Fakultät Technologie und Bionik
Faculty of Technology and Bionics

HOCHSCHULE RHEIN-WAAL
Rhine-Waal University of Applied Sciences

Module Description

of the study course

„Biomaterials Science B.Sc.“

Rev. 1. Stand 18.03.2014

Contents

Module “Chemistry of Materials"

Module name:	Chemistry of Materials
Module code:	BM_1
Courses (where applicable):	Physical Chemistry Inorganic Chemistry
Semester:	1st Semester
Module coordinator:	Prof. Dr. Neil Shirtcliffe
Lecturer:	Prof. Dr. Neil Shirtcliffe Prof. Dr. Amir Fahmi
Language:	English
Place in curriculum	Core subject
Timetabled hours:	Physical Chemistry: Lecture: 2 SWS Exercise 1 SWS Laboratory: 1 SWS Inorganic Chemistry: Lecture: 2 SWS Exercise 1 SWS Laboratory: 1 SWS
Workload:	120 h Attendance 30 h Self-study 30 h Exam preparation
Credits:	6
Recommended prerequisites:	N/A
Module objectives:	Physical Chemistry: Students will be able to: • Use concepts and terms from general chemistry correctly. • Sketch simple inorganic reactions with equation and structure. • Recognise the basics of physical chemistry; kinetics; thermodynamics; chemical potential; equilibria; oxidation. • Carry our safely simple laboratory processes • Analyse and present data measured in experiments.

	Inorganic Chemistry Students will be able to: • Describe the basic chemistry of the elements. • Recognise periodic trends vertically and horizontally on the periodic table • Describe the use of inorganic materials, especially in medicine. • Explain the hazards of inorganic chemicals • Describe the role of inorganic chemicals in biology
Content:	Physical Chemistry: • Material Structure Atoms, Elements and bonding Types of chemical bond • Chemical equilibria • Acids and bases pH strong and weak acids and bases • Redox reactions Oxidation and reduction redox equations corrosion • Electrochemistry Standard electrode potentials Electrolysis and batteries Introduction to chemical thermodynamics Introduction to Kinetics • Reaction rate • Rate laws • Enzme kinetics Spectroscopy • basics • basic quantum mechanics • optical spectroscopy Inorganic Chemistry Hydrogen, oxygen and waterWasserstoff, Sauerstoff und Wasser • production and reactions • Isotopes and their effects • Hydrogen bonding • Water as a solvent Main Group Elements • Alkali metals: production, reactions

	• Alkali metals: Na/K-Pumps • Alkaline Earths: production and reactions • Alkaline Earths: Biomineralisation • Boron Group: • Boron group semiconductors • Group IV : production, reactions • Group V: production, reactions • Group V Toxicity, other biological effects • Group VI: production, reactions • Halogens: production, reactions • Halogens: Acids and others • Noble Gases : production, reactions Transition Metals • Production, reactions • Metal complexes • General Trends in the d-block Crystal Structure • Basic Crystal Lattices • Spectroscopy on crystals
Assessment:	Exam/Lab reports
Forms of media:	Board/Projector/Laboratory
Literature:	Grundlagen der Chemie: John E. McMurry, Robert C. Fay: General Chemistry: Atoms First, Prentice Hall; 2009 Peter Atkins, Julio de Paula, Physical Chemistry for the Life Sciences, 2nd ed. Oxford University Press, 2011 John E. McMurry, Robert C. Fay: General Chemistry: Atoms First, Prentice Hall; 2009 Charles E. Mortimer, Ulrich Müller: Chemie, 10.Auflage Thieme; 2010 Geoffrey Alan Lawrance: Introduction to Coordination Chemistry François Mathey, Alain Sevin: Molecular Chemistry of the Transition Elements: An Introductory Course F. Albert Cotton , Carlos A. Murillo , Manfred Bochmann , Russell N. Grimes: Advanced Inorganic Chemistry, 6th Edition

Module „Sustainable Design“

Module name:	Sustainable Design
Module code:	BM_2
Courses (where applicable):	Ecology of Materials Fundamentals of Design
Study Semester:	1st Semester
Module Coordinator:	Prof. Dr.-Ing. Peter Kisters
Lecturers:	Prof. Dr.-Ing. Peter Kisters Prof. Dr. Matthias Kleinke
Language:	English
Place in Curriculum	Core Subject
Timetabled hours:	Ecology of Materials: Lecture: 2 SWS Fundamentals of Design Lecture: 2 SWS Exercise: 1 SWS
Workload:	75 h Attendance 45 h Self-study 30 h Exam preparation
Credit Points:	5
Recommended Prerequisits :	Non
Module objectives:	Ecology of Materials: • The students are able to identifiy ecological aspects fort he design of substances and materials. Furthermore they are able to allocate material properties and applicability for the materials. • They have knowledge about the ecological compartibility for different materials. • The students are aware that the knowledge of the material properties is decisive for the selection of an appropriate one from the range of materials. • They are able to ecologically evaluate a bio product Fundamentals of Design: After passing the course the students are able to • read technical drawings, • communicate with other technicians the contents of

	the drawing, • identify machine elements and explain their basic functions, • understand the general function of a given machine or tool, • analyse technical demands and structure them, • find technical solutions based on a function oriented structuring of the task, • evaluate the solutions in order to find the best for a given target • describe the design process process and analyse influences on the progress • communicate to marketing, design, production und operation departments in order to improve the design process of a product.

Content:	Ecology of materials:
	• Ecological basics for the design with materials and substances
	• Overview of industrial application of substances with regard to the “objects of protection” air, water, soil
	• Handling harmfull substances
	• Methods for pollution-free environment
	• Basics of product and product-integrated environmental protection
	• Basics of recycling management and ist application
	• Ecological consequences when using different substances / materials
	
	Fundamentals of Design:
	• Basics of Engineering drawing for technical products
	• Function and design for basic machine elements
	• The Design methodology according VDI 2220
	  • Analysis of requirements and demands for technical products
	  • Generation of a function structure for technical products under consideration of energy, signal and material flow
	  • Solution search and evaluation based on demands and requirements
	  • Combination of solutions for sub-functions to a product
	  • Design and calculation of products
	• Cost consideration during design, importance and potentials
	• communication und documentation of design processes

Assessment:	Written or oral exam
Forms of media	White board, PowerPoint, Presentation
Literature:	Ecology of materials: Matthias Bank: Basiswissen Umwelttechnik: Wasser, Luft, Abfall, Lärm und Umweltrecht Karl Schwister: Taschenbuch der Umwelttechnik Fundamentals of Designs: Cecil Jensen, Jay D. Helsel, Dennis R. Short: Engineering Drawing & Design, 7th revised edition, McGraw-Hill Higher Education, 2007 Richard G. Budynas: Shigley's Mechanical Engineering Design, Student international edition, 8th revised edition, ISBN 978-0071268967, McGraw-Hill College, 2009 Course materials from the lecturer Exercises from the lecturer Lecture notes compiled by class (open source)

Module „Mathematics and IT“

Module name:	Mathematics and IT
Module code:	BM_3
Courses (where applicable):	Introductory Mathematics Computer Based Engineering Tools
Semester:	1st Semester
Module coordinator:	Prof. Dr. Achim Kehrein
Lecturer:	Prof. Dr.-Ing. Stefanie Dederichs Prof. Dr. Matthias Krauledat
Language:	English
Part in Curriculum:	Core Subject
Timetabled hours	Introductory Mathematics: Lecture: 2 SWS Exercise: 2 SWS Computer Based Engineering Tools: Laboratory: 2 SWS
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Elementary algebra, exponential and logarithmic function, Trigonometry (cf. [1]: Chapter 1 – 8 and preparatory course „Mathematics for engineers“)
Module objectives:	Introductory Mathematics: The students are able to acquire knowledge in different ways and organize their study. The students know fundamental mathematical concepts and approaches, especially differentiation and its applications as well as the possibilities of visualizing mathematical expressions. After studying the module, the students possess the ability of exact thinking, working and presenting and have the feeling of handling numbers. They are able to find solutions independently and validate them. They are able to apply computational and graphical solution approaches for different tasks and interpret mathematical formulas. The students are familiar with not only standard methods but also

	the strategies of solving problems. Computer Based Engineering Tools: The students learn Matlab and the basics of programming. They are able to carry out complex calculations in the future study with the help of Matlab. They are able to implement and test simple mathematical algorithms.
Content:	Introductory Mathematics: • Numbers: irrational numbers and the problem in calculation with pocket calculator or computer, Heron-approach as an example of iterative algorithms – calculation till the desired accuracy, complex numbers in rectangular and polar forms, complex roots, the fundamental theorem of algebra • Systems of equations: Gaussian elimination approach • Vectors and spaces: linear combination, dot product, cross product, lines and planes in a space • Limits: definition, limit laws, continuity, Bisection algorithm • Differentiation: definition of derivatives, differentiation rules, tangent, Newton approach, monotonicity and concavity • Integration: inverse process of differentiation – indefinite Integral, Calculation of areas – definite integral, the fundamental theorem of calculus Computer Based Engineering Tools: • MATLAB commands und plots • MATLAB program structures (m-files): script and function • Basic program structures: branching, loop
Assessment	Introductory Mathematics: Written examination Computer Based Engineering Tools: Attestation
Forms of media:	Board, PowerPoint, Projector
Literature:	James Stewart, Lothar Redlin, Saleem Watson (2012). Algebra and Trigonometry. 3rd international Edition. Brooks/Cole James Stewart (2008). Calculus – Early Transcendentals. Metric International Version. 6th Edition. Brooks/Cole Gilbert Strang (2006). Linear Algebra and Its Applications. 4th Edition. Brooks/Cole (Video lectures available under http://www.mit.edu -> OpenCourseWare) Gilbert Strang (2010). Wissenschaftliches Rechnen.

	Springer (Video lectures Computational Science and Engineering available under http://www.mit.edu -> OpenCourseWare) Daniel Kaplan (2004). Introduction to Scientific Computation and Programming. Brooks/Cole Stormy Attaway (2012). MATLAB – A Practical Introduction to Programming and Problem Solving. 2nd Edition. Butterworth-Heinemann. Cleve Moler (2004). Numerical Computing with MATLAB. Society of Industrial and Applied Mathematics. (available under http://www.mathworks.de/moler/index_ncm.html) George Polya (2004). How to solve it: A New Aspect of Mathematical Method. Princeton University Press

Module “Business Economics and Project Management”

Module name:	Business Economics and Project Management
Module code:	BM_4
Courses (where applicable):	Cross-Cultural Management Project Management Business Economics and Marketing
Semester:	1st semester
Module coordinator:	Prof. Dr.-Ing. Dirk Untiedt
Lecturer:	Prof. Dr.-Ing. Ivan Volosyak Prof. Dr.-Ing. Dirk Untiedt Prof. Dr. D. Berndsen
Language:	English
Place in curriculum	Core subject
Timtabled hours	Cross-Cultural Management: Lecture: 2 SWS Project Management: Lecture: 1 SWS Exercise: 1 SWS Business Economics and Marketing: Lectures: 2 SWS
Workload:	90 h attendance 45 h Self-study 45 h Exam preparation
Credits:	6
Recommended prerequi-sites:	
Module objectives:	Cross-Cultural Management: Students know different cultures and ways of living and acting successfully in different social surroundings. Through this course, they are able to define their own cultural situation, to recognise the defining elements of other cultures, and to develop a familiarity with different cultures. The goal is to develop the student‘s ability to evaluate his own and public images and to commit to corresponding interactive perception and action. Project Management:

	After finishing this module, students will appreciate the need for project planning and are able to distinguish between project objectives and functional goals. They are able to define and document the objectives of a project. Depending on the type of project, they are able to design a suitable project structure and plan of execution. They are able to estimate project risks using a set of tools to analyse the project execution based on time and content and to communicate and document results by creating informative target group oriented presentations. After finishing the module, students are able to bring forward arguments, using core terms of business economics. They can assess investment plans regarding advantageousness and know how to distinguish between different forms of financing. Furthermore, students have profound basic knowledge of marketing. They are able to classify and structure marketing issues and to make business decisions. They know and are able to apply methods and instruments for issues relevant to marketing.
Content:	Course Cross-Cultural Management: • Cultures and their key aspects • Cultural identity and history • Globalisation of markets and economies • Negotiations in these situations • Development of a culture-related, management-oriented and socio-cultural behaviour settings • Living successfully in new and strange cultures • Discovering styles, fashions and scenes in different cultures • Copybook descriptions and methods Course Project Management: Projects as a modern form of working • Comparison of Project and Line Management • Challenges of Project Management Differentiation and contents of projects • Project phases • Developing project objectives (SMART) • Documentation: brief description of the project, project proposal Project organisation • Embedding projects in existing organisations • Typical project organisation form • Role descriptions of project committees Stakeholder Management

	• Analysis of influence and demand • Developing a strategy and action plan for targeted contact Project Planning • Milestones and activities • Project structure plan Network Techniques • Critical Path Method (CPM) • Programme Evaluation and Review Technique (PERT) Risk Management • Strategies for handling risks • Continuous risk assessment • Change Management within the project Project Documentation and Reports • Reports for different recipients • Planning of project meetings • Handling expectations Course Business Economics and Marketing: The module covers basic questions and methods of business economics and operational areas of activity. For example, overlapping subjects relating to investment and finance decisions in the company will also be looked at in depth. It includes a basic introduction to marketing. In particular, the relationship between sales and marketing will be deepened. Furthermore, aspects of strategic and operational marketing are considered and specific marketing objectives are analysed. Essential methods and Instruments of marketing are conveyed.
Assessment.	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Cross Cultural Management: Fred E. Jandt: An Introduction to Intercultural Communication (7th Edition), Sage Publications, 2013 Craig Storti: Cross-Cultural Dialogues: 74 Brief Encounters with Cultural Difference, Nicholas Brealey Publishing, 1994. Patrick L. Schmidt: In search of Intercultural Understanding, Meridian World Press, 2007 Sylvia Schroll-Machl: Doing Business with Germans, Vandenhoeck & Ruprecht, 2013 Marie-Joelle Browaeys: Understanding Cross-Cultural

	Management (2nd Edition), Pearson Education, 2011. Project Management: Standard: DIN 59901 J. Kuster, E. Huber et al.: Handbuch Projektmanagement (Guide to Project Management), Springer-Verlag, 2008 ISBN 978-3-540-7632-8 P. Clements/Jack Gido: Effective Project Management. Thomson South-Western, 2006. Rory Burke: Project Management. James 4th edition, John Wiley & Sons, 2003 Erling S. Andersen/Kristoffer V. Grude/Tor Haug: Goal Directed Project Management. 3rd ed., Kogan Page, London, 2004 International Project Management Association (www.ipma.ch) Project Management Institute (www.pmi.org): Project Management Body of Knowledge (PMBok) GPM Deutsche Gesellschaft für Projektmanagement (German Project Management society) (www.gpm-ipma.de) Business Economics and Marketing: Horváth, Peter: Controlling. 11th edition, Franz Vahlen, Munich, 2009 Kotler, Ph.: Armstrong, G.; Wong, V.; Saunders, J.: Principles of Marketing. 5th European edition, Pearson Education, 2008 Schierenbeck, H.; Wöhle, C. B.: Grundzüge der Betriebswirtschaftslehre (Basics of Business Economics), 17th ed., Munich/Vienna 2008 Wöhe, G.: Einführung in die Allgemeine Betriebswirtschaftslehre (Introduction to General Business Economics), 24th ed., Munich 2010

	Dias, L.P./Shah, A. J.: Introduction to Business, Boston et al. 2009 Nickels, W. G.; McHugh, J.M.; McHugh, S.M.: Understanding Business, 8th ed., Boston et al. 2008 Madura, J.: Introduction to Business, 4th ed., Mason 2007 McLaney, E.; Atrill, P.: Accounting: An Introduction, 5th ed., Harlow et al. 2010 Pride, W.M.; Hughes, R.J.; Kapoor, J.R.: Introduction to Business, 11th ed., Australia et al. 2010 O´Sullivan; Sheffrin; Perez: Microenonomics - Principles, Applications, and Tools. 6th edition, Pearson Education, Inc. Publishing as Prentice Hall, 2010

Module „Fundamentals of physics“

Module name:	Fundamentals of Physics
Module code:	BM_5
Courses (where applicable):	
Semester:	1st Semester
Module coordinator:	Prof. Dr. Georg Bastian
Lecturer:	Prof. Dr. Georg Bastian Prof. Dr. Alexander Struck
Language:	English
Place in curriculum:	Core Subject
Timetabled hours:	Lecture: 2 SWS Exercise : 1 SWS Laboratory: 1 SWS
Workload:	60 h presence 60 h preparation and wrap-up 30 h exam preparation
Credits:	5
Recommended prerequisites:	None
Module objectives:	• Students can understand and explain technical and scientific phenomena on the basis of their aquired theoretical knowledge. • The connection between theory and practical applications is recognized. • Students are able to approach and solve new kinds of problems with the learned methods. • Presentation of own results in exercise classes and lab reports can be done with proper terminology in digital form and English language.
Content:	• Physical units, measurement errors • Mechanics and kinematics • Oscillations and waves • Optics
Assessment:	Written exam, lab reports (attestation)
Forms of media:	Whiteboard, PowerPoint, projector
Literature:	Fundamentals of Physics: Paul A. Tipler: Physics for Scientists and Engineers, Freeman, 2008

Module „Applied Mathematics“

Module name:	Applied Mathematics
Module code	BM_6
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr. Achim Kehrein
Lecturer:	Prof. Dr.-Ing. Stefanie Dederichs
Language:	English
Place in curriculum	Core subject
Timetabled hours	Lecture: 2 SWS Exercise: 2 SWS
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	Introductory Mathematics
Module objectives:	The students are able to apply advanced mathematical concepts and methods and especially handle multivariable functions. They are able to carry out modeling with the help of differential equations. The students train their general social competences in the framework of group work. Their ability to communicate with the help of exact mathematical formulations will be trained. By doing homework the students will further develop their problem- solving thinking.
Content:	• Integration: Substitution rule, integration by parts, partial fraction decomposition, improper integrals • Series: Taylor series, approximation by partial sums, numerical aspects • Differentiation of multivariable functions: partial differentiation, gradient, maximum and minimum values • Ordinary differential equations: direction fields, separation of variables, first-order and second-order linear differential equations • Linear algebra: matrices, determinant, inverse matrix

Assessment:	Written examination
Forms of media:	Board, PowerPoint, Projector
Literature:	James Stewart (2008): Calculus – Early Transcendentals. Metric International Version. 6th Edition. Brooks/Cole Gilbert Strang (2006): Linear Algebra and 1st Applications. 4th Edition. Brooks/Cole (Video lectures available under http://www.mit.edu -> OpenCourseWare [or through iTunes U]) Arthur Mattuck: Differential Equations. Videos of a lecture at MIT, http://www.mit.edu -> OpenCourseWare [or through iTunes U]

Module „Fundamentals of Biomechanics“

Module name:	Fundamentals of Biomechanics
Modul code	BM_7
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. Henning Schütte
Lecturer:	Prof. Dr.-Ing. Henning Schütte
Language:	englisch
Place in curriculum:	Core subject
Timetabled hours:	Lecture: 2 SWS Excercise: 1 SWS
Workload:	45 h attendance 45 h self-study 30 h exam preparation
Credits:	4
Recommended prerequisites:	Introductoy Mathematics Fundamentals of Physics
Module objectives:	The students are able to analyse simple biomechanical systems for the flux of forces, bearing forces and deformations. They are able to analyise the mechanical strength of parts of a mechanical system. Furthermore they are able to analysie the behaviour of dynamical systems, e.g. sportmechanical systems.
Content:	• Graphical methods of statics • Central systems of forces • General systems of forces • Free-body fiagrams • Translation and rotation in the plane • Concept of stress • Deformation and strength of bodies • Tension rods • Material properties of bodies • Beding of beams • Principle of tension wiring • Fundamental principles of muscoloscelletal biomechanics • Bone structure as lightweight construction
Assessment:	Exam

Forms of media	Board, Power Point, projector
Literature:	• Brinkmann P., Frobin W., Leiveseth G., Musculoskeletal Biomechanics, 2002, Thieme • Kerr A., Introdutory Biomechanics, 2010, Churchill Livingstone • Fung, Y.C., Biomechanics: Motion, Flow, Stress and Growth, 1990, Springer • Fung, Y.C., Biomechanics: Mechanical Properties of Living Tissues, 1993, Springer • Beer & Johnston Statics and Mechanics of Materials, 2011, McGraw Hill • Meriam, J.L. & Kraige,L.G.: Engineering Mecahnics: Statics 7th ed., Wiley, 2012 • Meriam & Kraige, Dynamics 7th ed., Wiley, 2012

Module “Advanced Chemistry”

Module name:	Advanced Chemistry
Module code:	BM_8
Courses (where applicable):	Organic Chemistry Chemical Thermodynamics
Semester:	2nd semester
Module coordinator:	Prof. Dr. Neil Shirtcliffe
Lecturer:	Prof. Dr. Neil Shirtcliffe Prof. Dr.-Ing. Joachim Gebel
Language:	English
Place in curriculum:	Core subject
Timetabled hours:	Organic Chemistry Lectures: 1 SWS Exercises: 1 SWS Laboratory: 1 SWS Chemical Thermodynamics Lectures: 2 SWS Exercises: 1 SWS Practical Training: 1 SWS
Workload:	105 h attendance 35 h preparation and review 40 h exam preparation
Credits:	6
Recommended prerequisites:	Chemistry of materials Mathematics and IT Fundamentals of Natural Science Applied Mathematics
Module objectives:	Organic Chemistry Students will be able to: • Use the concepts and language of organic chemistry • Sketch simple organic chemical reaction mechanisms • Understand the importance of organic chemistry to daily life • To plan and carry out organic synthesis in a labora-

	tory in a safe manner. Chemical Thermodynamics Students know the terminology of intensive and extensive state variables (temperature, pressure, specific volume, density or enthalpy, entropy, exergy and anergy) and are able to apply them correspondingly. They are able to apply the first and second law of thermodynamics for solving thermodynamic problems and are able to analyse thermodynamic cycles. They know how to apply the relevant equations for chemical equilibrium to thermodynamic systems. They know what “Gibbs free energy” means and how to use this concept. In the laboratory framework, students learn how to measure temperature and pressure, how a boiling curve can be determined with a Marcet boiler, and how an ideal gas behaves under different conditions. They learn how to operate thermodynamic plants such as steam engines, hot air engines (Stirling motor) and heat pumps, especially with regard to valid safety standards.
Content:	Organic Chemistry Functional Groups in Organic Chemistry • Alkanes, alkese and alkynes • Aromatic groups • Halocarbons • Alcohols, Phenols and thiols • Ether and Epoxy groups • Aldehydes and Ketones • Carboxylic acids and their derivatives • Amines and other nitrogen groups • Heterocycles • Some metalloorganics Stereochemistry • Types of isomer • Optical Isomers Organic reactions and their mechanisms • Radical substitution • Nukleophilic Substitution SN1 and 2 • Elimination • Addition to double bonds • Substitution to aromatics • Oxidation and Reduction

	• Reaction of carbonyls and analogues Laboratory • Cleaning • Simple Synthesis • Basic analysis Chemical Thermodynamics Based on a detailed elaboration of the fundamentals of thermodynamics, the first and second law of thermo-dynamics will be introduced. This offers the requisite knowledge to be able to deal with thermodynamic pro-cesses – vapour and gas power systems, refrigeration and heat pump systems, reacting mixtures and com-bustion. In detail, the module contains the following: 1. General fundamentals 1.1 System and system limits 1.2 State and state variables 1.3 Process and change of state 1.4 Evaluating properties 2. First law of thermodynamics 2.1 Work and heat 2.2 Conservation of energy for a control volume 2.3 First law for steady-state flow processes 3. Second law of thermodynamics 3.1 Second law for closed systems 3.2 Entropy as state variable 3.3 Anergy and exergy 4. Gas power systems 4.1 Fuels and combustion equations 4.2 Heat value and fuel value 4.3 Molar enthalpies of reaction and formation 4.4 Ordinary gas turbine plant 5. Vapour power systems 5.1 Transformation of primary energy into electric energy 5.2 Conventional thermal power plants 5.3 Steam power plants 6. Reacting Mixtures and Combustion 6.1 Conservation of energy for reacting systems 6.2 Fuel cells

	7. Chemical equilibrium 7.1 Equation for reaction equilibrium 7.2 Calculating equilibrium compositions
Assessment:	Written examination, Lab reports
Forms of media:	Whiteboard, PowerPoint, Projector, Tablet
Literature:	Organic Chemistry John E. McMurry: Organic Chemistry 8th Ed. Brooks/Cole; 2011 David J, Hart, Christopher M. Hadad, Lesli E. Craine, Harold Hart: Organic Chemistry 13th Ed. Brooks/Cole; 2011 Brian S, Furniss, Antony, J. Hannaford, Peter W. G. Smith, Austin R. Tatchell: Vogel's Textbook of Practical Organic Chemistry, 5th ed. Pearson, 1989 John E. McMurry, Robert C. Fay: General Chemistry: Atoms First, Prentice Hall; 2009 Charles E. Mortimer, Ulrich Müller: Chemie, 10.Auflage Thieme; 2010 Geoffrey Alan Lawrance: Introduction to Coordination Chemistry François Mathey, Alain Sevin: Molecular Chemistry of the Transition Elements: An Introductory Course F. Albert Cotton , Carlos A. Murillo , Manfred Bochmann Russell N. Grimes: Advanced Inorganic Chemistry, 6th Edition Chemical Thermodynamics Michael J. Moran, Howard Shapiro: Fundamentals of Engineering Thermodynamics, SI-Version, ISBN 978-0-470-54019-0 Robert Balmer: Modern Engineering Thermodynamics, ISBN 978-0-12-374996-3 Yunus A. Cengel, Michael A. Boles: Thermodynamics An Engineering Approach: 7thedition in SI-Units, ISBN 978-007-131111-3

	Claus Borgnakke, Robert E. Sonntag: Fundamentals of Thermodynamics, International Student Version, 7th edition, ISBN 978-0-470-17157-8

Module „IT-Programming“

Module name:	IT-Programming
Module code:	BM_9
Courses (where applicable):	IT-Programming
Semester:	2nd Semester
Module coordinator:	Prof. Dr. Alexander Struck
Lecturer:	Prof. Dr. Alexander Struck Prof. Dr. Matthias Krauledat
Language:	English
Place in curriculum:	Core Subject
Timetabled hours:	Lecture: 2 SWS Practicals: 2 SWS
Workload:	60 h attendance 60 h self-study 30 h exam preparation
Credits:	5
Recommended prerequisites:	Basic computer skills Introductory mathematics
Module objectives:	After successful completion of the module, students can • develop small programs • analyze source code • detect limits and complexity of computational calculations • transfer technical and mathematical problems into programs • describe and program probles from the field of feedback systems, e.g. from control theoryProbleme rückgekoppelter Systeme, z.B. aus der Regelungstechnik, zu beschreiben und zu programmieren
Content:	Programming: • Introduction to programming • Tools for program creation • Data types, operators and expressions • Input and Output • Control structures • Program structure • functions

	• arrays • references and pointers • Data structures • Usage of libraries • Practical programming in a concrete language (e.g. C) Object oriented programming • Short introduction to the concept of object oriented programming • Examples in a concrete language (e.g. : C++, Python)
Assessment:	attestation
Forms of media:	whiteboard, PowerPoint, Projector, Flip-Chart, Computer
Literature:	Peter Van Roy and Seif Haridi: Concepts, Techniques, and Models of Computer Programming Steve Qualline: Practical C Programming King: Computer Science

Module „Applied Physics“

Module name:	Applied Physics
Module code:	BM_10
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr. Georg Bastian
Lecturer:	Prof. Dr. Georg Bastian Prof. Dr. Alexander Struck
Language:	Englisch
Place in curriculum:	Core subject
Timetabled hours:	Lecture: 2 SWS Exercise: 1 SWS Laboratory: 1 SWS
Workload:	60 h presence 60 h preparation and wrap-up 30 h exam preparation
Credits:	5
Recommended prerequisites:	Fundamentales of Physics
Module objectives:	• Students can understand and explain technical and scientific phenomena on the basis of their aquired theoretical knowledge. • The connection between theory and practical applications is recognized. • Students are able to approach and solve new kinds of problems with the learned methods. • Presentation of own results in exercise classes and lab reports can be done with proper terminology in digital form and English language.
Content:	• Electricity and Magnetism • Atomic physics • Nuclear physics • Solid State Physics • Sensor applications of physics
Assessment:	1 written exam, lab reports (attestation)
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Paul A. Tipler:

	Physics for Scientists and Engineers, Freeman, 2008

Module “Metallic Materials and Testing"

Module name:	Metallic Materials and Testing
Module code:	BM_11
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking
Lecturer:	Prof. Dr.-Ing. Raimund Sicking
Language:	English
Place in curriculum	Core subject
Timetabled hours:	Lecture: 2 SWS Laboratory: 2 SWS
Workload:	60 h Attendance 60 h Self-study 30 h Exam preparation
Credits:	5
Recommended prerequisites:	Chemistry of Materials
Module objectives:	Students will be able to: • Define crystal structures and different classes of metals • Report with basic knowledge concerning alloy systems, phase transformations, strength increasing mechanisms as well as mechanical and technological properties. • Select suitable thermal treatments in different areas of the metal industry. • Perform different testing and analysis methods for materials characterization.

Content:	• Introduction into atomic structure and built-up of single and polycrystals, lattice structures, lattice defects, alloying systems and stress-strain diagram • Strength increase mechanisms (cold forming/plastic deformation, Hall-Petch, solid solution, dispersion, precipitates, texture, phase transformation) • Thermal Effects (diffusion, recovery, recrystallization, grain coarsening, phase transitions, nucleation) • Mechanical load, fracture, metal groups as well as a first introduction into corrosion • Equilibrium: component / phase / microstructure, 2-component system / equilibrium diagrams, phase rule, lever rule. • Introduction of important manufacturing processes (overview) • Introduction of important testing methods (micro and macro hardness, impact test, tensile test) • In addition specific application examples are presented.
Assessment:	Exam / Lab Reports
Forms of media:	Board/PowerPoint/Projector/Laboratory
Literature:	Bunge, H.J., Pöhlandt, K., Tekkaya, A.E., Banabic, D.Banabic, D.; Pöhlandt, Klaus (Eds.): Formability of Metallic Materials, Plastic Anisotropy, Formability Testing, Forming Limits, XV, ISBN 978-3-540-67906-6, 2000 R.B. Ross: Metallic Materials Specification Handbook, 4th Edition, ISBN 978-0412369407, Springer US, 1991 E. Hornbogen, H. Warlimont: Metalle - Struktur und Eigenschaften der Metalle und Legierungen, 5th edition., ISBN-10 3-540-34010-6, Springer, 2006 George M. Crankovic: Metals Handbook: Materials Characterization, 9th Edition, ISBN 978-0871700162, ASM Intl., 1989 M. F. Ashby, D. R. H. Jones: Engineering Materials 2 – An Introduction to Microstructures, Processing and Design, 3rd edition, ISBN-13 978-0-

	7506-6381-6

Module „Applied Chemistry“

Module name:	Applied Chemistry
Module code:	BM_12
Courses (where applicable)	Chemical Reaction Engineering Polymer Chemistry
Semester:	3rd semester
Module coordinator:	Prof. Dr.-Ing. Joachim Gebel
Lecturer:	Prof. Dr.-Ing. Joachim Gebel Prof. Dr. Peter F.W. Simon
Language:	English
Place in curriculum:	Core subject
Timetabled hours:	Chemical Reaction Engineering Lectures: 1 SWS Practical training: 1 SWS Polymer Chemistry Lectures: 2 SWS Laboratory: 1 SWS
Workload	100 h attendance 40 h preparation and review 40 h exam preparation
Credits:	6
Recommended prerequisites:	Chemistry of materials Mathematics and IT Applied Mathematics Thermodynamics
Module objectives:	Chemical Reaction Engineering Students are able to design chemical reactors of different types (Batch reactors, Continuous-stirred tank reactors, Tubular reactors and Packed-bed reactors). They are able to give answers to the following questions: 1. Which type of reactor fits best to a given chemical reaction? 2. At which conditions should the reactor be operated (temperature, pressure, composition)? 3. Which dimensions should the reactor have (volume, height, width, diameter)?

	They are able to apply mole balances and energy balances on the different types of reactors. They understand the approach of power law models to obtain appropriate rate laws and the impact of chemical reaction kinetics on reactor design. In the laboratory framework, students learn how to measure and control essential process parameter of chemical reactors, especially temperature and pressure. They are able to operate a batch reactor. Polymer Chemistry The lecture will enable the students • to employ principle concepts and terms of macromolecular chemistry • to recognize the most important types of synthetic polymers • to derive suitable synthesis strategies from the macromolecules‘ principle structure • to estimate the importance of polymers in daily life. • to compare the advantages and disadvantages of the different methods of polymer analysis • to perform simple polymer synthesis in laboratory scale.
Content:	Chemical Reaction Engineering 1 Mole balances 1.1 Rate of reaction 1.2 General mole balance equation 1.3 Batch reactors 1.4 Continuous-flow reactors 1.4.1 Continuous-Stirred Tank Reactor (CSTR) 1.4.2 Tubular Reactor/Plug-Flow Reactor (PFR) 1.4.3 Packed-Bed Reactor (PBR) 2 Conversion and reactor sizing 2.1 Definition of conversion 2.2 Batch reactor design equation 2.3 Design equations for flow reactors 2.3.1 Continuous-Stirred Tank Reactor (CSTR) 2.3.2 Tubular Reactor/Plug-Flow Reactor (PFR) 2.3.3 Packed-Bed Reactor (PBR) 2.4 Reactors in series 3 Rate laws 3.1 Basic definitions 3.2 Reaction order and rate law

	3.2.1 Power law model 3.2.2 Nonelementary rate laws 3.2.3 Reversible reactions 3.3 Reaction rate constant 4 Stoichiometry 4.1 Batch systems 4.2 Flow systems 5 Isothermal reactor design 5.1 Design structure for isothermal reactors 5.1.1 Batch reactors (BR) 5.1.2 Continuous-Stirred Tank Reactor (CSTR) 5.1.3 Tubular Reactor/Plug-Flow Reactor 6 Nonisothermal reactor design – Steady state energy balance and adiabatic PFR applications 6.1 Energy balance 6.2 Adiabatic operation 6.2.1 Adiabatic energy balance 6.2.2 Adiabatic tubular reactor 6.3 Adiabatic equilibrium conversion and reactor staging 6.4 Optimum feed temperature 7 Nonisothermal reactor design – Flow reactors with heat exchange 7.1 Tubular reactor with heat exchange 7.2 CSTR with heat effects Polymer Chemistry 1 Historical overview 2 Number and mass distributions and their experimental determination 3 Step growth and chain growth reactions 4 Isomerism especially focusing on tacticity 5 Polymer synthesis 5.1 Polycondensation 5.2 Polyaddition 5.3 Anionic Polymerization 5.4 Cationic Polymerization 5.5 Radical Polymerization 5.6 Polyinsertion 5.7 Copolymerization

Assessment:	Written examination, Lab reports
Forms of media:	Whiteboard, PowerPoint, Projector, Tablet
Literature:	Chemical Reaction Engineering H. Scott Fogler Essentials of Chemical Reaction Engineering International Edition, 2011 Pearson Education International ISBN: 978-0-13-211936-8 H. Scott Fogler Elements of Chemical Reaction Engineering Pearson Education International Fourth Edition, 2006 ISBN 978-0-13-127839-8 George W. Roberts Chemical Reactions and Chemical Reactors John Wiley & Sons, 2009 ISBN 978-047-174220-3 Julian Smith, Peter Harriot Unit Operations of Chemical Engineering, 7th Edition ISBN 978-0-07-284823-6 Robin M. Smith Chemical Process: Design and Integration ISBN 978-0-471-48681-7 Polymer Chemistry D. Braun, H. Cherdron, M. Rehan, H. Ritter, B. Voit: Polymer Synthesis: Theory and Practice. 4th ed. Springer 2005 Paul C. Hiemenz, Timothy P. Lodge: Polymer Chemistry 2nd ed. CRC-Press 2007 Georg Odian: Principles of Polymerization, 4th ed. J. Wiley & Sons, 2004 Bernd Tieke: Makromolekulare Chemie. 4. Nachdruck der 1.Auflage. Wiley-VCH: Weinheim, 2012 Tim A. Osswald: Understanding Polymer Processing Processes and Governing Equations

	ISBN: 978-3-446-42404-3 Tim A. Osswald, Juan P. Hernandez-Ortiz: Polymer Processing Modeling and Simulation ISBN: 978-3-446-40381-9

Module „Material Property Calculations“

Module name:	Material Property Calculations
Module code:	BM_13
Courses (where applicable):	Numerics and Statistics Materials Simulations
Semester:	3rd Semester
Module coordinator:	Prof. Dr. Alexander Struck
Lecturer:	Prof. Dr. Alexander Struck Prof. Dr. Achim Kehrein
Language:	English
Place in curriculum:	Core Subject
Timetabled hours:	Numerics and Statistics: Lecture: 2 SWS Exercise: 1 SWS Materials Simulation: Lecture: 2 SWS Exercise: 2 SWS
Workload:	105 h attendance 45 h self-study 30 h exam preparation
Credits:	6
Recommended prerequisites:	Introductory Mathematics Computer based Engineering Tools Applied Mathematics IT Programming
Module objectives:	Materials Simulation: Students evaluate methods of materials simulation on different length and time scales. They learn methods for modeling different material properties an their numerical simulation. Students can decide which methods are suitable for the solution of a given problem, can employ them for practical purposes and critically evaluate their results. Numerics and Statistics: Students interpret data, summarize them in a meaningful way and represent them graphically. Moreover, students are able to draw generally valid con-

	clusions from sample data. In the process they learn to approach problems from the field of quality management and control. The necessary prerequisites from probability theory are independently developed in experiments by the students. For practical purposes, generic software for data analysis is used. The students can critically check computer results and their accuracy and accordingly select proper numerical methods.
Content:	Materials simulation: • Basics of molecular dynamics • Use and construction of special force fields for molecular dynamics simulation of material properties • Algorithms for solution of coupled differential equations in molecular dynamics • Typical boundary conditions • Effects of microscopic interactions on macroscopic properties • Introduction to Monte-Carlo-methods • Basics of macroscopic materials simulation, mechanical, thermal, electrical characteristics of materials • Introduction to Finite Element Modelling • Multi-scale modelling Numerics and Statistics: • Introduction: descriptive and conclusive statistics, role of probability theory • Basic concepts: Ensemble, sample, qualitative/quantitative data, classes, histograms, scatter plots, stem-and-leaf plot • Characteristic numbers: mean value, median, variance for ensembleand sample, standard deviation, z-values (standard units) • Regression: correlation und linear regression, nonlinear regression • Probability theory: Limit of large numbers, probability, conditional probability, probability tree, Bayes' theorem • Discrete and continuous random variables, normal distribution • Sample theory: sample mean, central limit theorem, variance of sample mean Numerics: • Floating point representation of numbers, roundoff errors • Numerical solution of equations

	• Numerical integration • Numerical solution of initial value problems
Assessment:	Numerics and Statistics: written exam Materials simulation: written exam
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Material Simulations: M. Griebel, S. Knapek, and G. Zumbusch. **Numerical Simulation in Molecular Dynamics**. Springer, Berlin, Heidelberg, 2007 Schlick: Molecular Modeling and Simulation: An Interdisciplinary Guide. 2nd edition. Springer. 2010 Allen, Tildesley: Computer Simulation of Liquids. Oxford University Press. 1989 Kurt Binder: Monte Carlo methods in statistical physics, Springer, Berlin [u.a.] 1979, ISBN 3-540-09018-5, und Applications of the Monte Carlo method in statistical physics, Berlin, Springer 1984, ISBN 3-540-12764-X R. Haberlandt, S. Fritzsche, G. Peinel: Molekulardynamik. Grundlagen und Anwendungen, Vieweg und Teubert Verlag Richard Lesar: Introduction to Computational Materials Science, Cambridge University Press, 2013 (ISBN:9780521845878) Numerics and Statistics: DeVeaux, Velleman: Intro Stats. Pearson, 2004 Freedman, Pisani, Purves: Statistics. 4th edition. Norton. 2007 Devore: Probability and Statistics for Engineering and the Sciences. 7th international student edition. Brooks/Cole, 2008 Montgomery, Runger: Applied Statistics and Probability for Engineers. SI Ver-

	sion. 5th edition. Wiley, 2011 Acton: Real Computing made Real. Preventing Errors in Scientific and Engineering Calculations. Dover. 1996 Strang: Wissenschaftliches Rechnen. Springer. 2010 (Videovorlesungen Computational Science and Engineering unter http://www.mit.edu -> OpenCourseWare) Burden, Faires: Numerical Analysis. 9th international edition. Brooks/Cole, 2011 Press, Teukolsky, Vetterling, Flannery: Numerical Recipes. 3rd Edition. Cambridge, 2007

Module “Material Analysis"

Module name:	Materials Analysis
Module code:	BM_14
Courses (where applicable):	
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking
Lecturer:	Prof. Dr.-Ing. Raimund Sicking
Language:	English
Place in curriculum	Core subject
Timetabled hours:	Lecture: 2 SWS Laboratory: 2 SWS
Workload:	60 h Attendance 60 h Self-study 30 h Exam preparation
Credits:	5
Recommended prerequisi-tes:	Chemistry of Materials
Module objectives:	Students will be able to: • Understand the basic scientific principles on which the analyzing methods are based • Apply gained knowledge in the laboratory in order to analyse and test a variety of materials • Explain the basic principles of mass spectroscopy. In addition they are familiar with basic analyzing methods so that they can select an appropriate method for a given material problem. • Consider specific german, European and interna-tional standards for the task in focus.

Content:	• Vibrational spectroscopies (IR, Raman) • Electron emission spectroscopies (UV) • Magnetic testing methods • Spectroscopy of inner electrons (XPS, XRF, EDX, Auger) including advantages and disadvantages • Metallographic Preparation (Grinding & Polishing, Etching, phase identification) • Material testing of standard materials • Thermal analysis (DSC, TGA) • Microscopic techniques (SEM, TEM and AFM), common alspects and differences • International, European and german standards for different testing and analyzing methods • Introduction to industrial surface inspection systems
Assessment:	Exam / Lab Reports
Forms of media:	Board/PowerPoint/Projector/Laboratory
Literature:	Callister, WD: Materials Science and Engineering - An Introduction, 2000 Charles Brooks: Failure Analysis of Engineering Materials Joachim Ohser and Frank Mücklich: Statistical Analysis of Microstructures in Materials Science D. J. O'Connor, Brett A. Sexton, Brett A. and Roger C.: Surface Analysis Methods in Materials Science Korad Herrmann Hardness Testing - Principles and Applications, ASM International, ISBN-13 978-1-61503-832-9 W. Grellmann, S. Seidler: Kunststoffprüfung, 2. Aufl., 2011, ISBN 978-3-446-42722-8, Carl-Hanser-Verlag C. R. Brundle, C. A. Evans, S. Wilson Encyclopedia of Material Characterization, 1992, Butterworth-Heinemann, ISBN 0-7506-9168-9

Module “Project I”

Module name:	Project I
Module code:	BM_15
Courses (where applicable):	
Semester:	3rd semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking Prof. Dr. Alexander Struck
Lecturer:	Depending on the project
Language:	English
Place in curriculum:	Core subject
Timetabled hours:	Project work: 4 SWS
Workload:	60 h attendance 120 h preparation and review
Credits:	6
Recommended prerequi-sites:	Specialised lectures in the respective courses of study, Project Management
Module objectives:	A team of students with 3-5 members works on a solution to a given problem using what they have learned so far. They are able to organise the project independently and to put together well-defined work packages to work on in a defined time span. They comprehend the task and contrib-ute purposefully and creatively to the solution. Students solve conflicts between team members independently. Students are able to professionally document the acquired results and to present them in a format suited to recipients.
Content:	Contents are course-specific.
Assessment:	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Lecture materials and literature for specialised courses

Module „Quality and Technology Management“

Module name:	Quality and Technology Management
Module code:	BM_16
Courses (where applicable):	Integrated Management Systems Technology Management
Semester:	3rd semester
Module coordinator:	Prof. Dr.-Ing. Alexander Klein
Lecturer:	Prof. Dr.-Ing. Dirk Untiedt Prof. Dr.-Ing. Alexander Klein
Language:	English
Place in curriculum:	Core subject
Timetabled hours:	Integrated Management Systems: Lectures: 2 SWS Tutorials: 1 SWS Technology Management: Lectures: 2 SWS
Workload:	75 h attendance 15 h preparation and review 30 h exam preparation
Credits:	4
Recommended prerequisites:	none
Module objectives:	Integrated Management Systems: Quality management, quality assurance, occupational safety health and envirolment managment After finishing this module the students have deep knowledge about Integrated Management Systems. This means Quality Management and Occupational Safety, Health and Envirolment Management. They know the idea for Total Quality Management, which is including the Quality Assurence. The students are able to use the main methods and techniques of Quality Management. Besides theoretical knowledge, they are also aware of the importance of work safety and envi-rolment management.

	Technology Management: Students know the essential terms, methods and tools of technology and management. They are able to arrange technologies and to evaluate these using suitable methods. They are aware of the importance of technolo-gies for businesses and society. They know the methods and tools of technology for early detection, planning and evaluation and are able to apply these to practical problem cases.
Content:	Integrierted Management Systems: • Quality Management - DIN ISO 9001 - Six Sigma (z.B. DMAIC) - Quality Function Deployment (House of Quality) - FMEA (Process- und Product-FMEA) - Risk Management - Quality Assurence: Capability, Test scheduling, Evaluation, Applied Statistics, Statistical Process Control • Environmental Management DIN EN ISO 14001 • Work safety BS OSHAS 18001 General Management Systems - Structure and implementation of Management Systems - Corporate Governance, Compliance Technology management • Fundamentals of Technology management • Scope of duties of Technology management • Technology foresight • Technology planning • Protection of intellectual property • Technology evaluation • Formulation of Technology strategies
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Integrated Management Systems: Pardy, Wayne, Andrews, Terri: Integrated Management

	Systems, Government Institutes, 2010 Sanders, Donald A., Scott, C. Frank: Passing Your ISO 9000/QS-9000 Audit, CRC Press LLC, 1997 May, Constantin, Schimek, Peter: TPM Total Productive Management, 2nd edition, CETPM Publishing, 2009 Hoyle, David: ISO 9000 Quality Systems Handbook, 6th edition, Routledge, 2009 Kelly, John M: IMS: The Excellence Model, BSI Business Information, 2004 Lindsay, Evans: The Management and Control of Quality, 8th edition, South-Western, Cengage Learning, 2011 DIN ISO EN 9000ff, raw documents BS OHSAS 18001; DIN ISO EN 14000 f, raw documents Technology Management: Burgelmann, R.: Strategic Management of Technology and Innovation. 5th revised edition, McGraw-Hill Higher Education, 2008 Arnold, H.; Erner, M.; Möckel, P.; Schläffer, Chr. (Eds.): Applied Technology and Innovation Management. Springer, 2010 Betz, F.: Managing Technological Innovation – Competitive Advantage from Change. 3rd edition, John Wiley & Sons, 2011 Narayanan, V. K.; Colarelli O'Connor, G. (Eds.): Encyclopedia of Technology and Innovation Management. 1st edition, John Wiley & Sons, 2010 Albers, S. (Eds.), Gassmann, O. (Eds.): Handbuch Technologie- und Innovationsmanagement: Strategie – Umsetzung – Controlling (Handbook Technology and Innovation Management: Strategy – Implementation – Controlling). Gabler Verlag, 2005

Module “Non-metallic Materials"

Module name:	Non-metallic Materials
Module code:	BM_17
Courses (where applicable):	Non-metallic Materials Polymer Processing
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking
Lecturer:	Prof. Dr.-Ing. Raimund Sicking External lecturer
Language:	English
Place in curriculum	Core subject
Timetabled hours:	Non-metallic Materials: Lecture: 2 SWS Laboratory: 1 SWS Polymer Processing: Lecture: 2 SWS
Workload:	75 h Attendance 45 h Self-study 30 h Exam preparation
Credits:	5
Recommended prerequisites:	Chemistry of Materials
Module objectives:	Students will be able to: Non-metallic Materials • Identify basic structures of polymers and to specify isomeric structures • To understand and to analyse properties of long chain macromolecules • To assign the connection between microstructure and macroscopic properties for polymers, ceramics and glass • Select appropriate materials with regard to its engineering application • Use their knowledge of the parameter influence on materials properties in order to optimize mechanical or thermal properties for specific applications.

	Polymer Processing • To plan the production of synthetic materials and to select an appropriate manufacturing method • To consider material properties within the manufacturing processes and see the limits of the processes • To assess the manufacturing methods with regard to quality and economic efficiency
Content:	Non-metallic materials • Sorts of polymers (natural and synthetic polymers, thermoplasts and duroplasts (thermosets)) • Recognize polymer states, describtion of polymer chain structure, chain configurations, structural isomery, detection of cross links and branches of long chains • Short introduction into co-polymers • Description of 3-dimensional structure of polymer chains • Link between structure and properties of polymers • Classification of polymers • Structural changes by temperature and glass transition • Structure change by melting • Physical properties of polymers - visco-elastic behaviour - elastic behaviour - viscous behavior - crystallization and morphology of polymers • microstructure and properties of ceramics and glass Polymer processing • Surrounding of polymer processing (raw materials, machines, manufacturer, user, recycler) • Material flow and manufacturing processes with advantages and disadvantages - die casting - extrusion - blow forming - foil blowing - reactive casting - duroplast (thermoset) processing • Rapid Prototyping • Thermodynamic of polymer processing • Process based geometric changes • Quality assurance with regard to parts geometry

	and materials properties
	Exam / Lab Reports
Forms of media:	Board/PowerPoint/Projector/Laboratory
Literature:	Stephen L. Rosen: Fundamental Principles of Polymeric Materials (Society of Plastics Engineers Monographs), 3rd rev. Edition, ISBN 978-0470505427, Wiley Blackwell, 2010 Jean Louis Halary, Francoise Laupretre, and Lucien Monnerie: Polymer Materials: Macroscopic Properties and Molecular Interpretations, 1st Edition, ISBN 978-0470616192, Wiley & Sons., 2011 William D. Callister: Materials Science and Engineering: An Introduction, 7th Edition, ISBN 978-0471736967, Wiley & Sons, 2006 Ian W. Hamley: Introduction to Soft Matter: Synthetic and Biological Self-Assembling Materials, 1st Edition, ISBN 978-0470516102, Wiley & Sons, 2007 G. W. Ehrenstein: Polymerwerkstoffe - Struktur – Eigenschaften – Anwendung, 3. Aufl., 2011, ISBN 978-3-446-42283-4, Carl Hanser Verlag W. Michaeli: Einführung in die Kunststoffverarbeitung, 5. Aufl., 2006, ISBN-13 978-3-446-40580-6, Carl-Hanser-Verlag C. B. Carter, M. G. Norton: Ceramic Materials - Science and Engineering, 2. Aufl., 2013, ISBN 978-1-4614-3522-8, Springer-Verlag

Module “Materials Technology"

Module name:	Materials Technology
Module code:	BM_18
Courses (where applicable):	Materials Production Materials and Mobility
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking
Lecturer:	Prof. Dr.-Ing. Raimund Sicking
Language:	English
Place in curriculum	Core subject
Timetabled hours:	Materials Production: Lecture: 2 SWS Materials and Mobility: Lecture: 2 SWS
Workload:	60 h Attendance 30 h Self-study 30 h Exam preparation
Credits:	5
Recommended prerequisites:	Metallic Materials and Testing Non-metallic Materials Materials Analysis
Module objectives:	Students will be able to: Material Production • Know the most important manufacturing processes for semi finished metals like casting, rolling and extrusion • To give an overview of the value creation chain from raw material to the final product for aluminium and steel • Show the connection between process, microstructure and macroscopic properties and can select a process accordingly. • To explain the primary forming by powder metallurgy and sintering of ceramics Materials and Mobility • Understand special demands to materials for mobil-

	ity applications including light weight constructions • To distinguish between different important light weight construction materials. In addition, appropriate joining technologies can be selected. • To answer basic questions concerning material selection
Content:	Material Production • Smelting of aluminium and steel • Casting, rolling and extrusion of metals • Microstructure development during the production process, • Influence on microstructure and properties by primary forming and semi finished forming processes • Sintering of ceramics and powder metals • Overview on chipping manufacturing and forming processes • Heat Treatment of steels Material and Mobility • Steels for transport applications, high strength steels, TRIP steels • Aluminum alloys • Reinforced materials for strength, stiffness and fire resistance • Carbon fibres and Kevlar®: Production and properties • Carbon nano fibres: production and properties • Rubber tires and their manufacturing • Joining techniques for mobile applications
	Written or oral exam
Forms of media:	Board/PowerPoint/Projector
Literature:	M. F. Ashby, D. R. H. Jones: Engineering Materials 2 - An Introduction to Microstructures, Processing and Design, 2006, ISBN-13 978-0-7506-6381-6, Elsevier B. Ilschner, R. F. Singer: Werkstoffwissenschaften und Fertigungstechnik – Eigenschaften, Vorgänge, Technologien; 5. Ed., 2010, ISBN 978-3-642-01733-9, Springer-Verlag A. C. Reardon (Editor): Metallurgy for the Non-Metallurgist, 2nd edition, 2011,

	ISBN-13 978-1-61503-821-3, ASM International E. Hornbogen, H. Warlimont: Metalle – Struktur und Eigenschaften der Metalle und Legierungen, 5. Ed., 2006, ISBN-13 978-3-540-34010-2 D. Altenpohl: Aluminium von Innen, 5. Ed., 1994, ISBN 3-87017-235-5, Aluminium Verlag G. W. Ehrenstein: Faserverbund-Kunststsoffe – Werkstoffe – Verarbeitung – Eigenschaften; 2nd Ed., 2006, ISBN 978-3-446-22716-3, Hanser C. B. Carter, M. G. Norton: Ceramic Materials - Science and Engineering, 2nd Ed., 2013, ISBN 978-1-4614-3522-8, Springer-Verlag F. Henning, E. Moeller (Hrsg.): Handbuch Leichtbau - Methoden, Werkstoffe, Fertigung; 1st Ed., 2011, ISBN 978-3-446-42267-4, Carl Hanser Verlag

Module „Biochemistry“

Module name:	Biochemistry
Module code:	BM_19
Courses (where applicable):	Biochemistry Biotechnology
Semester:	4th Semester
Module coordinator:	Prof. Dr. Amir Fahmi
Lecturer:	Prof. Dr. Amir Fahmi Prof. Dr. Neil Shirtcliffe
Language:	Englisch
Place in curriculum	Core subject
Timetabled hours:	Biochemistry: Lecture: 2 SWS Laboratory: 1 SWS Biotechnology: Lecture: 2 SWS Laboratory: 1 SWS
Workload:	90 h Attendance 45 h Self-study 45 h Exam preparation
Credits:	6
Recommended prerequisites:	Chemistry of Materials Organic chemistry
Module objectives:	Biochemistry: • The course is designed for the undergraduate students to emphasis the unique chemistry that occurs in the environment of a cell to facilitate basic understanding of the life's processes at a molecular level. • The student should obtain an in-depth knowledge of the structures of amino acids, carbohydrates, lipids and nucleic acids. • The student also will gain a deeper understanding of biochemical macromolecular structure, function and metabolism. Broadly, it encompasses the chemical nature and structure of biomolecules and how they interact with each other, simple cellular reactions and the generation of energy for cellular

	activity, communication and co-ordination between and within cells, and the replication and expression of genetic material. • A short introduction to genetics allows the students to understand Biotechnology. The goal is to give the students the tools to converse with biologists. • The laboratory introduces sterilisation and carrying out experiments under microbiologically clean conditions. • The students will also learn how to culture bacteria and simple cel culture procedures. • They will also understand the properties of plasmids, their function and how they can be used for genetic engineering and how this relates to other genetic carriers for genetic engineering. • The ethical and safety questions in bioengineering will be considered and the students will be able to understand some of the moral implications of genetic research as well as to work safely on simple experiments.
Content:	Biochemistry: • This is an introductory course that addresses basic concepts of the chemical processes in living organisms. • It deals with the chemistry, structures and functions of cellular components such as proteins, carbohydrates, lipids, nucleic acids and other biomolecules. • Among the vast number of different biomolecules, many are complex and/or large molecules (called polymers based on subunit called monomers), types of monomers, linkages and types of biochemical polymers that are formed for vast of biological functions. • Few examples will explain the mechanism of enzymatic catalysis and regulation of carbohydrate, lipid, nucleic acid and amino acid metabolism, and highlights their health and biotechnological implications. Biotechnology: • Introduction into basic microbial taxonomy, mor-

	phology and genetics • How genes effect the properties of proteins and therefore those of the whole organism. • Preparation of cell culture media. • Carrying out simple experiments to alter specific traits in microorganisms. • The basic problems that may occur in industrial fermenters will be discussed. • The students will learn how to use a laboratory book. • They will also practice writing laboratory reports in a scientific style. • Basic chromatography and different types of chromatography will be considered.
Assessment:	Exam/Lab reports
Forms of media:	Board/Projector/Laboratory
Literature:	Biochemistry: Lehninger Principles of Biochemistry Biochemistry, Donald Voet, Judith G. Voet Harper's Illustrated Biochemistry Biotechnology: Basic Biotechnology by Colin Ratledge (Editor), Bjorn Kristiansen, Paperback: 584 pages, Publisher: Cambridge University Press Cartoon Guide to Genetics, Larry Gonick, HarperCollins, 14.08.1991 Biotechnology Fundamentals von Firdos Alam Khan CRC Press

Module "Colloids and Biodegradable Materials"

Module name:	Colloids and Biodegradable Materials
Module code	BM_20
Courses (where applicable):	Colloids Natural and Biodegradable Materials
Semester:	4th Semester
Module Coordinator:	Prof. Dr. Neil Shirtcliffe
Lecturer:	Prof. Dr. Neil Shirtcliffe Prof. Dr. Amir Fahmi
Language:	English
Part of Curriculum	Core subject
Timetable hours	Colloids: Lecture: 2 SWS Natural and Biodegradable Materials: Lecture: 2 SWS
Workload	60 h Attendance 20 h Self-study 20 h Exam preparation
Credits:	4
Recommended prerequisites::	Organic and Inorganic Chemistry
Module objectives:	Colloids: The students will be able to: • Classify the types and stability of colloids, e.g. Suspensions (Solid in liquid), emulsions (liquid in liquid e.t.c. • Describe the properties of fine Particles and aggregates of macromolecules using the high interfacial area and interfacial energy. • To be able to quantify the structure and stability of colloids. • To recognise the factors affecting dispersability, flocking and sedimentation in both aqueous and non-aqueous media. • Describe and use methods to determine the propoerties of colloids, such as particle size, stability, rheology and Zeta potential.

	• Describe methematically the forces between colloidal particles and use this to predict the stability of a suspension. Natural and biodegradable Materials: The students will be able to • Describe the advantages and disadvantages of natural materials. • recognise the structure of the most important biodegradable polymers and how they are degraded. • Describe representative examples of biodegradable materials • Describe the chemistry of oxo-degredation • Describe the chemistry of most natural materials. • Understand how bioresorbable implants function • Understand the limits of bioproduction of materials using examples
Content:	Colloids: • An introduction into the properties and importance of different surface and dispersed systems and how this reaches into many areas of production and daily life. Using examples from areas such as medicine, food, ceramics and biology. • The properties of charged surfaces, their stability and how this can be influenced by adsorbtion of surface active species. This includes properties of emulsions, polymers in solution and at surfaces, wetting and aggregation. • The concept of amphiphiles, with their surface active properties and emergent phase behavior, micellar, liquid crystaline and microemulsions. Other aggregates, such as vesicles are also considered • The interactions between particles and their effect on colloidal stability are considered. The role of surface activity of additives on colloidal stability is described using systems such as foams and emulsions as examples. • The role of surface energy on wetting, filtration and sintering is discussed as ist he more general aspect of how surface and interfacial properties influence the bulk properties of dispersions. Natural and Biodegradable Materials:

	• Chemistry of oxo- and hydro-degradation. • Anaerobic degredation of polymers • Enzymatic degredation of biopolymers • The types and sources of biopolymers • Wood as an anisotropic, polymer -polymer composite • Bone and shell • The structure of nacre and diotoms e.t.c.; how they form and function • Chemistry of lignin and cellulose • Protein structure • Synthesis and degradation of biopolymers and energy cost/production • Artificial products from natural materials • Biodegradable implants
Assessment:	Exam
Forms of media:	Board/Slides/Demonstrations
Literature:	Long Yu: Biodegradable Polymer Blends and Composites from Renewable Resources Hee-Gweon Woo and Hong Li: Advanced Functional Materials Shalaby W. Shalaby and Karen J.L.: Absorbable and Biodegradable Polymers (Advances in Polymeric Biomaterials) C. T. K. Ching, David L. Kaplan and Edwin L., Ph.D. Thomas: Biodegradable Polymers and Packaging, 1993 E. S. Stevens: Green Plastics: An Introduction to the New Science of Biodegradable Plastics. Jan Mewis and Norman J. Wagner: Colloidal Suspension Rheology (Cambridge Series in Chemical Engineering) Ian D. Morrison and Sydney Ross: Colloidal Dispersions: Suspensions, Emulsions, and Foams

Module „Applied Materials“

Module name:	Applied Materials
Module code:	BM_21
Courses (where applicable):	Functional Materials Materials for Food Processing
Semester:	4th Semester
Module coordinator:	Prof. Dr. Amir Fahmi
Lecturer:	Prof. Dr. Amir Fahmi
Language:	Englisch
Place in curriculum	Core subject
Timetabled hours:	Functional Materials: Lecture: 2 SWS Materials for Food Processing Lecture: 2 SWS Laboratory: 1 SWS
Workload:	75 h Attendance 45 h Self-study 30 h Exam preparation
Credits:	5
Recommended prerequisites:	Chemistry of Materials Applied Chemistry
Module objectives:	Functional Materials: The students will be able • to define and solve materials problems • to classify materials dedicated for specific applications • to identify materials properties related to rigidity and light weight characteristics of the designed materials • to correlate the technical properties to decide the financial necessity in the development stages within the manufacturing strategy. • To decide the analytical tools to characterize the materials for the optimisation process to develop new design materials properties and application Materials for Food Processing: The course is designed that the students will be able

	• to classify the structure of food constituents (Major and minor component's) • To define the structure relate to the constituents, function and importance in foods with respect to food quality, nutrition, physical and chemical interactions of components • To identify the risk factors and risk mitigation in food process and packaging. • To describe mechanisms contribute to different food systems during its harvesting, handling, production, processing, packaging, storage and cooking.
Content:	Functional Materials: • Multilayers structures and function related to properties • Preparation and characterisation different types of carbon nanotubes • Materials defined the surfaces properties at different dimensions and length scale • Materials for renewable energy, fabrication, characterisation, mechanism and efficiency calculations • Materials for energy storage • Materials for fuel cells • New materials for mini-devices Materials for Food Processing: • This is a comprehensive foundation course express the basic chemistry and the physicochemical property of the major food constituents (water, carbohydrates, lipids and proteins) and the minor food components (vitamins, minerals, pigments and food additives). • Also the course outlines range of techniques available to the food analyst and the concept underling the more commonly used analytical methods in food industries. • It covers basic principles, equipment and quality of food processing and preservation operations such as mixing, separation, blanching, pasteurization, extrusion, baking, frying, chilling and packaging • general idea of major food processing, process optimisation, packaging in real industries
Assessment:	Exam/Lab reports
Forms of media:	Board/Projector/Laboratory

Literature:	Functional Materials: Zhong Lin Wang and Z. C. Kang Functional and Smart Materials Structural Evolution and Structure Analysis Hee-Gweon Woo and Hong Li: Advanced Functional Materials Kakeshita, Tomoyuki Progress in Advanced Structural and Functional Materials Design Materials for Food Processing: C.S. James: Analytical chemistry of foods , 1995 H.-D. Belitz, W. Grosch, P. Schieberle ; Food chemistry / translation from the fifth German edition 2004 Kirk L. Parkin, Owen R. Fennema: Fennema's food chemistry / edited by Srinivasan Damo-daran, 2008 Charles Zapsalis, R. Anderle Beck: Food chemistry and nutritional biochemistry. 1985 Murano, Peter S Understanding Food Science and Technology Singh, R. Paul, Heldman, Dennis R Introduction to Food Engineering

Module „Material Design and Rheology“

Module name:	Material Design and Rheology
Module code:	BM_22
Courses (where applicable):	Rheology Material Design
Semester:	5th Semester
Module coordinator:	Prof. Dr. Amir Fahmi
Lecturer:	Prof. Dr. Amir Fahmi Prof. Dr.-Ing. Raimund Sicking
Language:	Englisch
Place in curriculum	Core subject
Timetabled hours:	Rheology: Lecture: 2 SWS Laboratory: 1 SWS Material Design: Lecture: 2 SWS
Workload:	75 h Attendance 45 h Self-study 30 h Exam preparation
Credits:	5
Recommended prerequisites:	Chemistry of Materials Materials Analysis Non-metallic Materials
Module objectives:	Rheology The students expected to • conduct measurement to define rheological properties • analyse and interpret of rheological properties of different types of materials • choose a rheometer system • use rheometer system efficiently • use rheological measurements to describe materials properties • use rheological tests to solve processing problems • to design rheology tests for Colloidal Dispersions and formulate rheology modifiers Material Design: • to understand the basic possibilities to design mate-

	rials specifically for applications. They have the basic knowledge to distinguish between tailored materials of different material classes. • Collect exemplary experiences how to derive necessary material properties from specific applications and how to design a material solution out that.This also includes surface treatments and coatings • Know important techniques of material design about composition of reinforced materials, coatings or the process based design of specific properties like memory effect, high temperature corrosion resistance and others. • Select appropriate investigation methods on a scientific base and to use international, European as well as german standards
Content:	Rheology: • Introduction to Rheology: Basic principles, definitions and descriptions • Rheological measuring instruments: describe diverse measuring principles, measuring geometries. • Rheology Fundamentals: Stress and Strain Fundamentals, Elastic Solids and Viscous Models, Linear Viscoelasticity, the "structured fluids" model for describing rheology, Shear and extensional flow modes, Shear stress, shear strain, shear rate and viscosity, Newtonian and Non-Newtonian flow behaviour and shear viscosity and shear-thinning behaviour. • Structure effects: yield stress, thixotropy and describing viscoelasticity, elastic and viscous modulus, phase angle and tan delta, Viscoelasticity and deformation timescale effects and FT-Rheology. Material Design • Memory effect alloys with applications • Galvanic coating methods • Materials for electronic applications • Sol-Gel process and chemistry • Introduction to laquering technology • Metals and ceramics for different applications under corrosion load • Pieze electricity and its application • Thermal spray coatings and other thick layer coating processes • Surface hardening • Simple and complex material designs for high

	temperature applications
Assessment:	Exam/Lab reports
Forms of media:	Board/Projector/Laboratory
Literature:	Rheology Christopher W. Macosko: Rheology: Principles, Measurements, and Applications (Advances in Interfacial Engineering) Nhan Phan-Thien: Understanding Viscoelasticity: Basics of Rheology (Advanced Texts in Physics) Marianna Kontopoulou: Applied Polymer Rheology: Polymeric Fluids with Industrial Applications Material Design M. F. Ashby, D. R. H. Jones: Engineering Materials 2, 3rd Ed., 2006, ISBN-13 978-0-7506-6381-6, Elsevier Current Literature from journals and conference proceedings is used. Actual applications are considered.

Module „ Biocompatible and Healthcare Materials“

Module name:	Biocompatible and Healthcare Materials
Module code:	BM_23
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr. Amir Fahmi
Lecturer:	Prof. Dr. Amir Fahmi Prof. Dr.-Ing. Raimund Sicking
Language:	Englisch
Place in curriculum	Core subject
Timetabled hours:	Lecture: 2 SWS Laboratory: 2 SWS
Workload:	60 h Attendance 60 h Self-study 30 h Exam preparation
Credits:	5
Recommended prerequisites:	Non-metallic Materials Metallic Materials and Testing
Module objectives:	The students will be able to • Demonstrate a broad understanding of the multidisciplinary fields of biomaterials • Design the properties of biomaterials in bulk and surface, degradation, interfacing, processes, fabrication, characterisation, various biological responses to the materials • Define the clinical context of the biomaterials use in medical care sectors for implants and to build medical devices. • Select the dedicated biocompatible materials for specific healthcare applications based on the ethical description and limitation.
Content:	• This is a comprehensive foundation course addresses the basic concepts of synthetic materials that are interfacing at different dimensions and length scale and response with different biological systems in a safe, reliable, and physiological acceptable manner. • It demonstrates the development of wide range of biofunctional materials designed to replace or augment damaged organs, vessels, tissues, parts, to improve both the quality of life and the length of life of many peoples.

	• Course materials will rely on learning general concepts include ethical and economic aspects to select different types of biomaterials such as polymeric, ceramics, composites and metallic materials and their structural properties, biocompatibility characteristics and performance in medicine, dentist and health care. • The course includes wide range of polymeric biomaterials such as (inert, natural, bioactive,.. and biodegradable polymers), and fabrication technology such as (Extrusion) • The course demonstrates wide range of developed and improved biomaterials examples in different health care's fields and overview of national and international regulation to the compliance and performance requirements for clinical trials and ethical issues of the biocompatible and health care materials.
Assessment:	Exam/Lab reports
Forms of media:	Board/Projector/Laboratory
Literature:	Buddy D. Ratner , Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons: Biomaterials Science, Second Edition: An Introduction to Materials in Medicine Joon B. Park and Joseph D. Bronzino: Biomaterials: Principles and Applications G. D Baura: Medical Device Technologies – A System Based Overview Using Engineering Standards, 1. Aufl., 2012, ISBN 978-0-12-374976-5, Elsevier F. A. Rodriguez-Gonzales: Biomaterials in Orthopaedic Surgery, 1. Aufl., 2009, ISBN-13 978-1-61503-009-5, ASM International E. Wintermantel, S.-W. Ha: Medizintechnik – Life Science Engineering, 5. Aufl., 2009, ISBN 978-3-540-93935-1, Springer-Verlag

Module „ Nanomaterials and Surface Modification“

Module name:	Nanomaterials and Surface Modification
Module code:	BM_24
Courses (where applicable):	Nanomaterials Surface Modification
Semester:	5th Semester
Module coordinator:	Prof. Dr. Amir Fahmi
Lecturer:	Prof. Dr. Amir Fahmi
Language:	Englisch
Place in curriculum	Core subject
Timetabled hours:	Nanomaterials Lecture: 2 SWS Laboratory: 2 SWS Surface Modification Lecture: 2 SWS
Workload:	90 h Attendance 45 h Self-study 45 h Exam preparation
Credits:	6
Recommended prerequisites:	Chemistry of Materials
Module objectives:	Nanomaterials The students will be able to • Describe the fabrication processes and equipment involved in nano-scale technology, nano-materials and nano-devices. • understand the principles of molecular self-assembly and self-organisation and the role of weak non-covalent forces in determining structure, energetics and dynamics in complex molecular systems; • An understanding of methods for producing and characterising nanoparticles and thin films of organic, inorganic and hybrid nanomaterials. • understand phase behaviour, structures and properties of nanopartilces and ordered colloidal dispersions in terms of the principles of self-organisation; • Hands-on training in synthesising nanoparticles and films.

	• An appreciation of their potential applications in electronic, biomedical and structural engineering. • Describe and discuss existing and potential products based on nano-scale technology Surface Modification: • This course is designed for undergraduate students get acquainted with a number of important techniques for the functionalisation, manipulation and charactersation of surfaces on substrates based on organic and/or inorganic ranging from metals to inorganic/ceramic materials to polymers.
Content:	Nanomaterials • Introduction to Nanomaterials: definition of nanomaterials in compare with bulk. • Classification and properties of nanomaterial: Quantum size effects, Anomalous crystal structure, Physical properties of nanomaterials, Anomalous phase transition, Thermal properties of nanomaterials, Charge and quantum transport in nanomaterials, Chemical Reactivity of the Nanomaterials. • Nanostructured materials fabrication methods at different dimensions and length scale: different types of nanoparticles, nanowires, nanofibers, nanosheets, thin film and three dimensional structured materials • Nano Scale Synthesis & Fabrication (Top Down And Bottom Up Approach): Self-Assembly: Principles of Self-Assembly, Self-Assembly of Nano materials Lithography: printing and photo/electron techniques. • Nanomaterials Characterization techniques: principle of microscopy, spectroscopy and scattering instrumentation for characterisation of nanomaterials: Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), X-ray Diffraction (XRD) , Atomic Force Microscopy (AFM), Investigation of the Surface Charge Nanomaterials by Zeta-Potential, Thermal Stability by Thermogravimetric Analysis (TA) and Differential Scanning Calorimetry (DSC), Nano Tensile Tests, Dynamic Mechanical Analysis (DMA),Structural Characterisation of Nanomaterials, Scanning Tunneling Microscope (STM) Surface Modification: • This is an introductory course in the field of surface modifications and properties. • The course covers many techniques to engineer surfaces at different dimensions and length scale. • It surveys traditional techniques that are widely used today for industrial applications (e.g., auto-

	motive, electronics industry) as well as more recently developed physical and chemical methods for surface functionalisation characteristic for many practical examples (e.g. nanostructures on lotus leaves inspire research on self-cleaning surfaces). • Various state of the art fabrication routes of micro- and nanoscale thin films will be described and illustrated with examples (self-assembly and lithographic tools: microcontact printing, dip-pen lithography and e-beam lithography). • Brief Introductions to a wide range of surface characterisation techniques for surfaces analysis and interfacial properties at different length scale.
Assessment:	Exam/Lab reports
Forms of media:	Board/Projector/Laboratory
Literature:	Nanomaterials D. Vollath: Nanomaterials: An Introduction to Synthesis, Properties and Applications Guozhong Cao and Ying Wang: Nanostructures and Nanomaterials: Synthesis, Properties, and Applications: Synthesis, Properties, and Applications (2nd Edition) (World Scientific Series in Nanoscience and Nanotechnology) Geoffrey A. Ozin, et al: Nanochemistry: A Chemical Approach to Nanomaterials, 2008) Surface Modification Rachel Williams: Surface modification of biomaterials : methods, analysis and applications George E. Totten: Surface Modification and Mechanisms: Friction, Stress, and Reaction Engineering

Module “Project II”

Module name:	Project II
Module code:	BM_25
Courses (where applicable):	
Semester:	5th semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking Prof. Dr. Alexander Struck
Lecturer:	Depending on the project
Language:	English
Place in curriculum:	Core subject
Timetabled hours:	Project work: 4 SWS
Workload:	60 h attendance 120 h preparation and review
Credits:	6
Recommended prerequisites:	Project I, specialised lectures, Fundamentals of Business Economics
Module objectives:	Students work on solutions for a given task in teams. For this, students create a functional specifications document and calculate project costs and necessary capacities. They present their self-designed concepts to their clients and are able to defend these concepts. Students react constructively to suggestions and criticism and further develop their approaches into a marketable product. They determine implementation and product costs and are able to estimate market potentials. Students contact suppliers and decide on purchase of material and components. Apart from content-related processing, students also master documenting and presenting the results and thereby interact with potential customers.
Content:	Contents are course-specific.
Assessment:	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Lecture materials and literature for specialised courses

Compulsory-Module “Finite Element Analysis”

Module name:	Finite Element Analysis
Module code:	BM_26W01
Courses (where applicable):	
Semester:	4th or 5th semester
Module coordinator:	Prof. Dr.-Ing. Henning Schütte
Lecturer:	Prof. Dr.-Ing. Henning Schütte
Language:	English
Place in curriculum:	Compulsory-Module
Timetabled hours:	Lectures: 2 SWS Practicals: 1 SWS
Workload:	45 h attendance 45 h preparation and review 30 h exam preparation
Credits:	4
Recommended prerequisites:	Mathematics and IT Material Property Calculations
Module objectives:	Students are able to decide when Finite Element Analyses can be used in a sensible way. They master the theoretical backgrounds and are able to construct suitable calculation models. Hereby, they are able to allow abstractions in a result-oriented manner, to design the simulation process efficiently. Because of their fundamental knowledge of mechanics and physics, students are able to define material characteristics and boundary conditions and to transfer them to finite models. They are able to evaluate models regarding the design of finite elements. They master different physical types of analysis and non-linear calculations as well as transient analyses. Students assess results, present them and evaluate them critically regarding their significance. Students are able to conduct, document, present and defend calculations independently.
Content:	• Concept of Finite Element Analysis • Theoretical Background of FEM • Comparison with analytical and numerical methods • Sequence of finite element calculations • element types and shape functions • degrees of freedom and coupling of elements • Linear and non-linear calculations • geometry Clean-up • Preprocessing • Solution • Post Processing • Temperature Fields

	• Topological optimization
Assessment:	Oral examination
Forms of media:	Whiteboard, PowerPoint, Projector, ANSYS
Literature:	Daryl L. Logan: A First Course the Finite Element Method, 5th edition, ISBN 978-0-495-66827, Cengage Learning, 2011 Nam-Ho Kim, Bhavani V. Sankar: Introduction to Finite Element Analysis and Design, ISBN 978-0-470-12539, Wiley and Sons, 2009 Erdogan Madenci, Ibrahim Guven: The Finite Element Method and Applications in Engineering Using ANSYS, Corrected and 4th printing, ISBN 978-0-387-28289-3, Springer, 2007

Compulsory-Module „Recycling and Foamed Materials“

Module name:	Recycling and Foamed Materials
Module code:	BM_26W02
Courses (where applicable):	Recycling and Foamed Materials
Semester:	4th or 5th Semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking
Lecturer:	Prof. Dr.-Ing. Raimund Sicking
Language:	English
Place in curriculum:	Compulsory-Module
Timetabled hours:	Lecture: 2 SWS Laboratory: 2 SWS
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Chemistry of Materials Metallic Materials and Testing Ecology of Materials
Module objectives:	Foamed Materials: The students will have an understanding of the properties of foamed materials. In addition to the classical properties of the base material, the special properties of foams will be considered in depth. Knowledge gaps in physics, engineering and chemistry limiting understanding of foams will be addressed. In particular compression of materials, energy absorbtion, thermal properties and gas dynamics will be addressed. Additionally the student will be able to describe different gas introduction processes and process technologies for foams. Recycling: The students will have knowledge of the recycling cycle beginning from the product development to reuse, recovery and recycling. They will recognise the importance of life-cycle analysis/engineering and that of sustainable produce development. The students will develop the ability to critically question the choice of materials depending upon their recyclability. They will recognize mechanical and thermal separation methods.

	The students will understand the social meanings of recycling and consider this against material cost and the use of finite resources. This knowledge will be practised through the use of practical examples and exercises; ideally with the use of an excursion to a typical industrial site where the themes are important.
Content:	Foamed Materials: • Introduction • Physical and chemical basis of foamed materials • Properties of foams - Compressile stress - Energy absorption - Thermal properties - Gas dynamics • Materials and material structure • Inducing and maintaining foaming • Applications and market • Foamed materials in nature and medicine Recycling: • Motivation • The current legal guidelines • Use of materials • Life-Cycle Engineering/Analysis • The importance of sustainable use of materials • Basics of recycling technology • Physical seperation • Chemical seperation • Specifics of the recycling of different materials (metals, polymers, ceramics) • Recycling liquids and gasses • The reuse of materials and its limits • Alternative materials and recycling
Assessment:	Written or oral Exam
Forms of media:	Board, PowerPoint, Projector
Literature:	M. F. Ashby, A. Evans, N. A. Fleck et al.: Metal Foams – A Design Guide, 1. Ed., 2000, ISBN-13 978-0-7506-7219-1, Elsevier C. Koerner: Integral Foam Molding of Light Metals. Springer. 2008. ISBN 978-3-540-68838-9.

	N. Mills: Polymer Foams Handbook – Engineering and Biomechanics Applications and Design Guide, 1. Ed., 2007, ISBN-13 978-0-7506-8069-1, Elsevier D. Eaves: Handbook of Polymer Foams. Rapra Technology Limited. 2004. ISBN 1-85957-388-6. E.P. DeGarmo, J.T. Black, R.A. Kohser. Degarmo's: Materials and Processes in Manufacturing. John Wiley & Sons. 2012. ISBN 978-0-470-92467-9. F.C. Campbell: Manufacturing Technology for Aerospace Structural Materials. Elsevier. 2006. ISBN 978-1-85-617495-4. L. J. Gibson, M. F. Ashby, B. A. Harley: Cellular Materials in Nature and Medicine,1. Ed. 2010, ISBN 978-0-521-19544-7, Cambridge University Press V. Goodship: Management, Recycling and Reuse of Waste Composites; CRC Press, 2010, ISBN-13: 978-1439827659 Vincent Rich: The International Scrap and Recycling Industry Handbook, CRC Press, 2001, ISBN-13: 978-1855732483 John Scheirs: Polymer Recycling: Science, Technology and Applications, John Wiley & Sons, 1998), ISBN-13: 978-0471970545 Matthias Finkbeiner: Towards Life Cycle Sustainability Management, Springer Netherlands, 1st Edition, 2011, ISBN-13: 978-9400718982 H. Martens: Recyclingtechnik: Fachbuch für Lehre und Praxis; Spektrum Akademischer Verlag; 2010; ISBN-13: 978-3827426406

Compulsory Module „Composite and anorganic materials“

Module name:	Composite and anorganic materials
Module code:	BM_26W03
Courses (where applicable):	
Semester:	4th or 5th Semester
Module coordinator:	N.N
Lecturer:	N.N.
Language:	English
Place in curriculum	Compulsory course
Timetabled hours:	Lecture: 2 SWS Laboratory: 2 SWS
Workload:	60 h presence 60 h preparation and wrap-up 30 h exam preparation
Credits:	5
Recommended prerequisites:	Applied Chemistry Metallic materials and Material testing
Module objectives:	Anorganic materials: Students can describe and evaluate properties and features of ceramic materials. They can understand and analyze loading cases and failure mechanisms and can distinguish the material specific differences between ceramic and metallic materials. Students are able to identify, explain and compare technologies to strengthen materials and the corresponding mechanisms. They can identify, apply and evaluate manufacturing methods for ceramic materials. The lecture explains manufacturing processes with respect to technological and economical challenges in order to enable students to select and evaluate proper methods. Composite materials: Students can distinguish, describe and evaluate the classification of fiber and laminated composites and their properties. They understand mechanical, thermal and chemical loading cases and failure mechanisms and are able to analyze them. Students are able to identify, explain and compare technologies to strengthen materials and the corresponding mechanisms.They can identify, explain and evaluate manufacturing methods for composites and multilayer materials. Moreover, they can plan and apply the evaluation of material and device characterization.

Content:	Anorganic materials: The lecture deals with material characteristics and foundations of manufacturing of ceramic materials. In addition, concepts of construction and material specific fracture mechanics are discussed, as well as ceramic materials and their properties. Ceramic materials are juxtaposed against metallic materials. Using examples from engineering and industrial needs, the application domain and limits of ceramic materials are analyzed. The topics will be consolidated by lab works. Composite Materials: The lecture covers different possibilities to strengthen materials by using material composites and laminates, with respect to material, constructive and manufacturing aspects. Materials for the matrix and the strengthening components are discussed. Composites are juxtaposed against monolithic materials. Examples from industrial application illuminate use and limits of composite materials. A focus lies on manufacturing methods for fiber and laminate composites. The topics will be consolidated by lab works.
Assessment:	Oral exam
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Carter, C. Barry, Norton, M. Grant: Ceramic Materials Science and Engineering Ceramic Materials: Science and Engineering (Apr 4, 2007) Jan Wurm: Glass Structures: Design and Construction of Self-supporting Skins (Aug 17, 2007) Serope Kalpakjian,Steven R. Schmid,Ewald Werner: Werkstofftechnik, 2011, ISBN 978-3-86794-006-0

Compulsory-Module „Technical Investment Planning“

Module name:	Technical Investment Planning
Module code:	BM_26W04
Courses (where applicable):	
Semester:	4th or 5th Semester
Module Coordinator:	Prof. Dr.-Ing. Dipl.-Wirt. Ing. Roland Schmetz
Lecturer:	Prof. Dr.-Ing. Dipl.-Wirt. Ing. Roland Schmetz Prof. Dr.-Ing. Dipl.-Wirt. Ing. Dirk Untiedt
Language:	English
Place in Curriculum	Compulsory Course
Timetabled hours:	Project: 4 SWS
Workload:	60 h attendance 50 h preparation and review 10 h exam preparation
Credits:	5
Recommended Prerequisites:	Business Economics and Project Management; Quality and Technology Management; Polymer Processing; Materials Technology
Module Objectives:	Students are able to evaluate planned technical investments. They are able to systemize issues, to formulate investment planning tasks, to compile requirement and functional specifications if applicable and to select suitable methods and instruments of evaluation. They are able to evaluate results, to assess them critically and to present them to a well-informed audience.
Content:	Within the framework of a project, a distinct (industrial) investment project is made available to the students. Students work in teams. They analyse the task, create requirement and functional specifications if applicable, invite offers and evaluate investment alternatives according to technical and economical points of view. There will be a presentation of the overall results of the investment project.
Assessment:	Attestation
Forms of Media:	Slide Presentation, Whiteboard, Projector
Literature:	Documents of the Lecturer, suitable literature will be mentioned depending on the actual project task

Compulsory Module „Materials inspired by Nature“

Module name:	Materials inspired by Nature
Module code:	BM_26W05
Courses (where applicable):	
Semester:	4th or 5th semester
Module coordinator:	Prof. Dr. Amir Fahmi
Lecturer:	Prof. Dr. Amir Fahmi
Language	English
Place in curriculum:	Compulsory Course
Timetabled hours:	Lectures: 2 SWS Practical training: 1 SWS
Workload:	45 h attendance 45 h preparation and review 30 h exam preparation
Credits:	4
Recommended prerequisites:	Chemistry of Materials Biochemistry Applied Materials
Module objectives:	Students will be able to: • recognize the most important types of materials inspired by nature • identify structures on different levels of length scale • describe natural phenomena based on different interactions between biological components • perform simple synthesis of functional materials by imitating unique characteristics of natural materials
Content:	• Fundamentals of assembly of macromolecules • Fundamentals of principles of biomineralization • Fundamentals of technical imitation • Application of nucleic-acid, lipids, protein, and hybrids in different industry sectors • Introduction into processes of self-organisation • Introduction into measurement methods for pattern and structure recognition
Assessment::	Oral examination
Forms of media:	Whiteboard, PowerPoint, Projector, Tablet
Literature:	N. Katsube, W. O. Soboyejo, M. Sacks: Functional Biomaterials, 2001, ISBN: 978-0-87849-871-0

	John E. McMurry: Organic Chemistry With Biological Applications 2nd Ed. Brooks/Cole; 2011 Sujata V. Bhat, Bhimsen A. Nagasampagi, Meenakshi Sivakumar: Chemistry of Natural Products, 1st ed. Springer 2005

Compulsory-Module “Material Testing and Failure Analysis”

Module name:	Material Testing and Failure Analysis
Module code:	BM_26W06
Courses (where applicable):	
Semester:	4th or 5th semester
Module coordinator:	Prof. Dr. Amir Fahmi
Lecturer:	Dr. Peter-Kurt Sommer
Language:	English
Place in curriculum:	Compulsory Course
Timetabled hours:	Lectures: 2 SWS Practicals: 2 SWS
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	Metallic Materials and Testing
Module objectives:	Students learn the fundamentals of material testing procedures to enable them to select and apply the optimal mechanical or destruction-free testing process after analysis and determination of features of materials. Furthermore they gain knowledge of different kinds of sample preparation, calibration of devices, examination methods and measurement evaluation. Students will independently conduct different measurement methods (such as spectroscopy, microscopy, scattering methods, ultrasound and rheology and others).
Content:	• Mechanical test methods - Quasi-static test methods: traction, pressure and bend test, test at high temperatures and long periods of exposure (creep) - Dynamic test methods: Charpy impact test • Test method for cyclic deformation: fatigue and fracture development • Destruction-free test methods - Magnetic and electromagnetic test methods - Ultrasound method - Radiographic method • Examination of chemical composition of materials with integral and local solid state method • X-ray diffraction for examining crystal structure • Back scattering electron diffraction for measuring crystal texture • Light microscopic method

	• Scanning electron microscopy • Transmission electron microscopy • Ion microscopy
Assessment:	Oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Bunge, H.J., Pöhlandt, K., Tekkaya, A.E., Banabic, D.Banabic, D.; Pöhlandt, Klaus (Eds.): Formability of Metallic Materials, Plastic Anisotropy, Formability Testing, Forming Limits, XV, ISBN 978-3-540-67906-6, 2000 R.B. Ross: Metallic Materials Specification Handbook, 4th edition, ISBN 978-0412369407, Springer US, 1991 E. Hornbogen, G. Eggeler, E. Werner: Werkstoffe: Aufbau und Characteristics von Keramik-, Metall-, Polymer- und Verbundwerkstoffen, (Materials: Structure and Features of Ceramic, Polymeric and Composite Materials), 9th completely rev. ed., ISBN 978-3540718574, Springer, 2008 George M. Crankovic: Metals Handbook: Materials Characterization, 9th edition, ISBN 978-0871700162, ASM Intl., 1989

Module „Workshop Thesis“

Module name:	Workshop Thesis
Module code	BM_28
Courses (where applicable):	
Semester:	7th Semester
Module Coordinator:	Prof. Dr.-Ing. Raimund Sicking Prof. Dr. Alexander Struck
Lecturer:	NN
Language:	English
Part of Curriculum	Core subject
Timetable hours	Seminar
Workload	180 h
Credits:	6
Recommended prerequi-sites::	
Module objectives:	The students repeat the basics of project planning from the project definition to network and resource planning. They are able to measure the project's progress.
Content:	Repetition of the following topics: • Basic principles of project management • Project planning with consideration of boundary condi-tions • Project execution and controlling • Project Review • Special research projects
Assessment:	Attestation
Forms of media:	Board, Power Point
Literature:	J. Kuster, E. Huber et al.: Handbuch Projektmanagement (Guide to Project Man-agement), Springer-Verlag, 2008 ISBN 978-3-540-7632-8 P. Clements/Jack Gido: Effective Project Management. Thomson South-Western, 2006. Rory Burke: Project Management. James 4th edition, John Wiley & Sons, 2003

	Erling S. Andersen/Kristoffer V. Grude/Tor Haug: Goal Directed Project Management. 3rd ed., Kogan Page, London, 2004 International Project Management Association (www.ipma.ch) Project Management Institute (www.pmi.org): Project Management Body of Knowledge (PMBok) GPM Deutsche Gesellschaft für Projektmanagement (German Project Management society) (www.gpm-ipma.de)

Module „Workshop Scientific methods“

Module name:	Workshop Scientific Methods
Module code	BM_29
Courses (where applicable):	
Semester:	7th Semester
Module Coordinator:	Prof. Dr.-Ing. Raimund Sicking Prof. Dr. Alexander Struck
Lecturer:	NN
Language:	English
Part of Curriculum	Core subject
Timetable hours	Seminar
Workload	180 h
Credits:	6
Recommended prerequi-sites::	
Module objectives:	The students repeat the basic principles of scientific procedure and are able to practically implement. Not only methodological aspects are considered, but also raised ethical science problems: Copyright, correct citation, plagiarism, etc.
Content:	Methodological principles encompass the entire process of the scientific question to publication of the results and formulation of hypotheses, logic, numerical and graphical data analysis, descriptive and analytical statistics, verification and falsification of hypotheses, presentation of data / results. Important forms of academic writing are analyzed using examples and played by means of a model example. The writing of scientific articles in journals is analyzed and practiced, as well as other forms of publications (posters, web pages, etc.).
Assessment:	Attestation
Forms of media:	Board, Power Point
Literature:	M. Alley The Craft of Scientific Writing (Springer New York), ISBN 0387947663

Module „Bachelor thesis“

Module name:	Bachelor thesis
Module code:	BM_30
Courses (where applicable):	
Semester:	7th Semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking Prof. Dr. Alexander Struck
Lecturer:	Project dependent
Language:	English
Place in curriculum	Core Course
Timetabled hours:	none
Workload:	360 h
Credits:	12
Recommended prerequi-sites:	Depend on topic
Module objectives:	The students - Demostrate their capability to work independently on a subject in alignment with their course of studies, meeting all topical and scientific requirements in a limited period of time - Are able to organize their workflow in order to meet the demands of the problems formulated in their theses, as well as to monitor progress and make necessary amendments - Are able to document their approach and their results to meet the requirements of a scientific publication
Content:	Thesis content depends on the chosen topic and is agrred upon with the supervisor. Documentation is granted by an adequately sized description of the topic/problem, the chosen approach, used methods and results.
Assessment:	Written thesis in the range of 40–100 pages.
Medienformen:	
Literatur:	Depends on topic

Module „Colloquium“

Module name:	Colloquium
Module code:	BM_31
Courses (where applicable):	
Semester:	7th Semester
Module coordinator:	Prof. Dr.-Ing. Raimund Sicking Prof. Dr. Alexander Struck
Lecturer:	Supervisor of bachelor thesis
Language:	English
Place in curriculum	Core Course
Timetabled hours:	none
Workload:	90 h
Credits:	3
Recommended prerequisites:	Bachelor thesis
Module objectives:	Students • Defend the results of the bachelor thesis • Place their work in a context of practical application and present their results in proper form for the audience. They motivate their approach and make estimations, how assumptions and simplifications may affect the validity of their results • Are able to analyze questions concerning their thesis and results and answer them properly in the context of professional and extra-professional reference
Content:	Content is aligned with the content of the bachelor thesis, in addition methodological discussions
Assessment:	Oral exam
Forms of media:	
Literature:	