DEGGENDORF INSTITUTE OF TECHNOLOGY

Module Handbook

Programme

Engineering Physics
(Bachelor)

Faculty

Faculty of Applied Natural Sciences and Industrial Engineering

DEGGENDORF INSTITUTE OF TECHNOLOGY DIT

Contents

Module N-01 Foundations of Mathematics

Module	N-01
Module Name	Foundations of Mathematics
Module Components (courses)	N1101 Analytical Foundations of Engineering Studies N2101 Mathematics I
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	10
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr. Michael Moritz
Admission and Recommended Prerequisites	---
Aims of the Module	Primary learning objective: Students learn the foundations of mathematics. Furthermore, students gain the following competencies: o Learning mathematical basics (i.e. terms and solution methods) as far as they are necessary for the course of studies of the first semesters o Introduction into the independent acquirement of mathematical methods for engineering applications (esp. from the literature)

Course	N1101
Name	Analytical Foundations of Engineering Studies
Instructors	Prof. Dr. Michael Moritz
Assignment to the Module	N-01 Foundations of Mathematics
Semester	1
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: attendance 60h, homework 60h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures with integrated example exercises, homework
Media Forms	Writing on the board in combination with script
Literature	Papula, L., *Mathematik für Ingenieure und*

	Naturwissenschaftler, Vieweg Verlag, Wiesbaden, 2012 Papula, L., *Mathematische Formelsammlung für Ingenieure und Naturwissenschaftler*, Vieweg Verlag, Wiesbaden, 2013
Module Head	Prof. Dr. Michael Moritz
Content	Students gain formal and mathematical competencies so that they can formally describe problems from linear algebra. Content: o Basics (e.g. set of real and complex numbers, term of mapping, ...) o Linear systems of equations, matrices, determinants o Sequences and series (real numbers) o Functions of a real variable (plane) o Curves and their mathematical description o Functions of several variables o Remarks to the functions in the n-dim. space

Course	N2101
Name	Mathematics I
Instructors	Prof. Dr. Michael Moritz
Assignment to the Module	N-01 Foundations of Mathematics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	2
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: attendance 60h, homework 60h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures with integrated example exercises, homework
Media Forms	Writing on the board in combination with script
Literature	Papula, L., *Mathematik für Ingenieure und Naturwissenschaftler*, Vieweg Verlag, Wiesbaden, 2012 Papula, L., *Mathematische Formelsammlung für Ingenieure und Naturwissenschaftler*, Vieweg Verlag, Wiesbaden, 2013
Module Head	Prof. Dr. Michael Moritz
Content	Students gain formal and mathematical competencies so that they can formally describe problems from

	analysis. Students apply their mathematical knowledge for solving formal tasks. Content: o Differential calculus (for functions of a variable) o Integral calculus o Power series o Basic terms of differential geometry of plane curves o Area computation of plane areas delimited by (random) curves o Differential calculus for functions of several variables o Optimization, least squares method o Multiple integrals o Fourier series

Module N-02 Foundations of Physics

Module	N-02
Module Name	Foundations of Physics
Module Components (courses)	N1102 Physics I N2102 Physics II
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	12
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr. Florian Flossmann
Admission resp. Recommended Prerequisites	---
Learning Objectives	Understanding physical basics of mechanics, vibrations, waves and thermodynamics. In particular, comprehension of linear movement and rotational motion. Application of conservation laws of energy, linear impulse and angular momentum. Comprehension of physical properties of fluids at rest as well as in motion. Understanding harmonic vibrations and propagation of waves. Application of the wave equation. Understanding the terms temperature, thermal energy and the laws of thermodynamics. The student should be able to analyse natural systems and processes on the base of physical basic ideas, to

	describe them with the respective physical laws and to conduct computations for given system parameters.

Course	N1102
Name	Physics I
Instructors	Prof. Dr. Florian Flossmann
Assignment to the Module	N-02 Foundations of Physics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	1
Credit Hours	6
Credit Points (ECTS)	8
Workload	240h: lectures 90h, exercises 45h, homework 45h, exam preparation 60h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, overhead projector
Literature	Tipler P.A., Mosca G., *Physik für Wissenschaftler und Ingenieure*, 6. Auflage, Spektrum Akademischer Verlag, München, 2009 Mills D. et al., *Arbeitsbuch zu Tipler/Mosca*, 2. Auflage, Spektrum Akademischer Verlag, München, 2009
Module Head	Prof. Dr. Florian Flossmann
Content	Students gain an understanding for physical connections and the ability to mathematically model physical phenomena of mechanics. Students apply their physical knowledge for solving formal tasks. Content: o Systems of units o Mechanics one-dimensional movement, movement in two or three dimensions o Newton's axioms, application of Newton's axioms, work and energy, conservation of energy, o Particle systems and the conservation of the linear impulse, rotational motions, o The conservation of the rotational momentum, gravity, fluids

Course	N2102

Name	Physics II
Instructors	Prof. Dr. Florian Flossmann
Assignment to the Module	N-02 Foundations of Physics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	2
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, exercises 20h, homework 20h, exam preparation 20h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, overhead projector
Literature	Tipler P.A., Mosca G., *Physik für Wissenschaftler und Ingenieure*, 6. Auflage, Spektrum Akademischer Verlag, München, 2009 Mills D. et al., *Arbeitsbuch zu Tipler/Mosca*, 2. Auflage, Spektrum Akademischer Verlag, München, 2009
Module Head	Prof. Dr. Florian Flossmann
Content	Students gain an understanding for physical connections and the ability to mathematically model physical phenomena of vibrations, waves and thermodynamics. Students apply their physical knowledge for solving formal tasks. Content: o Vibrations and waves: vibrations, harmonic oscillator, damped oscillation, forced oscillation and resonance, propagation of waves, Doppler effect, superposition of standing waves, dispersion o Thermodynamics: temperature and kinetic theory of gases, absolute temperature, state equations for gases, thermal energy, phase transitions and latent heat, first and second law of thermodynamics, volume work, thermal capacity of gases and solids, thermal engines, Carnot cycle, entropy, third law of thermodynamics, thermal expansion, heat transmission

Module N-03 Applied Physics

Module	N-03
Module Name	Applied Physics
Module Components (courses)	N1103 Technical Optics N2103 Physics Technical Training
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	8
Valuation Mode	The final grade of the module is formed by the partial grades of the module components weighted by ECTS credits
Module Head	Prof. Dr. Florian Flossmann
Admission resp. Recommended Prerequisites	---
Learning Objectives	o Students are supposed to understand and be able to apply the theoretical basics of optics. o They are supposed to gain knowledge about the most important optical procedures and devices. o They know the limits of real optical set-ups and know how to assess them. o Students understand the basic functional groups in optical devices. o They are able to compute simple optical systems in ray tracing programs and to interpret the various presentations of the results Deepening the understanding through a physical practical training, i.e. by own experiments, the theoretically provided knowledge from the lectures are to be deepened.

Course	N1103
Name	Technical Optics
Instructors	Prof. Dr. Florian Flossmann
Assignment to the Module	N-03 Applied Physics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	1
Credit Hours	4
Credit Points (ECTS)	4

Workload	120h: lectures 60h, exercises 15h, homework 15h, exam preparation 30h
Examination Performance	Written exam 90 min.
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, overhead projector
Literature	Schröder G., Treiber H., *Technische Optik*, 10. Auflage, Vogel, Würzburg, 2007 Litfin G., *Technische Optik in der Praxis*, 3. Auflage, Springer, Berlin, 2005 Kühlke D., *Optik: Grundlagen u. Anwendungen*, 3. Auflage, Harri Deutsch, Frankfurt am Main, 2011 Hecht E., *Optik*, 4. Auflage, Oldenbourg, München, 2005
Module Head	Prof. Dr. Florian Flossmann
Content	Students gain compentencies in the areas of ray optics and optical components. Students apply these competencies when solving tasks from optics. Content: o Light propagation and optical imaging (light, wave optics, ray optics, optical imaging, image equations) o Imaging components (materials, lenses, optical flats, prisms, image defects) o Bundle limitations (field diaphragms, aperture diaphramgs, pupils, hatches) o Fibre optics o Optical instruments (telescope, microscope, magnifier, projectors, camera lenses, magnification) o Determining data of optical systems Exercises on PC with Raytracing program

Course	N2103
Name	Physics Practical Training
Instructors	Prof. Dr. Florian Flossmann und Prof. Dr. Josef Kölbl
Assignment to the Module	N-03 Applied Physics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	2

Credit Hours	2
Credit Points (ECTS)	4
Workload	120h: attendance 30h, homework 30h, reports 30h, seminar paper 30h
Examination Performance	Seminar paper
Final Grade Formation	See module
Language	German
Teaching Methods	Practical Training
Media Forms	Own experiments
Literature	Tipler P.A., Mosca G., *Physik für Wissenschaftler und Ingenieure*, 6. Auflage, Spektrum Akademischer Verlag, München, 2009 Mills D. et al., *Arbeitsbuch zu Tipler/Mosca*, 2. Auflage, Spektrum Akademischer Verlag, München, 2009
Module Head	Prof. Dr. Florian Flossmann
Content	Students gain practical competencies in the implementation and evaluation of experiments. Content: o Experiments in the area of mechanics (ballistic pendulum, mass moment of inertia) o Experiments in the area of optics (optical devices, deflection, polarization) o Experiments in the area of thermodynamics (gas laws, thermal conduction, heat transfer) o Experiments in the area of electrical engineering

Module N-04 Foundations of Electrical Engineering

Module	N-04
Module Name	Foundations of Electrical Engineering
Module Components (courses)	N1104 Foundations of Electrical Engineering I M2104 Foundations of Electrical Engineering II
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	8
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr. Josef Kölbl

Admission resp. Recommended Prerequisites	---
Learning Objectives	Prime learning objective: Students gain knowledge about the foundations of electrical engineering. Therefore, students gain the following competencies: o Understanding the physical foundations of electrical engineering o Ability to apply general procedures for the analysis of networks o Ability to determine parameters of periodic signals o The student is able to calculate networks with sinusoidal excitations while applying the complex alternating current calculation and vector diagrams o Ability to assess systems with transfer functions o The student is able to dimension simple electrical filters o Students have gained the ability to calculate transient phenomena with boundary conditions with the aid of the Laplace transformation o Students are able to determine the spectrum of non-sinusoidal periodic signals o Students possess knowledge in the application of the simulation tool SPICE for the simulation of simple steady and unsteady problems o Practical understanding of the most important electric components like resistance, capacity and inductivity o Creation of simple circuits in the laboratory on the plug board and printed circuit board, implementation of elementary measurements o Working with multimeters, signal generators and oscilloscope.

Course	N1104
Name	Foundations of Electrical Engineering I
Instructors	Prof. Dr. Josef Kölbl
Assignment to the Module	N-04 Foundations of Electrical Engineering
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	1
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, exercises 20h, homework, 20h,

	exam preparation 20h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, overhead projector
Literature	Führer A., Heidemann K., Nerreter W., *Grundgebiete der Elektrotechnik*, Band 1, 8. Auflage (auch Aufgabenbuch), Hanser, München, 2006 Hagmann G., *Grundlagen der Elektrotechnik,* 15. Auflage, Aula-Verlag (auch Aufgabenbuch), Wiebelsheim, 2011 Moeller F. et al., *Grundlagen der Elektrotechnik*, 23. Auflage, Vieweg, Wiesbaden, 2013
Module Head	Prof. Dr. Josef Kölbl
Content	Students gain the ability to analyse networks with general procedures and to determine parameters of periodic signals. Content: o Physical foundations: physical parameters, Ohm's law, work, power, sources o Network Theory: Kirchhoff's laws, general network analysis, network theorems o Non-linear elements o Periodic signals: parameters, power, Fourier series expansion o AC circuits: AC components, parameters, complex AC calculation o Frequency responses, normalization, Decibel-values o Practical training: Introduction into Spice, simulation of DC and AC currents

Course	N2104
Name	Foundations of Electrical Engineering II
Instructors	Prof. Dr. Josef Kölbl
Assignment to the Module	N-04 Foundations of Electrical Engineering
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	2
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, exercises 20h, homework, 20h, exam preparation 20h
Examination Performance	See module
Final Grade Formation	See module
Language	German

Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, overhead slides
Literature	Führer A., Heidemann K., Nerreter W., *Grundgebiete der Elektrotechnik*, Band 1 und 2, 8. Auflage (auch Aufgabenbuch), Hanser, München, 2006 Hagmann G., *Grundlagen der Elektrotechnik,* 15. Auflage, Aula-Verlag (auch Aufgabenbuch), Wiebelsheim, 2011 Moeller F. et al., *Grundlagen der Elektrotechnik*, 23. Auflage, Vieweg, Wiesbaden, 2013
Module Head	Prof. Dr. Josef Kölbl
Content	Students gain the ability to calculate and dimension electric filters and to analyse transient phenomena with boundary conditions with the aid of the Laplace transformation. Students gain competencies when describing systems in the state space (setting up equations, solving equations) Content: o Frequency response functions, Bode diagrams, locus o Electric filters: curves, filter types, realizations, passive filters, active filter circuits with operational amplifiers o Periodic non-sinusoidal and non-periodic non-sinusoidal signals: Fourier series, Fourier spectrum, Fourier transformation o Transient phenomena: Laplace transformation, calculation of transient phenomena with boundary conditions with the aid of the Laplace transformation

Module N-05 Chemistry and Materials

Module	N-05
Module Name	Chemistry and Materials
Module Components (courses)	N1105 Chemistry N2105 Materials
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	8
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr.-Ing. Christine Wünsche

Admission resp. Recommended Prerequisites	---
Learning Objectives:	Prime learning objective: Students learn the foundations of chemistry and materials. Thereto, students gain the following competencies: o Understanding the composition of matter and from that deriving the structure characteristics relationships of materials relevant for mechanical engineering like plastics, ceramics and metals. Mechanic, thermal and electric properties of matter are concluded from the bonding characteristics. o The chemical process with many ordinary reactions, like for example the solubilization of metals in acid or rusting, can be concluded by imparting chemical reactions like acid/base reactions or redox reactions. o Beyond that, course contents like chemical equilibrium and kinetics enable students to quantitatively describe chemical processes. o Ability to assess the behavior of materials o Adjust mechanical properties specifically by microstructure modifications o Understanding the basic structure property correlations o Ability to choose appropriate materials and material combinations considering the property profile, the component geometry and component load

Course	N1105
Name	Chemistry
Instructors	Dr. Roland Krieglstein
Assignment to the Module	N-05 Chemistry and Materials
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	1
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, exercises 20h, homework 20h, exam preparation 20h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, molecular models

Literature	Riedel E., Janiak Ch., *Anorganische Chemie*, 6. Aufl., de Gruyter, Berlin, 2007 Mortimer C.E., Müller U., Beck J., *Chemie*, 11. Auflage, Thieme, Stuttgart, 2014 Hoinkis J., Lindner E., *Chemie für Ingenieure*, 13. Auflage, Wiley-VCH, Weinheim, 2007
Module Head	Prof. Dr.-Ing. Christine Wünsche
Content	Students gain competencies when analyzing and solving tasks in the areas of organic, inorganic and physical chemistry. Content: o Composition of matter: elementary particles, radioactivity, atomic structure (shell model, orbitals), derivation of the period system of elements o Chemical bonding: covalent, ionic and metal bonding, semiconductors, semi-valences (van der Waals interactions, hydrogen bonds) o Chemical equations: acid/base reactions, redox reactions o Chemical equilibria: law of mass action, pH-value and acid/base starch, solubility product, general gas equation o Properties of catalysts o Foundations of electrochemistry: series, Danielle element, lead-acid battery, corrosion, corrosion control o Foundations of organic chemistry: alkanes, alkenes, alkynes, rules of nomenclature with simple substituents, cis-trans isomerism, radical polymerization, thermoplastics – duroplasts - elastomers

Course	N2105
Name	Materials
Instructors	Prof. Dr.-Ing. Christine Wünsche
Assignment to the Module	N-05 Chemistry and Materials
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	2
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, exercises 20h, homework 20h, exam preparation 20h
Examination Performance	See module

Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, overhead projector
Literature	Bergmann W., *Werkstofftechnik,* Teil 1 und 2, 6. Auflage, Hanser, München, 2008 Bargel H. J., Schulze G., *Werkstoffkunde*, 11. Auflage, Springer, Berlin, 2012 Ilschner B., Singer R. F., *Werkstoffwissenschaften und Fertigungstechnik*, 5. Auflage, Springer, Heidelberg, 2010
Module Head	Prof. Dr.-Ing. Christine Wünsche
Content	Students gain knowledge about the basics, production and application of materials. Students gain the ability to select materials according to predetermined specifications as well as to judge their operational behavior. Content: o Classification of materials, o Crystalline condition, o Elastic and plastic behavior, o Thermally-activated processes, o Phase transitions, formation of alloys, o Equilibrium diagrams, the system iron-carbon o Mechanically destructive test procedures o Electric, magnetic properties in relation to the composition of matter o Optical properties o Introduction into fracture mechanics o Foundations of production procedures of selected materials

Module N-06 Informatics

Module	N-06
Module Name	Informatics
Module Components (courses)	N1106 Informatics I N2106 InformaticsII
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	10

Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr. Thomas Stirner
Admission resp. Recommended Prerequisites	---
Learning Objectives	Prime learning objective: Students learn the foundations of informatics and the working with a programming language. Thereto, students gain the following competencies: o Basic understanding of computer hardware and peripheral devices o Skills in calculating with Boolean algebra, elementary calculation operations with binary numbers, conversion from and to the hexadecimal number system o Working with an operating system (windows and command lines-oriented) o Understanding the tools Editor, Assembler, Compiler, Linkers. o Knowledge of elementary software engineering methods, ability to apply programming guidelines o Mastering the handling of a C development environment, understanding the tasks of a precompiler o Students are to be enabled to algorithmize problems of simple to medium complexity and to code them successfully with the aid of the language C.

Course	N1106
Name	Informatics I
Instructors	Dipl.-Ing. (FH) Peter Eimerich
Assignment to the Module	N-06 Informatics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	1
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: attendance 60h, homework 60h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German

Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, script, projector, exercises
Literature	Rechenberg P., *Was ist Informatik?*, 3. Auflage, Hanser, München, 2000 Skript
Module Head	Prof. Dr. Thomas Stirner
Content	Students gain a basic understanding of digital computers and their functionality. Content: o Computer architecture and perpherical devices o Number systems, coding, Boolean algebra o Operating systems, working with operating systems and file systems o Software engineering tools: Editor, Complier, Linker

Course	N2106
Name	Informatics II
Instructors	Prof. Dr. Thomas Stirner
Assignment to the Module	N-06 Informatics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	2
Credit Hours	4 (2 V + 2 P)
Credit Points (ECTS)	5
Workload	150h: attendance lectures 30h, practical training 30h, preparation and follow-up lectures and computer practical training (partly as homework) 60h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Seminar-like lessons, exercises, practical training
Media Forms	Board, exercises Script, slides PC/Laptop, projector Computer practical training
Literature	Klima R., Selberherr S., *Programmieren in C*, 3. Auflage, Springer, Berlin, 2010 Erlenkötter H., *C Programmieren von Anfang an*, 13. Auflage, Rowohlt, Hamburg, 2007
Module Head	Prof. Dr. Thomas Stirner
Content	Students gain knowledge of and the ability to apply a higher programming language, in particular the programming language C.

	Content: o Software Engineering; process models, organization of software projects, programming guidelines o Theoretical informatics: minimal computer models, computability o Development environment for C programming: gcc, Dev-Cpp o Precompiler: include, define macros o Data types, data structures: integral numbers, numbers of points, characters/character strings, abstract data types o Arithmetic operators, comparisons, logical operators o Control structures: branches, loops, functions, recursions o Pointers: character strings, vectors, fields, linked lists o Dynamic memory management

Module N-07 English

Module	N-07
Module Name	English
Module Components (courses)	N2107 English for Engineers
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	4
Valuation Mode	Total module examination: Written exam 60 min or oral exam 30 min
Module Head	Tanja Mertadana M.A.
Recommended Prerequisites	B1: O-level; B2: A-level
Learning Objectives	o Analyze listening texts from engineering or business contexts for global and detailed information o Summarize orally reading and listening texts o Fluently comment in discussions o Create short presentations o Quickly read technical texts and distinguish between global and detailed knowledge o Be able to expand and apply vocabulary to general technical and business areas o Improvement of the written expression

Course	N2107
Name	English for Engineers
Instructors	Deborah Lehman-Irl M.A.
Assignment to the Module	N-07 English
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	2
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures with exercises 60h, homework 30h, exam preparation 30h
Examination Performance	Proof of academic achievement + written exam 60min or oral exam 30min
Final Grade Formation	Written exam 100% or oral exam 100%
Language	English
Teaching Methods	Language course with group and partner work
Media Forms	OHP, CD, board
Literature	„Englisch für technische Berufe“
Module Head	Tanja Mertadana M.A.
Content	Students gain foreign-language competencies, in particular through reading texts, listening texts and conversations in the area of technical English. Content: e.g. materials and their properties, energy, job applications, alternators, bridges, HDTV; Grammar: Passive, if needed additional topics; the material is partly taken from textbooks, partly current texts from magazines, Internet

Module N-08 Presentation Techniques

Module	N-08
Module Name	Presentation Techniques
Module Components (courses)	N3101 Presentation Techniques
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	2
Valuation Mode	Total module examination

	Oral exam 30 min
Module Head	Prof. Peter Schmieder
Recommended Prerequisites	---
Learning Objectives	The ability to prepare specialized and general educational topics for a presentation and to give a competent talk in front of audience.

Course	N3101
Name	Presentation Techniques
Instructors	Thomas Weiß M.A.
Assignment to the Module	N-08 Presentation Techniques
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	3
Credit Hours	2
Credit Points (ECTS)	2
Workload	60h: lectures with exercises 30h, homework 15h, presentation preparation 15h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, overhead projector
Literature	Bernstein, D., *Die Kunst der Präsentation*, Campus Verlag, Frankfurt a. M., 1992 Hierhold, E., *Sicher präsentieren – wirksamer vortragen*, 7. Auflage, Redline, Wien, 2005 Kratz, H.-J., *Rhetorik, Schlüssel zum Erfolg*, Modul Verlag, Wiesbaden, 1989 Scheler, U., *Informationen präsentieren*, Gabal Verlag, Offenbach, 1997
Module Head	Prof. Peter Schmieder
Content	Students gain the ability to present and defend scientific information in front of professional audience. Content: • Preparation of a presentation (addressee analysis, aim of the presentation, available time, available media, etc.) • Structure of a presentation (introduction, main part, conclusion) • Presentation and way of speaking • Gestures and facial expression • Visualization

	• Design of slides • Reaction to questions

Module N-09 Advanced Mathematics

Module	N-09
Module Name	Advanced Mathematics
Module Components (courses)	N3102 Mathematics II N4101 Mathematics III
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	9
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr.-Ing. Christine Wünsche
Admission resp. Recommended Prerequisites	N1101 Analytical Foundations of Engineering Studies N2101 Mathematics I
Learning Objectives	Prime learning objective: Students gain knowledge of higher mathematics. Thereto, students gain the following competencies. o Understanding the mathematical approach for engineer problem solving of technical problems that are solved and described applying the methods of higher mathematics. In particular, students look closely at the mathematical handling of vector analysis and differential equations in the technical application context, i.e. starting from modelling to (analytical) solving to the interpretation of results. o Ability to work in a team from a professional perspective (i.e. creating the preconditions to a professional discussion with colleagues from related scientific fields like for example engineers, economists, etc.) o The student gets familiar with the essence and the meaning of mathematical models as a major component of the increasingly important simulation programs, whereat in particular the topics from the application areas measurement and control engineering, heat transmission and fluid mechanics are in the foreground.

Course	N3102

Name	Mathematics II
Instructors	Prof. Dr.-Ing. Christine Wünsche
Assignment to the Module	N-09 Advanced Mathematics
Semester	3
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: attendance 60h, homework 30h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Mehtods	Lectures with integrated example exercises, homework
Media Forms	Writing on the board in combination with a script
Literature	Papula, L., *Mathematik für Ingenieure und Naturwissenschaftler*, Vieweg Verlag, Wiesbaden, 2009 Papula, L., *Mathematische Formelsammlung für Ingenieure und Naturwissenschaftler*, Vieweg Verlag, Wiesbaden, 2009 Rießinger T., *Mathematik für Ingenieure*, 5. Auflage, Springer, Berlin, 2005 Stroud, K.A., Dexter J. Booth: *Engineering Mathematics,* 7. Auflage, Industrial Press, New York, 2013 Stroud K.A., Dexter J. Booth: *Advanced Engineering Mathematics*, 5. Auflage, Palgrave Macmillan, New York, 2011
Module Head	Prof. Dr.-Ing. Christine Wünsche
Content	Students gain formal and mathematical competencies so that they can formally describe problems from the areas of differential equations, Fourier and Laplace transformation. Students apply their mathematical knowledge when solving formal tasks. Content: o (Ordinary) differential equations of the first, second and higher order o Examples of numerical methods for solving ordinary differential equations o Fourier series o Fourier transformation o Laplace transformation o Application examples from science and technology

Course	N4101

Name	Mathematics III
Instructors	Prof. Dr.-Ing. Christine Wünsche
Assignment to the Module	N-09 Advanced Mathematics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	4
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: attendance 60h, homework 60h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures with integrated example exercises, homework
Media Forms	Writing on the board in combination with a script
Literature	Papula, L., *Mathematik für Ingenieure und Naturwissenschaftler*, Vieweg Verlag, Wiesbaden, 2009 Papula, L., *Mathematische Formelsammlung für Ingenieure und Naturwissenschaftler*, Vieweg Verlag, Wiesbaden, 2009 Stroud, K.A., Dexter J. Booth: *Engineering Mathematics,* 7. Auflage, Industrial Press, New York, 2013 Stroud K.A., Dexter J. Booth: *Advanced Engineering Mathematics*, 5. Auflage, Palgrave Macmillan, New York, 2011
Module Head	Prof. Dr.-Ing. Christine Wünsche
Content	Students gain formal and mathematical competencies so that they can formally describe problems from vector analysis. Content: o Vector analysis o Scalar and vector fields o Gradient of a scalar field o Divergence and rotation of a vector field o Line and curve integrals o Surface integrals o Integral theormes by Gauß and Stokes

Module N-10 Advanced Physics

Module	N-10
Module Name	Advanced Physics
Module Components (courses)	N3103 Physics III N4102 Physics IV
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	12
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr. Thomas Stirner
Admission resp. Recommended Prerequisites	N1102 Physics I N2102 Physics II
Learning Objectives	Prime learning objective: students gain profound knowledge in the areas of electrodynamics and modern physics. Thereto, students gain the following competencies: Understanding physical basics in the areas of electricity, magnetism and light, as well as modern physics with the topics theory of relativity, quantum physics, quantum mechanics, solid-state physics and introduction into particle physics. Ability to analyze natural systems and processes on the base of physical main ideas, to describe them with the respective physical laws and to conduct calculations for given system parameters, right up to the interpretation of results. Ability to work in a team from a professional perspective (i.e. creating the preconditions to a professional discussion with colleagues from related scientific fields like for example engineers, chemists, etc.)

Course	N3103
Name	Physics III
Instructors	Prof. Dr. Thomas Stirner
Assignment to the Module	N-10 Advanced Physics

Semester	3
Credit Hours	6
Credit Points (ECTS)	6
Workload	180h: attendance 90h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures with integrated example exercises, homework
Media Forms	Projector, writing on the board in combination with a script
Literature	Tipler P.A., Mosca G., *Physik für Wissenschaftler und Ingenieure*, 6. Auflage, Spektrum Akademischer Verlag, München, 2009 Mills D. et al., *Arbeitsbuch zu Tipler/Mosca*, 2. Auflage, Spektrum Akademischer Verlag, München, 2009
Module Head	Prof. Dr. Thomas Stirner
Content	Students gain an understanding for physical connections and the ability to mathematically model physical phenomena of electrostatics and electrodynamics. Students apply their physical knowledge when solving formal tasks. Content: o Electric fields o Discrete and continuous charge distribution o The electric potential o Electrostatic energy o Capacity o Electric current – DC circuits o The magnetic field o Sources of a magnetic field o The magnetic induction o Maxwell‘s equations o Electromagnetic waves o Properties of light o Polarization o Interference and diffraction
Course	N4102
Name	Physics IV
Instructors	Prof. Dr. Thomas Stirner
Assignment to the Module	N-10 Advanced Physics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General

Semester	4
Credit Hours	6
Credit Points (ECTS)	6
Workload	180h: attendance 90h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures with integrated example exercises, homework
Media Forms	Writing on the board in combination with a script
Literature	Tipler P.A., Mosca G., *Physik für Wissenschaftler und Ingenieure*, 6. Auflage, Spektrum Akademischer Verlag, München, 2009 Mills D. et al., *Arbeitsbuch zu Tipler/Mosca*, 2. Auflage, Spektrum Akademischer Verlag, München, 2009
Module Head	Prof. Dr. Thomas Stirner
Content	Students gain an understanding for physical connections and the ability to mathematically model physical phenomena of the theory of relativity and quantum mechanics. Students apply their physical knowledge when solving formal tasks. Content: o Theory of relativity o Wave-particle duality o Quantum physics o Applications of Schrödinger equations o Solid-state physics o Elementary particles and the origin of the universe

Module N-11 Measurement Engineering

Module	N-11
Module Name	Measurement Engineering
Module Components (courses)	N3104 Measurement Engineering
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	6
Valuation Mode	Total module examination Written exam 90 min.

Module Head	Prof. Dr. Josef Kölbl
Prerequisites	Lectures: Physical and mathematical basics Practical training: 42 ECTS credits; two of the three exams N1101 Analytical Foundations of Engineering Studies, N1102 Physics I and N1104 Foundations of Electrical Engineering I
Learning Objectives	Knowledge of the principles of measurement technology, application of bridge circuits for the evaluation of sensor signals, ability to describe systematic and random errors and to assess the influence of several error sources on measurement results. Application of numeric methods like for example measurement statistics, curve-fitting, DFT, correlation functions.

Course	N3104
Name	Measurement Engineering
Instructors	Prof. Dr. Josef Kölbl
Assignment to the Module	N-11 Measurement Engineering
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	3
Credit Hours	6 (4 lectures + 2 practical training)
Credit Points (ECTS)	6
Workload	180h: lectures with exercises 60h, practical training 30h, practical training preparation and follow-up 45h, homework 20h, exam preparation 25h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises, practical training
Media Forms	Board, projector, overhead projector
Literature	Parthier, R., *Messtechnik*, 6. Auflage, Vieweg, Wiesbaden, 2012 Profos P., Pfeifer T., *Grundlagen der Messtechnik*, 5. Auflage, Oldenbourg-Verlag, München, 1997
Module Head	Prof. Dr. Josef Kölbl
Content	Students are able to assess the limits of a measurement, know the basic circuits and principles

	of measurement technology and are able to design and dimension measure arrangements. Content: o Measuring: measurement parameters, unit system o Measurement signals: classification and conversion, characterization o Measurement methods: amplitude, difference method, compensation o Measuring devices: basic structure, static and dynamic parameters o Evaluation of measurement results: deviations, error propagation of systematic and random deviations; types of errors o Measuring electric parameters: electricity, voltage, resistance, capacity, inductivity o Measuring non-electric parameters: time and frequency (setup of Cs and Rb atomic clocks) o Measurement technology of operational amplifiers o Structure and effect of a oscilloscope o Analogue and digital converters o Numeric procedures (measurement statistics, curve-fitting, DFT, FFT) o Correlation of signals (application in GPS, VLBI)

Module N-12 Microcomputer Technology

Module	N-12
Module Name	Microcomputer Technology
Module Components (courses)	N3105 Microcomputer Technology
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	5
Valuation Mode	Total module examination: Written exam 90 min.
Module Head	Prof. Dr. Robert Bösnecker
Prerequisites	Lectures: N-01 Foundations of Mathematics N-06 Informatics Practical training: At least 42 ECTS credits; two of the three exams N1101 Analytical Foundations of Engineering Studies,

	N1102 Physics I and N1104 Foundations of Electrical Engineering I need to be passed.
Learning Objectives	o Students know the hardware structure and function of microprocessors and microcontrollers o They understand the structure and the application possibilities of the most important memory and peripheral components o They learn basic abilities for the development, setup and programming of microcomputer systems

Course	N3105
Name	Microcomputer Technology
Instructors	Prof. Dr. Robert Bösnecker
Assignment to the Module	N-12 Microcomputer Technology
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	3
Credit Hours	4 (2 lectures + 2 practical training)
Credit Points (ECTS)	5
Workload	150h: lectures 30h, microcontroller laboratory 30h, laboratory preparation and follow-up 35h, homework 25h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises, practical training
Media Forms	Board, projector, overhead projector
Literature	Script
Module Head	Prof. Dr. Robert Bösnecker
Content	Students gain the ability to program „Embedded Systems“. Students gain competencies in the area of realization of complex microcomputer systems in hard and software. Content: o Structure and function of a simple microcontroller using the example of the Atmel AVR/ARM family o Layout of an own printed circuit board o Programming microcontrollers (assemblers, compilers, interpreters, IDE, typical program examples) o Typical error sources of microcontroller programs, debugging programs

	o Exemplary studies of peripheral functions of microcontrollers o Structures and abilities of greater microcontrollers o Insight into RISC/CISC architectures and DSP structures, criteria for the evaluation and selection of microcontrollers when used practically

Module N-13 Digital Technology

Module	N-13
Module Name	Digital Technology
Module Components (LV)	N3106 Digital Technology
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	6
Valuation Mode	Total module examination Written exam 90 min.
Module Head	Prof. Dr. Robert Bösnecker
Prerequisites	Lectures: N-04 Foundations of Electrical Engineering N-06 Informatics Practical training: 42 ECTS credits; two of the three exams N1101 Analytical Foundations of Engineering Studies, N1102 Physics I and N1104 Foundations of Electrical Engineering I
Learning Objectives	o Knowledge of the basics of digital circuits o Ability to synthesize and analyze digital systems o Knowledge of the advantages and disadvantages of various digital circuit families o Installation and start-up of digital circuits in lab experiments o Getting familiar with typical measurements on digital circuits

Course	N3106
Name	Digital Technology
Instructors	Prof. Dr. Robert Bösnecker
Assignment to the Module	N-13 Digital Technology
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	3
Credit Hours	4 (2V + 2P)
Credit Points (ECTS)	6
Workload	180h: lectures 30h, digital technology laboratory 30h, laboratory preparation and follow-up 45h, homework 35h, exam preparation 40h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises, practical training
Media Forms	Board, projector, overhead projector
Literature	Scarbata G., *Synthese und Analyse digitaler Schaltungen*, Oldenbourg, München, 2001 Pernards P., *Digitaltechnik*, Hüthig, Heidelberg, 2001 Hoffmann D. W., *Grundlagen der Technischen Informatik*, Hanser, München, 2013
Module Head	Prof. Dr. Robert Bösnecker
Content	o Theorems and laws of switching algebra o Switching function (normal forms of switching functions, minimization of switching functions) o Combinational circuits (general design guidelines, code converters, comparators, multiplexors and demultiplexors, adders, dynamic behavior of combinational circuits) o Flip-flop, bistable triggers (basis-RS-flip-flop, D-flip-flop, JK-flip-flop, conversion of flip-flop) o Counters (design of parallel counters, electric switches, latches) o Sequential switching, switchgears, digital automates (description and design of switchgears, switchgear of the change machine, operational modes of automates, types of automates, completeness and consistency, equivalence of Moore and Mealy automates, inventory reduction, coding of automates, design of complex circuits on the base of Moore and Mealy automates

	o Electronic realization of logic functions (CMOS logic families) o Programmable logic circuits o Principle structure

Module N-14 Control Engineering

Module	N-14
Module Name	Control Engineering
Module Components (courses)	N4103 Control Engineering
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	5
Valuation Mode	Total module examination Written exam 90 min
Module Head	Prof. Dr.-Ing. Peter Firsching
Recommended Prerequisites	N-01 Foundations of Mathematics N-04 Foundations of Electrical Engineering N-11 Measurement Technology
Learning Objectives	o Familiarity with the modelling of simple mechatronic systems in the state space, o Getting familiar with the most important properties of simple transfer functions o Master the application of algebraic stability criteria to controlled systems and closed loop systems o Abilities for stability testing according to Nyquist o Recognition of advantages and disadvantages of design methods my means of “frequency characteristics” and “root locus” o Furthermore, students are to be able to create simple simulation models with MATLAB and SIMULINK and to solve the described design tasks.

Course	N4103

Name	Control Engineering
Instructors	Prof. Dr.-Ing. Peter Firsching
Assignment to the Module	N-14 Control Engineering
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	4
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, demonstrations with MATLAB, SIMULINK on the projector
Literature	Unbehauen H. , *Regelungstechnik 1*, 14.Auflage, Vieweg, Wiesbaden, 2007 Dorf R. C., Bishop R. H., *Moderne Regelungssysteme*, Pearson-Deutschland, München, 2006
Module Head	Prof. Dr.-Ing. Peter Firsching
Content	o Basic terms, measurement principles and measurement chains o Modelling mechatronic systems o Repetition Laplace transformation o Linearization, inoperative state, transmission function o Creation, conversion of block diagrams o Properties of selected transmission functions of 1. and 2. order in the time and frequency domain o Influence of nulls on system dynamics o BIBO stability, proof according to Hurwitz / Routh o Bode diagram and Nyquist locus o Closed loop system and its properties, permanent control deviation o General and special Nyquist criterion in locus and Bode diagram, root locus according to Evans, main features of the design by means of WOK to dominant pole pairs o Parameterization of PID controller with frequency response and locus design o Multiloop control circutis

Module N-15 Microsystems Technology

Module	N-15
Module Name	Microsystems Technology
Module Components (courses)	N4104 Microsystems Technology
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	5
Valuation Mode	Total module examination Written exam 90 min
Module Head	Prof. Raimund Förg
Recommended Prerequisites	N-04 Foundations of Electrical Engineering N-06 Informatics N-12 Microcomputer Technology
Learning Objectives	o Students gain basic knowledge about application areas and production procedures of microsystems o They learn methods for the production of microsystems, resp. the production of transistors on silicon basis o Gaining a functional understanding of microsystems and acquisition of the ability to practically apply integrated circuits and systems.

Course	N4104
Name	Microsystems Technology
Instructors	Prof. Raimund Förg
Assignment to the Module	N-15 Microsystems Technology
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	4
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, projector, overhead projector
Literature	Widmann D., Mader H., Friedrich H., *Technologie hochintegrierter Schaltungen*, 2. Auflage, Springer, Berlin, 1996 Hoppe B., *Mikroelektronik 1 und 2*, Vogel, Würzburg, 1997 Gerlach G., Dötzel W., *Einführung in die Mikrosystemtechnik*, Hanser Verlag, München, 2006 Brück R., Rizvi N., Schmidt A., *Angewandte Mikrotechnik*, Hanser, München, 2001 Chang C. Y., Sze S. M., *ULSI Technology,* McGraw-Hill, Singapore, 1996
Module Head	Prof. Raimund Förg

Content	o Introduction and motivation, development of the IC market, overview: electronic circuits and IC technologies o Band model, Fermi energy, impurity atoms o Metal semiconductor contacts (Schottky contacts), pn junction o MOS capacitor, MOS transistor o Bipolar transistor o Semiconductor technology and microfabrication, production of monocrystalline silicon wafers, doping semiconductor material o Layer technology, SiO_2 layers, epitaxial layers o CVD surface layers, etching and cleaning technology, overall process o Housing technology, structure minimization and development trends in CMOS technology o Microsystems technology, sensors, actuators, integrated systems o Design and layout of integrated circuits

Module N-16 Foundations of Optoelectronics

Module	N-16
Module Name	Foundations of Optoelectronics
Module Components (courses)	N4105 Optoelectronics /Laser Technology 1
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	5
Valuation Mode	Total module examination
Module Head	Prof. Dr. Franz Daiminger
Recommended Prerequisites	N-02 Foundations of Physics N-03 Applied Physics
Learning Objectives	o Knowledge of the elementary processes of light development and the interaction of light and matter o Theoretic understanding about the functionality of a laser. The student is therefore supposed to be able to allocate the individual components of a laser to their fundamental functions o Knowledge about the properties and characteristics of laser radiation. The student is able to understand the given information about laser radiation in data sheets of lasers and to adjust those with the requirements of industrial applications. o Knowledge of the constructive structure of technical components of a laser o Knowledge of the operating modes of lasers and the thereby emitted laser radiation o Knowledge of the most important laser types and their characteristic properties. The student is able to name lasers that are possible to apply in various categories.

Course	N4105
Name	Optoelectronics/Laser Technology 1
Instructors	Prof. Dr. Franz Daiminger
Assignment to the Module	N-16 Foundations of Optoelectronics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	4

Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises, practical trainings
Media Forms	Board, projector, overhead projector, experiments during lectures and demonstration objects
Literature	Eichler J., Eichler H. J., *Laser*, 7. Auflage, Springer, Berlin, 2010 Meschede D., *Optics, Light and Lasers*, 2. Auflage, Wiley VCH, Weinheim, 2006 Hecht E., *Optik*, 5. Auflage, Oldenbourg, München, 2009
Module Head	Prof. Dr. Franz Daiminger
Content	o Light, atoms, molecules, solid bodies and black radiator o Absorption, spontaneous emission, stimulated emission, linewidth o Principle structure and functionality of a laser, balance equations o Propagation of light, Gaussian beam and its transformation, the beam parameter product o Optical resonators, longitudinal, transversal modes and coherence o Pulsed operating modes of lasers, relaxations oscillation, Q switch, Cavity Dumping, Modelocking, compression of pulses o Most important types of lasers, overview laser applications o Practical experiments parallel to lectures

Module N-17 Statistics

Module	N-17
Module Name	Statistics
Module Components (courses)	N4106 Statistics
Assignment to the Curriculum:	Applied Physics (Bachelor)

Study Focus	General
Credit Points (ECTS)	5
Valuation Mode	Total module examination Written exam 90 min
Module Head	Prof. Dr. Peter Ullrich
Recommended Prerequisites	N-01 Foundations of Mathematics N-11 Measurement Technology
Learning Objectives	o Students are able to solve self-reliantly simple statistical problems from scientific and engineering practice o Students master the methods of errors computation, in particular with error propagation of random errors o Students are able to classify influences of stochastic nature to measurement chains and to approximately compute their impact.

Course	N4106
Name	Statistics
Instructors	Prof. Dr. Peter Ullrich
Assignment to the Module	N-17 Statistics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	4
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Wird in der Vorlesung bekanntgegeben
Module Head	Prof. Dr. Peter Ullrich
Content	Introduction into the methods of statistics, as far as they are necessary for scientific and engineering applications. Content: o Introduction and overview o Descriptive statistics o Basic terms of probability calculus o Inferential statistics o Application examples from engineering practice (e.g. quality control, FMEA, design of experiments and test evaluation) o Application of statistical methods to sensors, measurement technology and quality management

Module N-18 Optical Materials

Module	N-18
Module Name	Optical Materials
Module Components (courses)	N5101 Optical Materials
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Credit Points (ECTS)	5
Valuation Mode	Total module examination Written exam 90 min
Module Head	Prof. Dr. Michael Moritz
Recommended Prerequisites	N-03 Applied Physics N-05 Chemistry and Materials N-10 Advanced Physics
Learning Objectives	o Supposed to be a foundation lecture so that future physics engineers understand and are able to evaluate the meaning of modern production and the applied optical materials, and the possible difficulties when dealing with and designing production equipment o Special focuses are the materials that are applied when manufacturing optical components.

Course	N5101
Name	Optical Materials
Instructors	Prof. Dr. Michael Moritz
Assignment to the Module	N-18 Optical Materials
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	5
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	See script for literature list

Module Head	Prof. Dr. Michael Moritz
Content	o The selection of appropriate optical materials is of major significance regarding the functionality of optical components and the modules produced from that. The economic success of a optomechatronic system substantially depends on the selection of appropriate materials. o The lectures are supposed to impart knowledge of the materials and their properties in technology and application. With that knowledge, the selection of materials should take place in a profound way. The respective material-specific properties are discussed by means of examples. o Focuses are the optical and other properties of materials and their description resp. classification.

Module N-19 Advanced Optoelectronics

Module	N-19
Module Name	Advanced Optoelectronics
Module Components (courses)	N5102 Optoelectronics/Laser Technology 2 N5103 Optical Sensor Technology and Measurement Engineering
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Credit Points (ECTS)	8
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr. Franz Daiminger
Recommended Prerequisites	N-11 Measurement Engineering N-16 Foundations of Optoelectronics
Learning Objectives	Students are supposed to have extended knowledge of manipulation of light. With that knowledge, they have the precondition to understand many existing technical solutions in laser technology, optical sensor technology and optical measurement technology.

	o Ability to work self-reliantly on new solutions after a certain training period o Students are supposed to understand the theoretical basics of the structure and the formation of light in optoelectronic semiconductor components and to have knowledge about the structure and characteristics of the most important semiconductor lasers and light-emitting diodes. o Understanding and application of sensor measurement principles in optical measurement engineering o Ability to assess measurement problems in optical sensor technology o Ability to select in an application-oriented way the measurement principles for special tasks and assessment of the implementation possibility. o Detailed knowledge and understanding for applications of optical sensor technology and measurement technology o Understanding optoelectronic systems, laser measurement technology and optical measurement technology

Course	N5102
Name	Optoelectronics/Laser Technology 2
Instructors	Prof. Dr. Franz Daiminger
Assignment to the Module	N-19 Advanced Optoelectronics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	5
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, homework 30h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector, demonstration objects
Literature	Eichler J., Eichler H. J., *Laser*, 7. Auflage, Springer,

	Berlin, 2010 Bludau W., *Halbleiter-Optoelektronik*, Hanser, Leipzig, 1995 Schubert E. F., *Light emitting diodes*, 3. Auflage, Cambridge University Press, Cambridge, 2010
Module Head	Prof. Dr. Franz Daiminger
Content	Students gain profound knowledge of optoelectronic systems and their application. Content: o Modulation and deflection of light o Frequency selection in lasers o Mirrors and coatings o Frequency transformation (creation of sum and difference frequencies, creation of higher harmonic and other non-linear effects) o Radiative and non-radiative recombination in semiconductors o Semiconductor heterostructures o Design of light-emitting diodes and semiconductor lasers o Parameters and properties of semiconductor lasers and light-emitting diodes o Special semiconductor lasers and light-emitting diodes o Aging behavior of optoelectronic semiconductor components o Micro-optics for diode lasers o Photodetectors o Beam characterization

Course	N5103
Name	Optical Sensor Technology and Measurement Engineering
Instructors	Dipl.-Ing. (FH) Paul Schötz
Assignment to the Module	N-19 Advanced Optoelectronics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	5
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, homework 30h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module

Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Script
Module Head	Prof. Dr. Franz Daiminger
Content	Students gain an understanding of sensor measurement principles and their application. Students are able to assess measurement problems in optical sensor technology and to select appropriate measurement principles for special tasks. Content: o Basics of ray and wave optics o Interference o Deflection o Light sources and detectors o Holography o Optoelectronic distance measurement o Spectroscopy o Speckle methods o Polarization and its application o Optical fibres in measurement technology o Time-resolved measurements

Module N-20 Production Engineering Optics

Module	N-20
Module Name	Production Engineering Optics
Module Components (courses)	N5104 Production Engineering Optics
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Credit Points (ECTS)	9
Valuation Mode	Total module examination: Written exam 90 min and grade from practical training with weighting 3:1
Module Head	Prof. Dr.-Ing. Christine Wünsche
Recommended Prerequisites	N-03 Applied Physics N-10 Advanced Physics N-11 Measurement Engineering N-05 Chemistry and Materials
Learning Objectives	Prime learning objective: students gain knowledge in

	optical production engineering by means of theoretical lectures and also during a lecture-accompanying practical training. Thereto, students gain the following competencies: o Supposed to be a foundation lecture so that future physics engineers understand and are able to evaluate the meaning of modern production and the applied optical materials, and the possible difficulties when dealing with and designing production equipment. o With the knowledge from that module, physics engineers are supposed to implement the conception and design of production equipment with technical expertise and in an optimized way for the manufacturing task. o Special focuses are standard procedures applied in manufacturing of optical components.

Course	N5104
Name	Production Engineering Optics
Instructors	Prof. Dr.-Ing. Christine Wünsche und Prof. Dr.-Ing. Rolf Rascher
Assignment to the Module	N-20 Production Engineering Optics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	5
Credit Hours	8 (4V + 4P)
Credit Points (ECTS)	9
Workload	270h: lectures 60h, practical training 60h, practical training preparation and follow-up 50h, homework 50h, exam preparation 50h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises, practical training
Media Forms	Board, overhead projector, projector
Literature	See script for literature list Bliedtner J., Gräfe G., *Optiktechnologie*, Hanser, München, 2010
Module Head	Prof. Dr.-Ing. Christine Wünsche
Content	o Production technology is of major significance when producing optical components with high precision. The lectures are supposed to impart

	knowledge about the technology and application of modern procedures in optical production engineering. o The respective procedure and calculation basics and characteristics are discussed by means of examples. o The ability to select the production procedures according to economic conditions and for the implementation of work planning is supposed to be achieved by the acquired knowledge and process-based manufacturing basics. o Focuses are the procedures of grinding and polishing of optical surfaces as well as selected procedures including form generation and the related measurement technology.

Module N-21 Project Work

Module	N-21
Module Name	Project Work
Module Components (courses)	N5105 Project Work
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Credit Points (ECTS)	6
Valuation Mode	Total module examination: Project work and presentation
Module Head	Prof. Dr. Thomas Stirner
Recommended Prerequisites	N-08 Presentation Techniques N-11 Measurement Engineering
Learning Objectives	o Get to know the methods and procedures in project management o Analyze and structure solutions for problems in a small team self-reliantly, distribute and work on tasks in the team, achieve and present plausible results o Practically apply knowledge gained in lectures o Complex tasks are distributed into working packages and are worked on together and in parallel. The information exchange between team members demands communication and cooperation skills (ability to work in a team). o A self-reliant formulation of specific working

	objectives after new interim results (proposals for realignment) and their discussion require a strategic overview and assessment of one's own contribution to the team. o Working on one's own task, the required documentation and the presentation of results in the group promote team discipline and collaboration. o Methodical and systematic proceedings when working on a comprehensive, complex problem.

Course	N5105
Name	Project Work
Instructors	Several lecturers: Reclassification (semester start) for each project group
Assignment to the Module	N-21 Project Work
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	5
Credit Hours	4
Credit Points (ECTS)	6
Workload	180h: supervised attendance 60h, other workload 60h, preparation of documentation and presentation 60h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Project work with subtasks for each student
Media Forms	Team meetings, interim and final presentation
Literature	Project specific
Module Head	Prof. Dr. Thomas Stirner
Content	o Projects and/or subtasks within a project can be theoretically (e.g. literature research, program development, data collection, project management), experimentally (e.g. measurements) or constructively based. o The project tasks are announced at the beginning of the semester. Afterwards, the distribution into groups takes place. o Students achieve results that they document in the form of a report and present in a presentation.

Module N-22 Innovation

Module	N-22
Module Name	Innovation
Module Components (courses)	N5106 Innovations Management
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Credit Points (ECTS)	2
Valuation Mode	Total module examination: Written exam 90 min
Module Head	Prof. Dr. Thomas Bartscher
Recommended Prerequisites	---
Learning Objectives	Imparting basics on the subject of innovations management and business development. Students are to be able to understand the importance of a continuous and structured active corporate development and to specifically select and apply suitable management instruments in professional practice. By imparting basic elements of innovations management, students are to be put in the position to analyze the innovation process in a company, to recognize opportunities and risks of innovation and to actively form the innovations management of a company.

Course	N5106
Name	Innovations Management
Instructors	Prof. Dr. Thomas Bartscher
Assignment to the Module	N-22 Innovation
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	5
Credit Hours	2
Credit Points (ECTS)	2
Workload	60h: attendance 30h, self-study 15h, exam preparation 15h
Examination Performance	See module
Final Grade Formation	See module
Language	German

Teaching Methods	Seminar-like lessons and exercises
Media Forms	Presentations, slides, board, script
Literature	Brockhoff K., *Management von Innovationen*, Gabler Verlag, Wiesbaden, 1995 Strebel H., Gelbmann U., *Innovations- und Technologiemanagement*, Facultas-Verlag, Wien, 2007 Glazinski B., *Strategische Unternehmens-entwicklung*, Gabler Verlag, Wiesbaden, 2004 Wittmann R. G., *Innovation erfolgreich steuern*, Verlag Redline Wirtschaft, Heidelberg, 2006
Module Head	Prof. Dr. Thomas Bartscher
Content	o Basic terms and tasks of innovations management o Dimensions of innovation o Innovation process o Innovations-strategic decision errors and opportunity evaluation o Introduction into Business Development o Basics of technology management o Industrial property rights o Growth and sustainability management o Business modelling and business field planning o Assessment procedures and investment calculation o Business development through Corporate Venturing

Module N-23 Optical Technologies

Module	N-23
Module Name	Optical Technologies
Module Components (courses)	N7101 Optical Technologies
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Credit Points (ECTS)	5
Valuation Mode	Total module examination: Written exam 90 min
Module Head	Prof. Dr.-Ing. Christine Wünsche
Recommended Prerequisites	N-03 Applied Physics N-18 Optical Materials N-20 Production Engineering Optics
Learning Objectives	Prime learning objective: Students gain profound

	knowledge in the area of optical technologies. Thereto, students gain the following competencies: o Supposed to be a consecutive lecture so that future physics engineers understand and are able to evaluate the importance of optical technologies. o Here, preconditions are in particular optical materials and techniques that are deployed in the production and application of optical components.

Course	N7101
Name	Optical Technologies
Instructors	Prof. Dr.-Ing. Christine Wünsche und Prof. Dr.-Ing. Rolf Rascher
Assignment to the Module	N-23 Optical Technologies
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	7
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	See script for literature list
Module Head	Prof. Dr.-Ing. Christine Wünsche
Content	Students gain knowledge in modern optical technologies (e.g. in optical data transfer, information and communication technology) and their application. Students gain the ability to select suitable optical technologies for special areas of tasks. Content: o Distance measurement through travel time measurement of optical impulses o Optical data transfer o Optical information and communication technology o Development of new production and measurement technologies for the optical

	industry o Precision machining of optical surfaces after polishing, structuring of optical surfaces, manufacturing of micro-optics o Procedures and their fields of application and limits from production technology for optical components

Module N-24 Continuative Procedures

Module	N-24
Module Name	Continuative Procedures
Module Components (courses)	N7102 Photonics N7103 Spectroscopy
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Credit Points (ECTS)	10
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr. Michael Moritz
Recommended Prerequisites	N-03 Applied Physics N-10 Advanced Physics N-17 Statistics N-18 Optical Materials
Learning Objectives	o Overview of the basic concepts, methods, models as well as technical realizations and experimental applications of photonics and spectroscopy o Creation of the connection between the theoretical terms and results of photonics and spectroscopy with experimental results o Knowledge of key experiments and experimental techniques/measurement methods of photonics and spectroscopy o Detailed knowledge and understanding for systems and applications of photonics and spectroscopy: development of optical systems, laser development, laser measurement technology, microscopic procedures, laser materials processing,

	optical measurement technology and optical telecommunications
Course	N7102
Name	Photonics
Instructors	Prof. Dr. Michael Moritz
Assignment to the Module	N-24 Continuative Procedures
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	7
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Lehrform	Vorlesung, Seminaristischer Unterricht, Übung
Media Forms	Board, overhead projector, projector, demonstration objects
Literature	Reider G. A., *Photonik: Eine Einführung in die Grundlagen,* 2. Auflage, Springer, Wien, 2005 Hering E., Martin R., *Photonik: Grundlagen, Technologie und Anwendung,* 1. Auflage, Springer Verlag, Wien, 2006 Saleh B.E.A., Teich M.C., *Fundamentals of Photonics (Wiley Series in Pure and Applied Optics),* 2. Auflage, Wiley, New Jersey, 2007
Module Head	Prof. Dr. Michael Moritz
Content	Students gain knowledge about the basic terms of photonics. Students are able to apply the gained knowledge to special fields of tasks (e.g. optical fibers, light technology etc.). Content: o Geometric optics o Wave and ray optics o Fourier optics o Propagation in media o Polarization / optical and photonic crystals o Optical wave guides / optical fibers o Statistical optics o Photon optics o Lasers o Electro- and acoustooptics o Lighting engineering o Applications

Course	N7103
Name	Spectroscopy
Instructors	Prof. Raimund Förg
Assignment to the Module	N-24 Continuative Procedures
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	7
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Böcker J., *Spektroskopie*, Vogel Verlag, Würzburg, 1997 Skrabal P. M., *Spektroskopie – Eine methoden-übergreifende Darstellung vom UV- bis zum NMR-Bereich,* vdf Hochschulverlag AG, Zürich, 2009 Demtröder W., *Laserspektroskopie: Grundlagen und Techniken,* 5. Auflage, Springer, Berlin, 2007 Haken H., Wolf H. C., *Molekülphysik und Quantenchemie,* 5. Auflage, Springer, Berlin, 2006
Module Head	Prof. Dr. Michael Moritz
Content	Students gain knowledge and understanding of the basic terms of spectroscopy and its different application forms. Students are able to select suitable spectroscopic procedures for special tasks. Content: o Physical foundations: atomic spectroscopy, molecular spectroscopy, line spectra, band spectra, selection rules, occupation numbers o Classical spectroscopy o Kinds of spectroscopy: infrared spectroscopy, UV/Vis spectroscopy, Raman spectroscopy, fluorescence spectroscopy, X-ray spectroscopy, atomic absorption, mass, NMR; RFA, Auger spectroscopy, etc. o Applications of spectroscopy

Module N-25 Industrial Sensor Systems

Module	N-25
Module Name	Industrial Sensor Systems
Module Components (courses)	N5111 Industrial Sensor Systems
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Credit Points (ECTS)	6
Valuation Mode	Total module examination: Written exam 90 min
Module Head	Prof. Raimund Förg
Recommended Prerequisites	N-10 Advanced Physics N-11 Measurement Engineering N-14 Control Engineering N-17 Statistics
Learning Objectives	o Sound knowledge of metrological terms and physical units o Knowledge of fundamental measurement principles o Students dispose of knowledge concerning procedures for measuring electric and non-electric parameters o Knowledge of the fundamental structure of various sensor types which are relevant for industrial applications o Students are able to select sensors that are suitable for a metrological problem o Students are able to classify influences of stochastic nature to measuring chains and to approximately calculate their effect.

Course	N5111
Name	Industrial Sensor Systems
Instructors	Prof. Raimund Förg
Assignment to the Module	N-25 Industrial Sensor Systems
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Semester	5
Credit Hours	6
Credit Points (ECTS)	6
Workload	180h: lectures 90h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Schiessle E., *Industriesensorik*, Vogel, Würzburg, 2010 Parthier R., *Messtechnik*, 7. Auflage, Springer, Wiesbaden, 2014 Lambert M., *Grundlagen der Sensortechnik,* Elektor Verlag, Aachen, 1991 Kleger R., *Sensorik für Praktiker*, 2. Auflage, VDE-Verlag, Düsseldorf, 2008
Module Head	Prof. Raimund Förg
Content	Students gain knowledge and understanding of the basic terms of sensors and their different application forms. Students are able to select suitable sensors for special industrial tasks. Content: o Basics of sensor systems o Assessment of measurement deviations/ measurement errors o Sensor elements of measurement technology o Industrial sensors for measurement and control of changes of environmental, biological and technical systems o Sensors for geometry, power, vibration, temperature and flow measurement o Actuators o Laboratory, industrial and automatized measuring systems

Module N-26 Advanced Sensor Systems

Module	N-26
Module Name	Advanced Sensor Systems
Module Components (courses)	N5112 High-frequency Sensor Systems N5103 Optical Sensor Systems and Measurement Engineering
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Credit Points (ECTS)	12
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Dr. Josef Kölbl
Recommended Prerequisites	N-11 Measurement Engineering N-14 Control Engineering N-16 Foundations of Optoelectronics
Learning Objectives	Students gain extended knowledge in sensor systems. With that knowledge, they have the prerequisite to understand many existing technical solutions of high-frequency sensor systems, optical sensor systems and optical measurement technology. o Ability to work self-reliantly on new solutions after a certain training period o Students are to understand the theoretical basics of the structure and the functionality of sensors and to have knowledge about the structure and characteristics of the most important high-frequency sensors. o Understanding and application of sensor measurement principles in optical measurement technology o Ability to assess measurement problems in optical sensor systems o Ability to select measurement principles in an application-oriented way for special tasks and assessment of implementation possibilities o Detailed knowledge and understanding for applications of optical sensor systems and measurement technology o Understanding optoelectronic systems, laser measurement technology and optical

	measurement technology
Course	N5112
Name	High-frequency Sensor Systems
Instructors	Prof. Dr. Josef Kölbl
Assignment to the Module	N-26 Advanced Sensor Systems
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Semester	5
Credit Hours	6
Credit Points (ECTS)	8
Workload	240h: lectures 90h, exercises 45h, homework 45h, exam preparation 60h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Kleger R., *Sensorik für Praktiker*, 2. Auflage, VDE-Verlag, Düsseldorf, 2008 Niebuhr J., Lindner G., *Physikalische Messtechnik mit Sensoren*, Oldenbourg, München, 2001 Meinke H. H., Gundlach F. W., *Taschenbuch der Hochfrequenztechnik,* Springer-Verlag, Berlin, 1992 Chang K., *Microwave Solid-State Circuits And Applications*, Wiley, New York, 1994
Module Head	Prof. Dr. Josef Kölbl
Content	Students gain profound understanding of sensor systems, in particular in the area of high-frequency sensor systems. Students are able to calculate and dimension components of high-frequency technology. Content: o Fundamentals of high-frequency sensor systems o Quadripole theory and S-parameters o Level computation o Components in high-frequency technology (mixers, amplifiers, filters, antennas, directional coupler, etc.) o Noise and noise measurement technology o HF measurement technology (performance measurement, spectrum and network analyzer) o Modulation o Active detection of movement (RADAR and LIDAR, GPS, VLBI)

	o Transmission lines and Smith diagram

Course	N5103
Name	Optical Sensor Systems and Measurement Engineering
Instructors	Dipl.-Ing. (FH) Paul Schötz
Assignment to the Module	N-19 Advanced Optoelectronics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Optical Technologies
Semester	5
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, homework 30h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Script
Module Head	Prof. Dr. Josef Kölbl
Content	Students gain an understanding of sensor measurement principles and their application. Students are able to assess measurement problems in optical sensor systems and to select suitable measurement principles for special tasks. Content: o Fundamentals ray and wave optics o Interference o Deflection o Light sources and detectors o Holography o Optoelectronic distance measurement o Spectroscopy o Speckle methods o Polarization and its applications o Optical fibers in measurement technology o Time resolved measurements

Module N-27 Project Work

Module	N-27
Module Name	Project Work
Module Components (courses)	N5105 Project Work
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Credit Points (ECTS)	6
Valuation Mode	Total module examination Project work and presentation
Module Head	Prof. Dr. Thomas Stirner
Recommended Prerequisites	N-08 Presentation Techniques N-11 Measurement Engineering
Learning Objectives	o Get to know the methods and procedures in project management o Analyze and structure solutions for problems in a small team self-reliantly, distribute and work on tasks in the team, achieve and present plausible results o Practically apply knowledge gained in lectures o Complex tasks are distributed into working packages and are worked on together and in parallel. The information exchange between team members demands communication and cooperation skills (ability to work in a team). o A self-reliant formulation of specific working objectives after new interim results (proposals for realignment) and their discussion require a strategic overview and assessment of one's own contribution to the team. o Working on one's own task, the required documentation and the presentation of results in the group promote team discipline and collaboration. o Methodical and systematic proceedings when working on a comprehensive, complex problem.

Course	N5105
Name	Project Work
Instructors	Several lecturers: Reclassification (semester start) for each project group
Assignment to the Module	N-27 Project Work

Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Semester	5
Credit Hours	4
Credit Points (ECTS)	6
Workload	180h: supervised attendance 60h, other workload 60h, preparation of documentation and presentation 60h
Examination Performance	See module
Final Grade Performance	See module
Language	German
Teaching Methods	Project work with subtasks for each student
Media Forms	Team meetings, interim and final presentation
Literature	Project specific
Module Head	Prof. Dr. Thomas Stirner
Content	o Projects and/or subtasks within a project can be theoretically (e.g. literature research, program development, data collection, project management), experimentally (e.g. measurements) or constructively based. o The project tasks are announced at the beginning of the semester. Afterwards, the distribution into groups takes place. o Students achieve results that they document in the form of a report and present in a presentation.

Module N-28 Innovation

Module	N-28
Module Name	Innovation
Module Components (courses)	N5106 Innovations Management
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Credit Points (ECTS)	2
Valuation Mode	Total module examination Written exam 90 min
Module Head	Prof. Dr. Thomas Bartscher
Recommended Prerequisites	---
Learning Objectives	Imparting basics on the subject of innovations management and business development. Students are

	to be able to understand the importance of a continuous and structured active corporate development and to specifically select and apply suitable management instruments in professional practice. By imparting basic elements of innovations management, students are to be put in the position to analyze the innovation process in a company, to recognize opportunities and risks of innovation and to actively form the innovations management of a company.

Course	N5106
Name	Innovations Management
Instructors	Prof. Dr. Thomas Bartscher
Assignment to the Module	N-28 Innovation
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Semester	5
Credit Hours	2
Credit Points (ECTS)	2
Workload	60h: attendance 30h, self-study15h, exam preparation 15h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Seminar-like lessons and exercises
Media Forms	Presentations, slides, board, script
Literature	Brockhoff K., *Management von Innovationen*, Gabler Verlag, Wiesbaden, 1995 Strebel H., Gelbmann U., *Innovations- und Technologiemanagement*, Facultas-Verlag, Wien, 2007 Glazinski B., *Strategische Unternehmens-entwicklung*, Gabler Verlag, Wiesbaden, 2004 Wittmann R. G., *Innovation erfolgreich steuern*, Verlag Redline Wirtschaft, Heidelberg, 2006
Module Head	Prof. Dr. Thomas Bartscher
Content	o Basic terms and tasks of innovations management o Dimensions of innovation o Innovation process o Innovations-strategic decision errors and opportunity evaluation o Introduction into Business Development o Basics of technology management

	o Industrial property rights o Growth and sustainability management o Business modelling and business field planning o Assessment procedures and investment calculation o Business development through Corporate Venturing

Module N-29 Optical Analytical Procedures

Module	N-29
Module Name	Optical Analytical Procedures
Module Components (courses)	N5113 Surface Analysis N7103 Spectroscopy
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Credit Points (ECTS)	9
Valuation Mode	Total Module Examination (Grade of the module is weighted according to the ECTS credits of the module components): Written exam 90 min
Module Head	Prof. Raimund Förg
Recommended Prerequisites	N-03 Applied Physics N-10 Advanced Physics N-11 Measurement Engineering N-17 Statistics
Learning Objectives	o Overview of the basic concepts, methods, models as well as technical realizations and experimental applications of surface analysis and spectroscopy o Creation of the connection between the theoretical terms and results of surface analysis and spectroscopy with experimental results o Knowledge of key experiments and experimental techniques/measurement methods of surface analysis and spectroscopy o Detailed knowledge and understanding of systems and applications of surface analysis and spectroscopy: surface preparation,

	surface-sensitive methods, development of optical systems, laser development, laser measurement technology, microscopic procedures, laser material processing, optical measurement technology and optical telecommunications

Course	N5113
Name	Surface Analysis
Instructors	Prof. Dr.-Ing. Christine Wünsche
Assignment to the Module	N-29 Optical Analytical Procedures
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Semester	5
Credit Hours	4
Credit Points (ECTS)	4
Workload	120h: lectures 60h, homework 30h, exam preparation 30h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Somorjai G. A., *Introduction to surface chemistry and catalysis,* 2. Auflage, Wiley, New York, 2010 Ertl G., *Reactions at solid surfaces,* Wiley, New Jersey, 2009
Module Head	Prof. Raimund Förg
Content	Students gain knowledge and understanding of the methods of surface analysis and their different application forms. Students are able to select suitable procedures of surface analysis for special tasks. Content: o Basics of surface analysis and surface chemistry o Surface preparation: methods for surface cleaning and techniques for applying further layers o CVD, PECVD, PVD, MBE o Surface coordination chemistry o Surface-sensitive methods: microscopy, spectroscopy, deflection, kinetic methods, sorptive methods, combinations

	o XPS, AES, SIMS, ISS o Applications of surface analysis and surface chemistry
Course	N7103
Name	Spectroscopy
Instructors	Prof. Raimund Förg
Assignment to the Module	N-29 Optical Analytical Procedures
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Semester	7
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Böcker J., *Spektroskopie*, Vogel Verlag, Würzburg, 1997 Skrabal P. M., *Spektroskopie – Eine methoden-übergreifende Darstellung vom UV- bis zum NMR-Bereich,* vdf Hochschulverlag AG, Zürich, 2009 Demtröder W., *Laserspektroskopie: Grundlagen und Techniken,* 5. Auflage, Springer, Berlin, 2007 Haken H., Wolf H. C., *Molekülphysik und Quantenchemie,* 5. Auflage, Springer, Berlin, 2006
Module Head	Prof. Raimund Förg
Content	Students gain knowledge and understanding of the basic terms of spectroscopy and its different application forms. Students are able to select suitable spectroscopic procedures for special tasks. Content: o Physical fundamentals: atomic spectroscopy, molecular spectroscopy, line spectra, band spectra, selection rules, occupation numbers o Classical spectroscopy o Kinds of spectroscopy: infrared spectroscopy, UV/Vis spectroscopy, Raman spectroscopy, fluorescence spectroscopy, X-ray spectroscopy, atomic absorption, mass, NMR, RFA, Auger spectroscopy, etc. o Applications of spectroscopy

Module N-30 Bionics

Module	N-30
Module Name	Bionics
Module Components (courses)	N7111 Bionics
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Credit Points (ECTS)	5
Valuation Mode	Total module examination Written exam 90 min
Module Head	Prof. Dr. Thomas Stirner
Recommended Prerequisites	N-02 Foundations of Physics N-05 Chemistry and Materials N-10 Advanced Physics
Learning Objectives	o Fundamental understanding for bionics o Interdisciplinary connection of biology and technology o Learning problem solving strategies bionics o Ability to apply bionics when solving technical challenges

Course	N7111
Name	Bionics
Instructors	Dipl.-Biol. (Univ.) Kristina Wanieck
Assignment to the Module	N-30 Bionics
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Semester	7
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German
Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	Nachtigall W., *Bionik: Grundlagen und Beispiele für Ingenieure und Naturwissenschaftler*, 2. Auflage, Springer-Verlag, Berlin, 2002 Lindemann U., *Methodische Entwicklung technischer Produkte*, 3. Auflage, Springer-Verlag, Heidelberg, 2009
Module Head	Prof. Dr. Thomas Stirner
Content	Students gain knowledge about the basic principles of bionics. Students are able to select suitable aspects of biological systems for special technical applications. Content: o Basics of bionics o History and definition of bionics o Bionics as science o Application areas of bionics o Process of bionic working o Bionics as methodology for idea generation o Bionics as innovation strategy o Bionics in innovations management o Sensory systems in biology and technology o Literature seminar o Laboratory tours and exercises o Practical exercises o Innovation Day

Module N-31 Remote Sensing

Module	N-31
Module Name	Remote Sensing
Module Components (courses)	N7112 Remote Sensing
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Credit Points (ECTS)	5
Valuation Mode	Total module examination Written exam 90 min
Module Head	Prof. Dr. Florian Flossmann
Recommended Prerequisites	N-10 Advanced Physics N-25 Industrial Sensor Systems N-26 Advanced Sensor Systems
Learning Objectives	o Understanding and application of remote sensing systems o Ability to assess measurement problems in remote sensing o Ability to select in an application-oriented way measurement principles for special tasks in remote sensing and to assess implementation possibilities o Analysis of practice-oriented examples of remote sensing and understanding of systematic approaches to solution by means of modern production tasks

Course	N7112
Name	Remote Sensing
Instructors	Prof. Dr. Florian Flossmann
Assignment to the Module	N-31 Remote Sensing
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	Sensory Systems
Semester	7
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: lectures 60h, homework 45h, exam preparation 45h
Examination Performance	See module
Final Grade Formation	See module
Language	German

Teaching Methods	Lectures, seminar-like lessons, exercises
Media Forms	Board, overhead projector, projector
Literature	See script for literature list
Module Head	Prof. Dr. Florian Flossmann
Content	Students gain knowledge about the basic principles of non-contact measuring methods. Students are able to select suitable non-contact measuring methods for special technical applications. Content: o Optical properties of the atmosphere o Transparence and refraction index of the atmosphere o LIDAR principles o Space based technologies o Remote sensing for measurement of environmental influences o Future of optical remote sensing

Module N-32 Business Practice

Module	N-32
Module Name	Business Practice
Module Components (courses)	N6101 Internship N6102 Practical Seminar N6103 Practice Complementary In-Depth Subject
Assignment to the Curriculum:	Applied Physics (Bachelor)
Study Focus	General
Credit Points (ECTS)	30
Valuation Mode	All module components need to be evaluated with „passed“
Module Head	Prof. Peter Schmieder
Prerequisites	The precondition for the admission to the practical semester is that at least 90 ECTS credits have been achieved.
Learning Objectives	o The general objective is to prematurely give the students the opportunity to apply their gained knowledge in practice and at the same time to get to know the processes in a company. o Practical application of the knowledge gained in other modules. o Application, rooting and extension of the already gained knowledge to the problems in

	engineering practice. o Gaining key qualifications like for example analytical competencies, problem solving methodology, statistical experiment planning, management skills, etc. o Getting familiar with the improvement of cooperation and communication skills and the meaning of team work. o Target group-appropriate presentation of the tasks during the internship and the results achieved during work.

Course	N6101
Name	Internship
Instructors	Prof. Peter Schmieder
Assignment to the Module	N-32 Business Practice
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	22
Credit Hours	Internship with a duration of 18 weeks
Credit Points (ECTS)	Internship: 22 ECTS
Workload	Internship : 660h incl. documentation
Examination Performance	Internship: o Report about the tasks done during the internship (written activity report 18 pages DIN A4 in digital form) o Certificate of the firm in form of an employment reference letter
Final Grade Formation	Evaluated as „passed“ when taken part successfully
Language	German, in accordance with the supervisor, work can be done in English language
Module Head	Prof. Peter Schmieder
Content	Practical work in an industrial company or other appropriate training companies for the duration of 18 weeks. Students get involved in current projects of the company. Individual topics from the areas: o Development, projecting, construction o Production (manufacture and assembling) o Production preparation and control o Assembling, operation and maintenance of machines and facilities o Examination, acceptance, manufacturing

	control o Information technology in industrial processing of products

Course	N6102
Name	Practical Seminar
Instructors	Prof. Peter Schmieder
Assignment to the Module	N-32 Business Practice
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	6
Credit Hours	2
Credit Points (ECTS)	3
Workload	Total : 90 h; attendance seminar 30 h, preparation: 60 h
Examination Performance	Presentation (duration 20 min) The successful participation on the practical seminar is a precondition for passing the module „Business Practice and therefore for the recognition of the ECTS credits from the internship
Final Grade Formation	Evaluated as „passed“ when taken part successfully
Language	German, in accordance with the supervisor, work can be done in English language
Teaching Methods	Presentation
Media Forms	o Writing on board o Projectors o Presentations
Literature	Diverse, as well as internet research
Module Head	Prof. Peter Schmieder
Prior Knowledge	none
Content	Creation of a presentation and report about the activities and tasks of the students that were done during the internship. In the practical seminar, all students receive information about new developments, procedures and proficiencies conducted in various companies. By means of the presentations, students are to familiarize each other with information about the respective firms. Students gain insights into the various firms of the region and their core competencies as well as information about the manufacturing process of products in the physical-technical environment.

Course	N6103
Name	Practice Complementary In-Depth Subject
Instructors	Prof. Peter Schmieder
Assignment to the Module	N-32 Business Practice
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	6
Credit Hours	4
Credit Points (ECTS)	5
Workload	150h: 60h seminar, 60h simulation, 30h excursion
Examination Performance	Written exam („successfully passed“)
Final Grade Formation	See module
Language	German
Teaching Methods	Seminar-like lessons, self-reliant working, demonstrations with simulation software business game
Media Forms	Writing on board, projectors, simulation software
Literature	To be announced during the course
Module Head	Prof. Peter Schmieder
Content	Students gain competencies with direct connection to the practical activities of a physics engineer, e.g. company lectures, excursions, software applications, social skills seminars, legal seminars, etc. Further topics contain for example: o Statistical experiment planning o Statistical experiment evaluation o SixSigma o Applications and examples for experiment planning o Basics of business administration o Business game simulation o Application of the simulation software to a business example

Module N-33 Bachelor

Module	N-33
Module Name	Bachelor
Module Components (courses)	N7104 Bachelor Thesis N7105 Oral Examination

Assignment to the Curriculum:	Physical Engineering (Bachelor)
Study Focus	General
Credit Points (ECTS)	15
Valuation Mode	The total grade of the module is computed by the partial grades weighted by the ECTS credits of the module components.
Module Head	Prof. Dr. Thomas Stirner
Admission Prerequisites	You can register your Bachelor thesis if you have achieved at least 130 ECTS credits. Recommended prerequisites: N-08 Presentation Techniques N-21 resp. N-27 Project Work
Learning Objectives	o Insight into the topics, methodology and mode of thoughts of general scientific specific areas o Gaining key qualifications like for example ability to work in a team, problem solving methods, project planning, communication skills etc. o Ability to assess interdisciplinary topics and applications o Gaining intercultural, social competencies o Ability to present and defend a scientific work

Course	N7104
Name	Bachelor Thesis
Instructors	Supervising Professor
Assignment to the Module	N-33 Bachelor
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	7
Credit Hours	Supervision effort ca. 0,2 credit hours
Credit Points (ECTS)	12
Workload	360h
Examination Performance	Written final paper, no oral examination
Final Grade Formation	See module
Language	German, in accordance with the supervisor, work can be done in English language
Teaching Methods	Self-reliant working
Media Forms	---
Literature	Depending on the area of expertise
Module Head	Prof. Dr. Thomas Stirner
Content	Theoretical and/or experimental work for solving practice-oriented problems.

Course	N7105
Name	Oral Examination
Instructors	---
Assignment to the Module	N-33 Bachelor
Assignment to the Curriculum	Applied Physics (Bachelor)
Study Focus	General
Semester	7
Credit Hours	---
Credit Points (ECTS)	3
Workload	90h
Examination Performance	Oral examination Presentation 20 min or written exam poster with questions each
Final Grade Formation	Presentation about the final paper (100%) or poster (100%)
Language	German, in accordance with the supervisor, presentation and/or poster can be done in English language
Teaching Methods	Seminar
Media Forms	Lectures, presentations with projectors, poster
Literature	Eco U., *Wie man eine wissenschaftliche Abschlussarbeit schreibt*, 13. Auflage, UTB, Heidelberg, 2010 Von Werder L., *Grundkurs des wissenschaftlichen Schreibens*, Schibri-Verlag, Milow (Uckerland), 1995
Module Head	Prof. Dr. Thomas Stirner
Content	o Preparation for the writing of the written Bachelor thesis o Structure and written form of a scientific work o Presentation, discussion and evaluation of the work progresses o Final presentation or creation of a poster