutional and interstitial solid solution; selected binary and ternary systems; Choice of materials, steel groups: unalloyed mild steels, structural steels, soft magnetic steels, stainless steels, aluminum, titanium and magnesium alloys, copper base alloys, super alloys, high melting metals, hard materials and compounds of hard materials; magnetic materials; design of composite materials phase transformation: precipitation and aging, pearlite, bainite, martensite; heat treatment of steels; steel processing: continuous casting, hot rolling, cold rolling, annealing, surface treatment; development of microstructure.				Students are proficient in the metal-physical phenomena and their different possibilities for systematic influence on metals properties. Further on, students manage the transfer of the learned theories on practical applications of metallic materials. For selected examples, students are capable of analyzing the development of microstructure through process chain.		
Prerequisites				**Grading**		
				Written exam (180 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		4		Exam (180 min)		8
Exercise		2				

Mineral Materials (Basic course)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
1	1	6	8	2	WS 2008/09	English

CONTENTWISE INFORMATION	
Content	**Educational objectives**
a) Glass: Thermodynamic functions of a glass, the glass transition, random network versus cluster hypothesis of the glass structure, viscosity (VFT, Angell, and Gibb-Adam plot), crystallization and nucleation. Ionic versus covalent bonds, hybrid bonds, anion-cation packing, Dietzel field strength, electronegativity, short-range order building blocks of oxide glasses; optical and spectral properties; thermal expansion, thermal stresses, strength and fracture mechanics of a material having no internal microstructure b) Ceramics: Definitions of ceramics, chemical composition and interatomic bonding; sintering phenomena; introduction to brittle fracture; ceramics in application: high-temperature properties: refractories, insulating materials, ceramics in automotives and energy technology; electrical and electronic properties, ion conductivity, super conductors, NTC, PTC, medical properties. c) Crystallography of Mineral Materials: Basic systematic crystal chemistry: Chemical and topological classification; fundamental structure types. Structure and chemical bonding. Principles of structure-property relations in inorganic solids (mechanical, electrical, magnetic, thermal properties etc.). Structural defects and structural phase transitions and their influence on macroscopic properties. Crystal chemical tailoring of materials properties (doping, substitution etc.); Selected examples of technically important materials (e.g. perovskites, spinells, semiconductors, oxide- and non-oxide ceramics, ultrahard materials, refractories etc.) d) 'Glass': Calculation of viscosity by Lakatos factors, derivation of VFT parameters from experiments, set-up of Angell and Gibbs-Adam plot; determination of the crystallization time law from crystallite geometry; design of a full-fledged industrial cooling programme e) 'Ceramics': Microstructural evolution during sintering; thermal expansion; thermal shock; lambda probe, SOFC, linings of gas turbines; corrosion in liquids and gasses, active and passive oxidation; dental and bone implants. f) like c)	a) Lecture: The students conceive 'glass' as a special aggregate state of matter and know how to describe it in terms of thermodynamic, structural, and kinetic categories. They understand the meaning of chemical bonds in oxide systems, and are able to derive the short-range order entities of the glass structures. They gain an overview over spectral, optical, and thermo-mechanical properties of industrial glasses. b) Lecture: The students understand the chemical and physico-chemical properties of ceramic materials; they know about the most important structure-property relations such as brittle behavior, thermal properties; ion and super conductivity, piezo effect, medical behavior; they know what kind of material is used for what purposes and recognize advantages and disadvantages. c) Lecture: The students acquire a basic understanding of the building principles of crystal structures in terms of chemical bonding and structural topology. This includes an overview over the most important structure types and of structure-property relations in inorganic (non-metallic) engineering materials. d) Exercise: The students know to derive the viscosity-temperature function from the chemical composition of a glass, to determine working and cooling range. They are able to derive the crystallization curve for a given glass. They know how to influence the color of a glass. They know how to set up a cooling programme for an industrial product. e) Exercise: The students know about fundamentals of sintering behavior and are able to give qualitative estimates on the microstructural evolution during densification; they are able to estimate the stress-failure behavior of ceramics by means of Griffith- Equation. f) Exercise: The students will learn 'hands-on' how to understand, draw and interpret crystal structures both qualitatively (identify structure type, identify coordination, describe polyhedral linkage etc.) and quantitatively (derive bond-lengths and -angles, discuss bond-strength and derive structure related properties).
Prerequisites	**Grading**
	Written exam (180 min)

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
Lecture	4	Exam (180 min)	8
Exercise	2		

Module segment 2:

Materials Science of Steel (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2 und 3	2	8	9	2	SS 2009	English

CONTENTWISE INFORMATION	
Content	**Educational objectives**
Basic aspects of strength, toughness, fracture: conventional stress-strain-diagram, influence of temperature and strain rate, yielding behavior, thermal activated flow stress, superplasticity, anisotropy; strengthening mechanisms, materials failure: fracture mechanics, cold forming properties, high temperature behavior; economical importance of steel; environmental aspects of steel production and products. High strength steels for automotive application, high strength structural steels, high temperature steels, multiphase steels, special deep-drawing steels, rail steels	Students are able to link metal-physical phenomena with materials properties. They know methods and processes to analyze and influence corresponding materials properties. For selected processes, students are able to set up a process chain, including lifecycle assessment and cost effective analysis. For selected steel groups, students are proficient in defining correlations between microstructure and properties. They know the industrial implementation of these materials.
Prerequisites	**Grading**
	a, c, d) Written exam 120 min + 15-30 min oral exam, successful passed practical training to the admission of examination. Practical training is successful passed if certificate is given. (75 %) b) Written exam 60 min (25 %)

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
Lecture I	2	Exam I (120 min) + Oral exam	4
Exercise	1	Practical course	3
Lecture II	2	Exam II (60 min)	2
Practical course	4		

Introduction to Texture Analysis (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	3	3	2	WS 2008/2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Introduction (Motivation, introduction to the principal concepts of texture analysis, diffraction for texture analysis); Fundamentals (definitions, orientation, misorientation, orientation spaces); Measurements of macrotexture (X-ray diffraction, neutron diffraction, pole figures, ODF-analysis, typical textures); Measurements of microtexture (TEM-based techniques, Kikuchi-patterns, SEM-EBSD, OIM, orientation mapping); other techniques; application examples.				Students become familiar with the basics of texture analysis. By a comprehensive coverage of the theory and practice, students learn about different texture techniques now available. A discussion of applications of texture analysis in research and industry enables students to verify their knowledge.		
Prerequisites				**Grading**		
				Written exam (60 min)		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Lecture		2		Exam (60 min)		3
Exercise		1				

Materials Characterization (Study major)						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1	3	3	2	SS 2009	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Tensile test, compression tests, long period creep test, bending test, hardness test, Charpy test, fracture mechanic test and fatigue test, safety analysis; non-destructive materials testing; FEM; technological testing				Students know common methods to characterize materials properties. They are able to perform and analyze selected experiments.		
Prerequisites				**Grading**		
				Certificate of participation if all experiments are passed successful and successful passed presentation of one practical test.		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
Exercise		1		Practical course		2
Practical course		2		Presentation		1

Module segment 3:

Complementary course						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
2	1		3	1	WS 2010/2011	
CONTENTWISE INFORMATION						
Prerequisites				**Grading**		
				Certification		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Certification		3

Internship						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		10	1	WS 2010/2011	

CONTENTWISE INFORMATION	
Content	**Educational objectives**
- Fabrication and processing of materials - Business procedures	The internship provides the students an insight into the chosen occupational field; delivers a first guide for a future professional life and an impression of the social relations in industry. The possibility to get to know industrial processes enables a deeper understanding of and motivation for their studies.
Prerequisites	**Grading**
	Certification

FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION			
Course	**SWS**	**Examination**	**CP**
		Presentation	10

Student Research Project						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		8	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Selected task within a research and development project, theoretically or experimentally, including independent information sourcing, structuring of the topic, and exposition of the investigations, presentation and defense of the thesis.				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor.		
Prerequisites				**Grading**		
for Master Thesis				Written thesis		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Written thesis		8

Experimental Student Research Project						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
3	1		10	2	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
- Experimental Research Skills				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor within a Experimental Student Research Project.		
Prerequisites				**Grading**		
for Master Thesis				80% Experimental Student Research Project 20% Colloquium		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Experimental Student Reasearch Project		8
				Colloquium		2

Master Thesis						
GENERAL INFORMATION						
Semester	**Duration**	**SWS**	**CP**	**Rotation(semester)**	**Rotation start**	**Language**
4	1		30	1	WS 2008/09	English
CONTENTWISE INFORMATION						
Content				**Educational objectives**		
Selected task within a research and development project, theoretically or experimentally, including independent information sourcing, structuring of the topic, exposition of the investigations, presentation and defense of the thesis.				Independent working on a problem in the area of expertise of the student within a given period according to scientific methods guided by a supervisor.		
Prerequisites				**Grading**		
• Complementary Course • Student Research Project • Internship OR Experimental Student Research Project • 66 additional Credit Points				Written thesis 90% Colloquium 10 %		
FORM OF LESSON / COURSES & ASSOCIATED EXAMINATION						
Course		**SWS**		**Examination**		**CP**
				Master thesis		27
				Colloquium		3

Appendix 2

Programme of study Specialization „Process Technology of Metals“

Programme of study	SWS	LP
1. Semester (WS)		
Thermochemistry	V4 Ü2	8
Physical Metallurgy	V4 Ü2	8
Process Metallurgy and Recycling	V4 Ü2	8
Process Control Engineering	V2 Ü1	4
Transport Phenomena	V2 Ü1	4
		32
2. Semester (SS)		
Fabrication Technology of Metals	V4 Ü2	8
Process Control Engineering	V2 Ü1	4
Transport Phenomena	V2 Ü1	4
Melt Treatment and Continuous Casting	V2 Ü1 P1	4
Unit Operations in Nonferrous Metallurgy	V2 Ü1 P2	5
Complementary course		3
		28
3. Semester (WS)		
Casting Processes and Casting Alloys	V2 Ü1 P1	4
Fundamentals and Solving Methods in Metal Forming	V2 Ü1 P1	4
Industrial Furnaces	V2 Ü2	4
Student Research Project		8
Internship or Experimental Student Research Project		10
		30
4. Semester (SS)		
Master Thesis		27
Colloquium		3
		30
Total		**120**

Programme of study Specialization „Physical Metallurgy and Materials“

Programme of study	SWS	LP
1. Semester (WS)		
Thermochemistry	V4 Ü2	8
Physical Metallurgy	V4 Ü2	8
Process Metallurgy and Recycling	V4 Ü2	8
Mineral Materials	V4 Ü2	8
		32
2. Semester (SS)		
Fabrication Technology of Metals	V4 Ü2	8
Metallic Materials	V4 Ü2	8
Advanced Physical Metallurgy	V2 Ü2	4
Introduction to Texture Analysis	V2 Ü1	3
Micromechanics of Materials	V3 Ü1	4
Comprehensive Physical Metallurgy Lab	Ü1	1
Complementary course		3
		31
3. Semester (WS)		
Comprehensive Physical Metallurgy Lab	Ü2 P7	9
Student Research Project		8
Internship or Experimental Student Research Project		10
		27
4. Semester (SS)		
Master Thesis		27
Colloquium		3
		30
Total		**120**

Programme of study Specialization „Materials Science of Steels“

Programme of study	SWS	LP
1. Semester (WS)		
Thermochemistry	V4 Ü2	8
Physical Metallurgy	V4 Ü2	8
Process Metallurgy and Recycling	V4 Ü2	8
Mineral Materials	V4 Ü2	8
		32
2. Semester (SS)		
Fabrication Technology of Metals	V4 Ü2	8
Metallic Materials	V4 Ü2	8
Materials Science of Steel	V2	2
Introduction to Texture Analysis	V2 Ü1	3
Materials Characterization	Ü1 P2	3
Complementary course		3
		27
3. Semester (WS)		
Materials Science of Steel	V2 Ü1 P4	7
Physical Metallurgy Lab	Ü1 P5	6
Student Research Project		8
Internship or Experimental Student Research Project		10
		31
4. Semester (SS)		
Master Thesis		27
Colloquium		3
		30
Total		**120**

Appendix 3

Directive regarding the practical training in the Master's programme "Metallurgical Engineering"

Objectives:
Practical training (or a training placement) in a company is part of the studies in the Master's degree programme Metallurgical Engineering. This practical training is intended to deliver insight into the chosen occupational area for the students, to provide initial guidance for future occupational goals, and to provide an impression of the social context of an industrial company. Acquaintance with industrial procedures is intended to achieve a better understanding and an enhancement of the course content.

Duration:
For these purposes the total duration of the practical training is prescribed to be 10 weeks.

Procedure:
Periods when there are no lectures between the semesters are available for attending the training. The emphasis of the practical training should be closely related to the chosen specialism. The student has to designate a supervisor for the training in consultation with the examination board. All university professors of the Master's degree programme Metallurgical Engineering can be supervisors for the practical training. The student chooses a company unit in agreement with the company and, where required, with the examination board of the Master's degree programme Metallurgical Engineering. This choice should aim at gaining knowledge about production and treatment of materials and insight into operational processes and interconnections. Practical training with a focus on research and development is not possible.
The students should complete their practical training in Europe or throughout the world with a German company.
The professional associations concerned can help with finding a placement. Their addresses can be obtained at the section or institute offices.

Acceptance of the practical training:
Presentation:
The trainees shall report on their practical training in the form of a presentation at the institute of their supervisor. The form and duration of the presentation shall be agreed with the supervisor. After the presentation and a subsequent discussion, the supervisor issues an attestation, which has to be submitted to the examination board for acceptance of the practical training together with a confirmation of placement.

Confirmation of placement:
On completion of the practical training the student has to get a confirmation of his or her training from the company. In addition to the exact name of the company and of the operational unit, this confirmation has to show the time, duration, and the kind of work. It is not necessary to keep a logbook of activities.

Acceptance:
The examination board of the Master's degree programme Metallurgical Engineering shall decide on acceptance of the practical training and shall issue an overall attestation. This comprises the presentation and the confirmation of placement.