Description of the degree course

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<tr>
<th>Name of the degree course</th>
<th>Shorthand expression of degree course</th>
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<tr>
<td>Master Metallurgy and Metal Forming PO08</td>
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**Description**

The master degree course “Metallurgy and Metal Forming” is a consecutive master program of the disciplinary bachelor program “Metallurgy and Metal Forming”. The graduates of the bachelor degree course will be deeply introduced into the metallurgic and metal-physical fundamentals of metallic material production as well their processing, heat treatment and refinement. In so doing, they will be put in the position where they are able to develop, implement and optimize processes, as well as independently plan and realize materials and procedures.

The graduates will in particular be able to occupy functions as leaders or executives in the corresponding companies as well as being able to communicate with customers and authorities. Besides the deepening lectures from the metallurgy, plasto-mechanics, and thermodynamics areas, areas of process simulation, data processing and project management questions will be handled in special lectures.

For the graduates, excellent career perspectives as leaders or executives in the iron- and steel industry as well as in the metal-processing industry are possible, and there is also the possibility to do a PhD at German or even foreign universities.

The sphere of activities of the graduates particularly lies in the area of metal-processing with the focus point on iron and steel industry and further-processing as well as in companies which use metallic materials in manufacturing, production and processing.

This ranges from particular consulting in constructive mechanical engineering for metallic materials up to heat treatment companies involved in the processing for volume or flat oriented materials and the metal-processing industry involved in, for example, the manufacturing of components or the car body manufacturing in the automotive and vehicle sector.

Here, potential employers are in particular large and international concerns, but also executive positions in small and middle-sized companies are of great interest, not leaving out corresponding freelance work as consulting engineer or even in particular consultancy firms involved in the technology sector.

Independent of all other materials, steel is a worldwide outstanding construction material, in such a way that specialists in this field are highly demanded in many domains of industrial engineering, so that it represents excellent career opportunities for the graduates.
## Study plan

### Master Metallurgy and Metal Forming PO08
Maschinenbau und Verfahrenstechnik

<table>
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| 2. Finite Element Method 1                                                  | Prof. Dr.-Ing. Kowalczyk     | d        | 1 | 2 | 0 | 0 | 4 |
| Casting and Solidification of Steel                                        | Prof. Dr. Deike              | d        | 2 | 2 | 0 | 0 | 5 |
| Metallography and Metallphysics                                            | Dr.-Ing. Myronova            | d        | 2 | 1 | 0 | 0 | 4 |
| Metallography and Metallphysics Lab                                        | Dr.-Ing. Myronova            | d        | 0 | 0 | 1 | 0 | 1 |
| Theory of Plasticity and Forming Mechanism                                  | Prof. Dr.-Ing. Mauk          | d        | 2 | 1 | 0 | 0 | 4 |
| Theory of Plasticity and Forming Mechanism Lab                             | Prof. Dr.-Ing. Mauk          | d        | 0 | 0 | 1 | 0 | 1 |
| Recycling of Oxidic and Metallic Materials                                  | Prof. Dr. Deike              | e        | 2 | 1 | 0 | 0 | 4 |
| Recycling of Oxidic and Metallic Materials Lab                             | Prof. Dr. Deike              | e        | 0 | 0 | 1 | 0 | 1 |
| Elective 2                                                                  | NN                          | d/e      | 2 | 1 | 0 | 0 | 4 |
| Heat and Mass Transfer                                                      | Prof. Dr. rer. nat. Atakan   | d        | 2 | 1 | 0 | 0 | 4 |
| **Total**                                                                   |                             |         | 13| 9 | 3 | 0 | 32|
| 3. | **Computer Application in Metallurgy and Metal Forming** | Prof. Dr.-Ing. Mauk  
Prof. Dr. rer. nat. Gottschling  
Dr.-Ing. Weyh  
Prof. Dr. Deike | e | 2 | 0 | 0 | 0 | 4 |
| Continuum Mechanics MT | Prof. Dr.-Ing. Bluhm | e | 2 | 0 | 0 | 0 | 4 |
| Non-technical Catalog M | NN | d/e | 0 | 0 | 0 | 6 | 8 |
| Vibration Analysis of Metallurgical Systems | Dr.-Ing. Weyh | d | 2 | 1 | 0 | 0 | 4 |
| Elective 3 | NN | d/e | 2 | 1 | 0 | 0 | 4 |
| Heat Treatment of Metallic Materials | Prof. Dr.-Ing. Mauk  
Dr.-Ing. Myronova | d | 2 | 1 | 0 | 0 | 4 |
| Heat Treatment of Metallic Materials Lab | Dr.-Ing. Myronova | d | 0 | 0 | 1 | 0 | 1 |
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# Module- und course catalog

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<td>Testing of Metallic Materials</td>
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## Module Coordinator

Prof. Dr.-Ing. Paul Josef Mauk

## Used in degree course
- Master Computational Mechanics PO07
- Master Metallurgy and Metal Forming PO08
- Master Metallurgy and Metal Forming PO15

## Year | Duration | Type of module
--- | --- | ---
1 | 1 | Pflichtmodul

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Testing of Metallic Materials

# Course/Examination Name
Testing of Metallic Materials

# Course Coordinator
Prof. Dr.-Ing. Paul Josef Mauk

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# Teaching form
Lectures, exercises, tutorials

# Learning objectives
The student knows the destructive and non-destructive tests for metallic materials and their results for strength and toughness for metallic materials

# Description
The content of this module focuses on the procedures and methods used to test metallic materials. Based on the crystalline construction of metallic materials and the causes of metallic plasticity, fundamental attempts to determine the stability and tenacity in static and dynamic loads will be outlined. Alongside the standard material mechanical tests, the procedures of the substance analysis and the analysis methods will be described. The metallographic investigation methods via light-optical microscope bring us to the x-ray-graphical and electron microscope methods. Corrosion test procedures in chemical and especially electro-chemical corrosion as well as thermal corrosion accompany the study. The test of physical characteristics of metals should supplement the material-mechanical test procedures. In the case of the non-destructive test procedures, both acoustic as well as radiographic tests will be treated. The electric and magnetic testing procedures as well as the testing of surface smoothness comprise the content of this module.

# Kind of examination
written examination 90 min.

# Literature
Schmidt, Werner M; Dietrich, Hermann; Praxis der mechanischen Werkstoffprüfung Expert Verlag, Esslingen, 1999, Band 585 ISBN 3-8169-1612-0


Weiler, Wolfgang W.;
Härteprüfung an Metallen und Kunststoffen
Expert Verlag, Esslingen, 1998, Band 155
ISBN 3-8169-0552-8

Steeb, Siegfried;
Zerstörungsfreie Werkstück- und Werkstoffprüfung
Expert Verlag, Esslingen, 1993, Band 243
ISBN 3-8169-0964-7

Bergmann, Wolfgang:
Werkstofftechnik 2 – Werkstoffherstellung – Werkstoffverarbeitung – Werkstoffanwendung
Hanser Verlag, München, 2002
ISBN 3-446-21639-1

Shackelford, James F.;
Werkstofftechnologie für Ingenieure
Pearson Studium Verlag, München, 2005
ISBN 3-8273-7159-7

Requirements
Kenntnisse der Analysis, technischen Mechanik und Werkstoffkunde
Module Name
Testing of Metallic Materials

Course/Examination Name
Testing of Metallic Materials Lab

Course Coordinator
Prof. Dr.-Ing. Paul Josef Mauk

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Teaching form
Laboratory experimental tests

Learning objectives
The student knows the destructive and non-destructive tests for metallic materials and their results for strength and toughness for metallic materials. The student knows the conditions for the experimental tests and the data evaluation for the test results

Description
Lab for lecture: Testing of metallic materials
The following lab-tests are executed:
tensile test with and without exensiometer,
upsetting test,
charpy test,
hardness tests acc. to Brinell, Vickers and Rockwell;
Ultrasonic testing,
surface crack checking

Kind of examination
test, experimental procedure

Literature
Schmidt, Werner M; Dietrich, Hermann;
Praxis der mechanischen Werkstoffprüfung
Expert Verlag, Esslingen, 1999, Band 585
ISBN 3-8169-1612-0

Pöhlandt, K.;
Werkstoffprüfung für die Umformtechnik
Springer Verlag, Berlin, 1986
ISBN 3-540-16722-6

Blumenauer, Horst;
Werkstoffprüfung
Deutscher Verlag für Grundstoffindustrie, Stuttgart, 1994
ISBN 3-342-00547-5

Weiler, Wolfgang W.;
Härteprüfung an Metallen und Kunststoffen
Expert Verlag, Esslingen, 1998, Band 155
ISBN 3-8169-0552-8

Steeb, Siegfried;
Zerstörungsfreie Werkstück- und Werkstoffprüfung
Expert Verlag, Esslingen, 1993, Band 243
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Hanser Verlag, München, 2002
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Shackelford, James F.;
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Module Name
Mathematics and Mechanics

Course/Examination Name
Tensor Calculus

Course Coordinator
Prof. Dr.-Ing. Joachim Bluhm

Semester | Cycle | Language
--- | --- | ---
1 | WS | englisch

SWS | Contact hours | Self-study hours | Workload in h | ECTS-Credits
--- | --- | --- | --- | ---
4 | 60 | 120 | 180 | 6

Teaching form
Lecture (2 SWS)
Tutorial (2 SWS)

Learning objectives
Problem formulations in mechanics, especially in continuum mechanics can be clearly formulated with help of tensor calculus. In the lecture students will acquire the skills necessary to describe complex physical facts and laws with the help of tensor calculus in an effective and compact way. The students are able to better understand mathematical theories and modeling in the continuum mechanics and thermodynamics.

Description
The content of the this course is divided into the sections
• Aspects of tensor calculus in vector algebra
• The arbitrary basic system
• Operations using the component representation
• Operations using the tensor representation
• Shift between coordinate systems
• Gradient, Divergence and Rotation of tensor fields
• Differentiation of tensor fields
• Cauchy law

The lecture is accompanied by numerous tutorial sessions focusing on the construction of computer simulations to deepen the theoretical issues.

Kind of examination
written examination 90 min.

Literature
Module Name
Mathematics and Mechanics

Course/Examination Name
Continuum Mechanics MT

Course Coordinator
Prof. Dr.-Ing. Joachim Bluhm

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Teaching form
a) Lecture: Auditorium lecture, Lecture notes  
b) Tutorial Session: Auditorium Tutorial

Learning objectives
When a body is subjected to a process, the density, velocity and temperature are not equal in every material point of the body (solid, liquid or gas). In general these quantities are not constant in time.

The aim of this course is to discuss the field equations (balance equations) with respect to the determination of time dependent field quantities for boundary and value problems.

Description

Kinematics
- Motion
- Transport theorems
- Deformations and strain measurements
- Deformations and strain velocities
- Lie Derivation
- Polar Decomposition
- Spectral Decomposition

Forces and stresses
- Cauchy’s lemma and theorem
- Cauchy, Kirchhoff and Piola-Kirchhoff stress tensors

Balance equations
- Balance equation of mass
- Balance equation of momentum
- Balance equation of moment of momentum
- Balance equation of energy (first law of thermodynamics)

Material Theory
- Concepts
- Principles: Determinism, Equipresence, Local Action, Material Objectivity, Material Symmetry
- Material Objectivity for Stresses
- Constitutive Modeling
- Helmholtz free Energy
- Material laws for Elastic Materials
- Linearization of Stresses
**Kind of examination**

According to the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts.

**Literature**

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<th>Author</th>
<th>Title</th>
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<td>Holzapfel, G.A.</td>
<td>Nonlinear solid mechanics</td>
<td>Wiley</td>
<td>2000</td>
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<tr>
<td>Hutter, K. &amp; Jöhnk, K.</td>
<td>Continuum methods of physical modeling.</td>
<td>Springer</td>
<td>2004</td>
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<td>Müller, I.</td>
<td>Grundzüge der Thermodynamik</td>
<td>Springer</td>
<td>1994</td>
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<td>Wilmanski, K.</td>
<td>Thermomechanics of continua</td>
<td>Springer</td>
<td>1998</td>
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**Teaching form**
Lecture, overhead sheets, excercises in small groups

**Learning objectives**
On the basis of theoretical fundamentals the students are able to analyse and to calculate the enthalpy changes when the composition of a mixture is changed, for example when liquid steel is alloyed. The students are able to analyse and to calculate if metallurgical reactions between melts, slags, solid particles and different composed gases take place or not. The students are qualified to examine and calculate equilibria under different pressure and temperature conditions. Rates and velocities of reactions, together with the corresponding laws which control the reactions, can be identified and analysed by the students. With this knowledge the students are able to optimize metallurgical processes.

**Description**
The behaviour of solutions is discussed on the basis of partial and integral variables, introduced by the tangent method. With the Gibbs-Duhem equation the changes of partial variables in an mixture are described. Enthalpy changes as the result of alloying steels are calculated. The thermodynamic activities of components in solutions are introduced and calculated. In this lecture chemical equilibria are analysed and process variations are calculated under typical varying conditions, which are known from real processes. The fundamentals of transport processes in heterogeneous phases and at phase boundaries are presented in detail

**Kind of examination**
Written exam, duration 90 min

**Literature**


Oeters, F.: Metallurgie der Eisen und Stahlerzeugung Verlag Stahleisen mbH, Düsseldorf 1989
## Requirements

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<th>Analysis, Differentialgleichungen, Physikalische Chemie</th>
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Module Name
Thermodynamics and Transport Phenomena

Course/Examination Name
Finite Element Method 1

Course Coordinator
Prof. Dr.-Ing. Wojciech Kowalecyk

Semester | Cycle | Language
--- | --- | ---
2 | SS | deutsch

SWS | Contact hours | Self-study hours | Workload in h | ECTS-Credits
--- | --- | --- | --- | ---
3 | 45 | 75 | 120 | 4

Teaching form
Lecture, PowerPoint, Exercise class, PC

Learning objectives
The course provides an understanding of the basic mathematical methods for the treatment of linear problems. The participants are able to apply an appropriate finite element formulation to define and resolve independently questions from the linear elastostatics.

Description
The Finite Element Method (FEM) has become the standard tool in mechanics of materials. The lecture provides a brief introduction into the theoretical foundations of the method. The main part of the course consists of calculated exercises and practical problems to be worked on independently using a computer. Selected problems of mechanics of materials are solved using the FE software system Z88Aurora. Special emphasis is given to linear, static problems.

Kind of examination
Written examination (120 min)

Literature
Klein: FEM
Zienkiewicz: Methode der finiten Elemente. Hanser Verlag
Betten: Finite Elemente für Ingenieure 1. Grundlagen, Matrixmethoden, Elastisches Kontinuum. Springer
Module Name
Thermodynamics and Transport Phenomena

Course/Examination Name
Heat and Mass Transfer

Course Coordinator
Prof. Dr. rer. nat. Burak Atakan

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Teaching form
lecture with Powerpoint and transparencies
exercises in problem solving
materials and discussions in moodle

Learning objectives
The students will be able to decide, which mechanisms of heat and mass transfer will be important for a given situation. The students will be able to formulate the governing equations and decide if simplifications regarding dimensionality are possible and reasonable. Simple heat transfer problems can be solved using either similarity correlations, analytical solutions or numerical solutions. The analogy between heat and mass transfer will be thoroughly understood and heat exchangers calculations can be performed using the NTU method.

Description
The fundamentals of heat and mass transfer will be taught. Both being important in many technical processes within energy conversion and chemical engineering.
1. Introduction/Concepts
2. Conduction (stationary / instationary)
3. Diffusion
4. Convection (boundary layers, similarity, forced/free conv., flow around bodies, flow in channels)
5. Convection with phase change: boiling, condensation
6. Heat exchangers
7. Radiation

Kind of examination
written examination (120 min.)

Literature
Polifke, Kopitz, Wärmeübertragung, Pearson Studium, München 2005
## Module Name

**Computer Application in Material Technology**

## Module Coordinator

Prof. Dr. rer. nat. Johannes Gottschling

## Used in degree course

- Master Metallurgy and Metal Forming PO08

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Module Name
Computer Application in Material Technology

Course/Examination Name
Process Simulation in Metallurgy and Metal Forming

Course Coordinator
Prof. Dr. rer. nat. Johannes Gottschling

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Teaching form
Lecture: Presentation via interactive whiteboard
Exercise: working on small projects with PC using MATLAB

Learning objectives
The students are able to transfer metallurgical processes and processes of metal forming in simulateable models. Furthermore, they can analyze simulation results purposeful. They select appropriate mathematical methods and apply these in a proper way.

Description
Generation of simulateable process models, numerical methods for solving ordinary and partial differential equations, simulation of metallurgical processes and simulation of metal forming processes by means of suitable examples.

Kind of examination
Projectwork in groups (up to 4 students)

Literature
Skript zur Veranstaltung

Requirements
Numerik für Ingenieure
<table>
<thead>
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| Course Coordinator | Prof. Dr. rer. nat. Johannes Gottschling  
|                     | Dr.-Ing. Bernhardt Weyh                     |

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**Teaching form**

Laboratory

**Learning objectives**

The students are able to transfer the appropriate lecture topics and given problems to projects.

**Description**

Laboratory to the lecture Process Simulation in Metallurgy and Metal Forming. Transfer and consolidation of the acquired topics of the lecture.

**Kind of examination**

Technical discussion (individual)

**Literature**

Skript zur Vorlesung

**Requirements**

Computer Based Engineering Mathematics, Numerics for Engineers
# Module Name
Computer Application in Material Technology

# Course/Examination Name
Computer Application in Metallurgy and Metal Forming

# Course Coordinator
Prof. Dr.-Ing. Paul Josef Mauk  
Prof. Dr. rer. nat. Johannes Gottschling  
Dr.-Ing. Bernhardt Weyh  
Prof. Dr. Rüdiger Deike

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**Teaching form**
- Lecture: powerpoint presentation  
- Exercise: working on tasks with MATLAB on PC

**Learning objectives**
Students develop the ability to solve more complex numerical and analytical problems in the field of metallurgy and metal forming using existing software or software written by themselves.

**Description**
This course does not aim at the modelling, but gives a deeper insight into the use of computers in metallurgy and metal forming. For this purpose selected examples from the field of metallurgy and metal forming will be processed e.g. approximation of flow curves, conversion of models of rolling theories as well as working thermo-mechanic metal forming processes. The computerized course also deals with tools for data analysis, such as fuzzy technology and neural networks.

**Kind of examination**
Projectwork in groups (up to 4 Students)

**Literature**
.1 Script of the lecture
Module Name
Computer Application in Material Technology

Course/Examination Name
Vibration Analysis of Metallurgical Systems

Course Coordinator
Dr.-Ing. Bernhardt Weyh

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Teaching form
Lecture: powerpoint presentation
Exercise: working on tasks with MATLAB on PC

Learning objectives
- The students can apply analytic methods of linear and nonlinear concepts on elements of metallurgical systems/plants,
- know the symbolic processing and numeric conversion of the methods,
- know in particularly characteristics of continuous, discretized and discrete model structures as well as their coupling characteristics,
- are able to linearize overall systems,
- can formulate eigenvalue, initial value and boundary value problems and solve them with software tools (here for example in MATLAB),
- are able to interpret results with the typical vibration/oscillation phenomena.

Description
The lecture presents fundamental methods of the computer aided analysis of technical, often mechanical (multi-body) systems from the field of the metallurgical mechanical components, machines and systems/plants, where systematic procedures of the problem definition over the important aspects of the modeling up to the evaluation of the simulation results and their interpretation as well as specific basic approaches for a system improvement will be discussed.

The lecture introduces practical computing methods used for investigation/study of natural oscillations including stability and forced movements in dynamic systems. To illustrate the computation methods and the arising phenomena, selected examples from the field of the metallurgical machines and systems/plants will be compiled on PCs, visualized and discussed with the help of the programming surface MATLAB.

Kind of examination
Examination with duration of 120 minutes in German language.

Literature
Gasch/Knote: Strukturdynamik, Bd.1/2. Springer 1987/89
Holzweißig/Dresig: Maschinendynamik. Springer 2004
Spur/Stöferle: Handbuch der Fertigungstechnik, Bd.1/2. Carl Hanser ~1983
Lange,K. (Herausg.): Umformtechnik, Bd 1/2/... Springer ~1984

Requirements
Prozesssimulation in der Metallurgie und Umformtechnik
Methode der finiten Elemente 1
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Module Name
Advanced Material Science

Course/Examination Name
Metallography and Metallphysics

Course Coordinator
Dr.-Ing. Olga Myronova

Semester | Cycle | Language
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2 | SS | deutsch

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Teaching form
Lecture

Learning objectives
The students will receive an adequate knowledge of metallurgie and metal physics. The lecture provides knowledge of the influence of mechanical and physical interactions on the microstructure of materials. Based on this knowledge the students will be able to analyze metallurgical processes.

Description
The students will receive an adequate knowledge of the atomistic structure of solids and the crystallographic microstructure of metals. Crystallographic structures and their orientations will be calculated and the practical use will be explained. More information according to defects in crystallographic structures (i.e. vacancies, dislocations and grain boundaries) will be given. In the field of thermodynamic methods there will be an introduction to ternary phase diagrams with the aim to train the practical use of phase diagrams. Metallurgical mechanisms like diffusion, deformation and recrystallisation were discussed based on atomistic models. The lecture is closed by an explanation of the physical properties of metals (i.e. magnetism, thermal and electrical conductivity) based on an atomistic point of view.

Kind of examination
written examination 90 min.

Literature
Literaturempfehlung (Deutsch):

Literaturempfehlung (Englisch):

Requirements
Grundlagen der Metallkunde 1 und 2
Module Name
Advanced Material Science

Course/Examination Name
Metallography and Metallphysics Lab

Course Coordinator
Dr.-Ing. Olga Myronova

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Teaching form
Test performance in the laboratory

Learning objectives
The students will be able to understand the physical background of complex metallurgical processes on the basis of their own experiments.

Description
In small groups the students will receive the background of complex metallurgical processes. They learn to measure and to analyze these processes by means of special methods of materials analysis. With tutorial instruction they will carry out practical experiments by themselves

Kind of examination
Active participation

Literature
Macherauch; Praktikum Werkstoffkunde
G. Wassermann; Praktikum der Metallkunde und Werkstoffprüfung,
Hornbogen Warlimont: Praktikum der Metallkunde
**Module Name**
Advanced Material Science

**Course/Examination Name**
Heat Treatment of Metallic Materials

**Course Coordinator**
Prof. Dr.-Ing. Paul Josef Mauk  
Dr.-Ing. Olga Myronova

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**Teaching form**
Lecture, exercises, tutorials

**Learning objectives**
The student knows the heat treatment procedures of metallic materials. The student knows how a certain sequence of temperature and time influences the properties, their testing, and their scatter. He also knows the possible uncertainties and failures. The students can select the suitable heat treatment, the application and further developments of heat treatments.

**Description**
The characteristic properties of metallic materials are in many cases as part of the production process set by a controlled heat treatment. The lectures of “Heat Treatment of Metallic Materials” are the metallurgical fundamentals of heat treatment and the technological processes as well as the instrumental execution of heat treatment processes within the industrial production.
Beside the volume-oriented heat treatment process for hardening, precipitation and tempering the thermo and thermo-chemical heat treatment procedures are needed for surface hardening and/or surface treatment. An important part of the lectures forms the modern heat treatments for strip and plate materials for car building with continuous processing lines which are today state-of-the-art technology for car body manufacture.
Beside the technological principles the student is able to inspect the microstructure of heat-treated materials and to decide whether or not the results are in line with the given requirements. The theoretical bases of the heat treatment of metallic materials, obtained in the lecture, are deepened in exemplary lab tests.

**Kind of examination**
written examination 90 min.

**Literature**
Lidtke D.; Jönsson R.:  
Wärmebehandlung: Grundlagen und Anwendungen für Eisenwerkstoffe  
Kontakt & Studium, Band 349  
Expert-Verlag, Renningen bei Meimsheim, 1991

Kohtz, D.:  
Wärmebehandlung metallischer Werkstoffe: Grundlagen und Verfahren  
VDI-Verlag, Düsseldorf, 1994

De Cooman, B.C., Speer, J.G., Pyshmintsev, I.Yu., Yoshignaga, N.:  
Material Design - The Key to Modern Steel Products
Grips media GmbH, 2007

Lidtke, D.:  
Wärmebehandlung von Eisenwerkstoffen: Nitrieren und Nitrocarburieren  
3., völlig neu bearbeitete Auflage  
Kontakt & Studium, Expert-Verlag, Renningen, 2006

Werkstofftechnologie 1.  
Wärmebehandlungstechniken.  
Normen  
DIN Taschenbuch 218.  
Beuth Verlag, 2007

Schumann, H., Oettel, H.:  
Metallografie  
Module Name
Advanced Material Science

Course/Examination Name
Heat Treatment of Metallic Materials Lab

Course Coordinator
Dr.-Ing. Olga Myronova

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Teaching form
laboratory experiments

Learning objectives
The student is able to select the right heat treatment process for a given task and to determine the technological parameters for the process. He can examine the microstructure and the mechanical properties of the material and decide whether or not the results are in line with the required data.

Description
The theoretical bases of the heat treatment of metallic materials, obtained in the lecture, are deepened in exemplary lab tests, so that the students receive a deeper understanding of the metallurgical and technological connections during the heat treatment of metallic materials. Additionally they are in position to estimate the structure of metallic materials developed by the heat treatment and can evaluate to what extent after a heat treatment the structural condition of this material corresponds to the requirements, and whether heat treatment errors are present, that require appropriate quality-assurance measure.

Kind of examination
Internship report

Literature
W. Dahl u. a.: Werkstoffkunde Stahl, Band I +II
Verlag Stahleisen, Düsseldorf, 2002

G. Spur, Th. Stöferle, Herausg.: Handbuch der Fertigungstechnik, Band V: Wärmebehandlung
Hanser Verlag, München, 1998

H.J. Eckstein: Technologie der Wärmebehandlung von Stahl
Deutscher Verlag für Grundstoffindustrie, Stuttgart, 1997

V. Läpple: Wärmebehandlung des Stahls
Europa Verlag, Haan, 2006
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**Module Name**
Production Engineering

**Course/Examination Name**
Welding Technical Manufacturing Method

**Course Coordinator**
Prof. Dr.-Ing. Gerd Witt  
Dr.-Ing. Reinhard Christian Winkler

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**Teaching form**
Lecturing on the basis of powerpoint slides and videos. Theoretical and practical exercises.

**Learning objectives**
The students shall understand and use different welding technologies for industrial applications.

**Description**
This course give`s an overview of the most important welding techniques in their practical use. Thereby the advantages, disadvantages and the applications of the different welding processes- TIG-, Plasma-, Laser-, EB-, MMA-, SAW-, MIG/MAG-, Resistance- and Acetylene-Welding - were discussed. In the associated practical lab the students have the chance to improve some welding processes by themselves. Because of the reason that the SLV is the important welding trainer in Europe all technical an personal assumptions are given. A one visit trip to a welding manufacturer is finishing the course.

**Kind of examination**
Written examination, 60 minutes

**Literature**
SFI-Aktuell 2003 , SLV Duisburg  
Killing,R.: Kompendium der Schweißtechnik , DVS-Verlag Düsseldorf
Module Name
Production Engineering

Course/Examination Name
Welding Technical Manufacturing Method Lab

Course Coordinator
Prof. Dr.-Ing. Gerd Witt
Dr.-Ing. Reinhard Christian Winkler

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Teaching form
Practical demonstration of different welding methods

Learning objectives
The students shall get practical welding-experiences.

Description
Presenting of different welding technologies (laser, resistance welding, thermal spraying). Other welding methods (WIG-, MIG, autogenous) can be explored by oneself.

Kind of examination
test, experimental procedure

Literature
Praktikumsunterlagen
Module Name
Production Engineering

Course/Examination Name
Theory of Plasticity and Forming Mechanism

Course Coordinator
Prof. Dr.-Ing. Paul Josef Mauk

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Teaching form
Lectures, exercises, tutorials

Learning objectives
The students are able to use basic slab methods for calculation of forming processes as well as methods of higher plasticity.

Description
Content of the lecture are the calculation methods for metal forming processes. Based on the slab method hot and cold rolling is explained followed by advanced methods of plasticity as slip line theory and boundary methods.

Kind of examination
written examination ; 90 min

Literature
H. Pawelski, O. Pawelski
Technische Plastomechanik, Kompendium und Übungen
Verlag Stahleisen, Düsseldorf, 2000

A. R. Boer, N. Rebelo, H. Rydstad, G. Schröder
Process modelling of metal forming and thermomechanical treatment
Springer-Verlag, Berlin, 1986

W. Johnson, P. B. Mellor
Engineering plasticity
van Nostrand Reinhold Comp., London, 1978

R. Hill
The mathematical theory of plasticity
Oxford at the Clarendon Press, 1983

H. Ismar, O. Mahrenholtz
Technische Plastomechanik
Vieweg Verlag, Braunschweig, 1980

P. Hartley, I. Pillinger, C. Sturgess
Numerical Modelling of Material Deformation Processes
Springer-Verlag, London, 1992
G. W. Rowe, C.E.N. Sturgess, P. Hartley, I. Pillinger
Finite-Element Plasticity and Metal Forming Analysis

S. Kobayashi, S.-I. Oh, T. Altan
Metal Forming and the Finite-Element Method

D.R.J. Owen, E. Hinton
Finite Elements in Plasticity
Pineridge Press Ltd., Swansea, 1980
### Module Name
Production Engineering

### Course/Examination Name
Theory of Plasticity and Forming Mechanism Lab

### Course Coordinator
Prof. Dr.-Ing. Paul Josef Mauk

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### Teaching form
Laboratory experiments

### Learning objectives
The student is able to use basic slab methods for calculation of forming processes as well as methods of higher plasticity.

### Description
Content of the lab for the lecture are experiments on hot and cold rolling of flat and profile sections and the calculation methods. Based on the slab method hot and cold rolling is explained followed by advanced methods of plasticity as slip line theory and boundary methods.

### Kind of examination
test, experimental procedure

### Literature
- H. Pawelski, O. Pawelski
  Technische Plastomechanik, Kompendium und Übungen
  Verlag Stahleisen, Düsseldorf, 2000

- A. R. Boer, N. Rebelo, H. Rydstad, G. Schröder
  Process modelling of metal forming and thermomechanical treatment
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Pineridge Press Ltd., Swansea, 1980
**Module Name**
Metallurgical Technology

**Module Coordinator**
Prof. Dr. Rüdiger Deike

**Used in degree course**
- Master Metallurgy and Metal Forming PO08

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Module Name
Metallurgical Technology

Course/Examination Name
Casting and Solidification of Steel

Course Coordinator
Prof. Dr. Rüdiger Deike

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Teaching form
Lecture, Overheadprojection, Powerpoint

Learning objectives
The students are able to describe the principles of solidification in general and they are able to transform this knowledge on continuous casting processes. The students are qualified to evaluate the influence of casting velocities, segregation, microstructures and mechanical strand deformation on the quality of steel products. On that basis students are able to analyse failures in continuous casting processes.

Description
In this lecture the important items of homogeneous and heterogeneous nucleation, different kinds of crystal growth and the principles of constitutional supercooling are presented. The importance of the oxidic cleanliness, the formation of micro- and macrosegregation and resulting concentration profiles are explained in detail. Different causes of crackformation are discussed in dependance on casting velocities, heat transfer conditions in the ingot mould and solidification rates. Different possibilities (construction of continous casting machines, electromagnetic stirring and so on) to improve the metallurgical cleanliness of steels are presented.

Kind of examination
Written examination, duration 90 min

Literature
Flemings, M.C.: Solidification Processing

Chalmers, B. : Principles of Solidification

Schwerdtfeger, K. (Hrsg.): Metallurgie des Stranggießens
Verlag Stahleisen mbH, Düsseldorf 1991

Requirements
Analysis, Differentialgleichungen, Physikalische Chemie
Module Name
Metallurgical Technology

Course/Examination Name
Recycling of Oxidic and Metallic Materials

Course Coordinator
Prof. Dr. Rüdiger Deike

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Teaching form
Lecture, Overheadprojection, Powerpoint

Learning objectives
The students are able to understand and to evaluate the problems that do exist, if waste oxides in comparison to metallic waste materials are recycled. The students are qualified to describe the different requests that must be fulfilled, if recycling processes should run successful under economic and ecological conditions.

Description
Raw material and energy productivity are important items for future developments. The changes in non-sustainable raw material markets for the production of metals are discussed under technical and economic aspects. The composition and the produced tonnages of typical waste materials from the iron and steel industry and the processes to extract valuable raw materials from waste materials are described. The lecture focuses on the metallurgical problems of the mainly high temperature processes.

Kind of examination
Written examination, duration 90 min

Literature

Schlacken in der Metallurgie, GDMB Gesellschaft für Bergbau, Metallurgie, Rohstoff- und Umwelttechnik, Clausthal-Zellerfeld 1999

Koch, K.; Janke, D.: Schlacken in der Metallurgie, Verlag Stahleisen GmbH, 1984,


Richardson, F.D.: Physical Chemistry of Melts in Metallurgy (Vol 1 and 2) Academic Press, London and New York, 1974

Requirements
Analysis, Chemie, Physikalische Chemie
### Module Name
Metallurgical Technology

### Course/Examination Name
Recycling of Oxidic and Metallic Materials Lab

### Course Coordinator
Prof. Dr. Rüdiger Deike

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### Teaching form
Practical training

### Learning objectives
The students are able to decide, which different ways must be taken to recycle oxidic and metallic waste materials to get back the valuable elements.

### Description
In a practical training fundamental experiments are done to recycle oxidic and metallic waste materials. Mixtures of these materials are prepared with mechanical and magnetic methods. Afterwards the fraction with the valuable content is agglomerated and reduced under varying temperature conditions and different gas compositions. Final phases are identified by metallographic methods and SEM.

### Kind of examination
oral exam

### Literature
siehe Recycling oxidischer und metallischer Werkstoffe

### Requirements
Recycling oxidischer und metallischer Werkstoffe
Module Name
Electives Module

Module Coordinator
NN

Used in degree course
- Master Computer Engineering PO04
- Master Computer Science and Communications Engineering PO04
- Master Control and Information Systems PO04
- Master Electrical and Electronic Engineering (Communications Engineering) PO04
- Master Electrical and Electronic Engineering (Power and Automation) PO04
- Master Mechanical Engineering (Water Resources and Environmental Engineering) PO04
- Master Mechanical Engineering (Production and Logistics) PO04
- Master Mechanical Engineering (Mechatronics) PO04
- Master Mechanical Engineering (General Mechanical Engineering) PO04
- Master Management and Technology of Water and Waste Water PO08
- Master Automation and Control Engineering PO08
- Master Electrical and Electronic Engineering (Communications Engineering) PO08
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- Master Computer Science and Communications Engineering PO08
- Master Mechanical Engineering (Energy and Environmental Engineering) PO08
- Master Metallurgy and Metal Forming PO08
- Master Mechanical Engineering (General Mechanical Engineering) PO08
- Master Mechanical Engineering (Mechatronics) PO08
- Master Mechanical Engineering (Production and Logistics) PO08

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### Module Name

Electives Module

### Course/Examination Name

Elective 1

### Course Coordinator

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### Teaching form

#### Learning objectives

With a targeted choice of the elective subjects, the students should follow their affinities and qualify themselves for a job resp. for an academic career.

#### Description

The electives module should give the students the opportunity to expand the focus of their study program and of their specialization. By so doing, the deepness of the disciplinary education becomes more important. This can be on one hand very precious for a clearly defined professional use but on the other hand a door-opening to a scientific research (PhD) consecutive to the master degree. Alternatively, other subjects, which are relevant of other study fields of the Faculty of Engineering or which belong to other specializations, could also be chosen. In this way, interdisciplinary abilities, which are considerably important in the professional world in the sense of double qualifications, could be acquired.

#### Kind of examination

According to the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts.

#### Literature
**Module Name**
Electives Module

**Course/Examination Name**
Elective 2

**Course Coordinator**
NN

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**Teaching form**

**Learning objectives**
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**Kind of examination**
According to the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts.

**Literature**
### Module Name

Electives Module

### Course/Examination Name

**Elective 3**

### Course Coordinator

NN

### Semester | Cycle | Language
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3 | | deutsch/englisch

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### Teaching form

### Learning objectives

With a targeted choice of the elective subjects, the students should follow their affinities and qualify themselves for a job resp. for an academic career.

### Description

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Non-technical Subjects M

### Course/Examination Name
Non-technical Catalog M

### Course Coordinator
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### Teaching form
The type of instruction depends on the chosen course.

### Learning objectives
The module aims at deepening the general knowledge of the students and resp. at improving their language skills as well as strengthening their professional qualifications through the learning of teamwork and expose techniques.

### Description
This module offers the students the opportunity to, besides the pure technical courses they take, attend some so called “non-technical subjects” and latter provide an attest for them. These courses can be chosen from the overall offers of the Duisburg-Essen university, whereby the “Institut für Optionale Studien“(IOS) proposes a catalog containing courses which fall under the named supplementary area.

### Kind of examination
The type and duration of the examination will be defined from the lecturer before the semester starts.

### Literature
Spezifisch für das gewählte Thema
### Module Name

**Master-Thesis**

### Module Coordinator

NN

### Used in degree course

- Master Computational Mechanics PO07
- Master Management and Technology of Water and Waste Water PO08
- Master Automation and Control Engineering PO08
- Master Electrical and Electronic Engineering (Communications Engineering) PO08
- Master Electrical and Electronic Engineering (Power and Automation) PO08
- Master Computer Engineering (Reliable Systems) PO08
- Master Computer Engineering (Interactive Systems and Visualization) PO08
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- Master Mechanical Engineering (Energy and Environmental Engineering) PO08
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Module Name
Master-Thesis

Course/Examination Name
Master Thesis

Course Coordinator
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Teaching form
Master Thesis
6 month
including a colloquium

Learning objectives
The master thesis is used to show that a student is capable of processing a problem from the corresponding field of engineering sciences autonomously and with scientific methods and presenting it comprehensibly, within a given period of time.

Description
The master thesis is an examination paper which concludes the scientific education in every master degree course within the academic program ISE. Within the colloquium the students will present intermediate and final results of their master thesis and will also participate in discussions of other thesis projects.

Kind of examination
A master thesis can be topically assigned without restrictions somewhere inside the faculty of engineering sciences. The processing time for a master thesis amounts to six months. The master thesis has to be drafted in German or English language and three hardcopies have to be handed in to the examination committee in time. The hardcopies have to be in DIN A4 format and they have to be bound. The master thesis shall normally consist out of 40 to 60 pages.

Literature
### Module Name
Master-Thesis

### Course/Examination Name
Master Thesis Colloquium

### Course Coordinator
NN

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### Teaching form
Presentation and discussion of the master thesis.

### Learning objectives
The aim of the colloquium is to bring the students to be able to present the intermediate and final results of their work within a given length of time in a reasonable way.

### Description
In the course of the accompanying colloquium, the students present the intermediate and final results of their master thesis and likewise take part in the discussions on other presented master thesis.

### Kind of examination
Assessment of the master thesis together with the presentation of the colloquium.

### Literature
Imprint

University of Duisburg Essen
Faculty of Engineering
Coordinator: Prof. Dr.-Ing. Paul Josef Mauk
Street: Forsthausweg 2
City: 47057 Duisburg
Phone: 0203 379-3462
Fax: 0203 379 3464
E-mail: profmaukgmu@aol.com

Legally binding is only the exam regulation.

Legend

WS  Winter Semester
SS  Summer Semester
SWS Contact hours per week
Cr.  Credits
V  Lecture
Ü  Exercise
P  Laboratory
S  Seminar
d  German
e  English