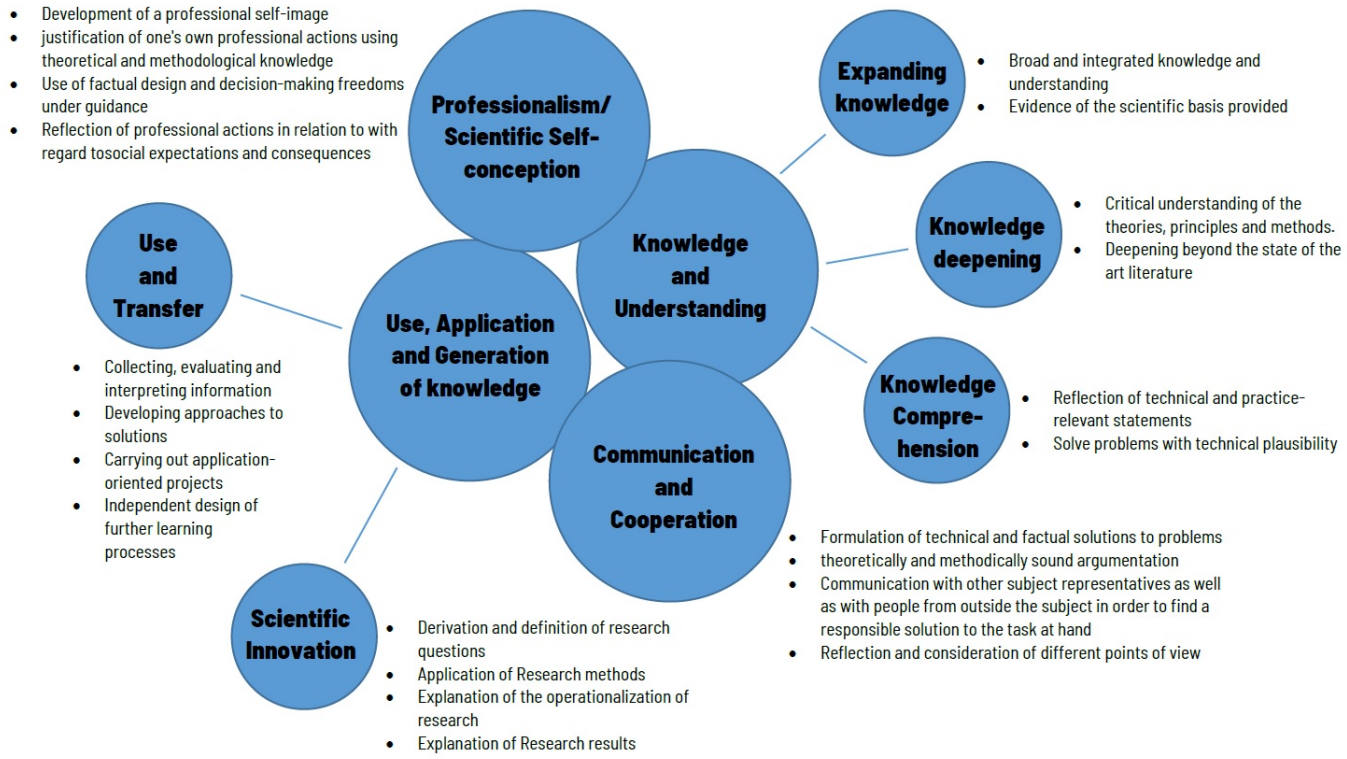
Hochschule Ravensburg-Weingarten Postfach 30 22, 88216 Weingarten

Module Manual Physical Engineering

When designing a study program, in addition to study and examination regulations, a module handbook is created that contains a description of the content of the modules and the competencies to be acquired. Modules can be compulsory or part of the elective range. Each module is concluded with a final module examination and is assigned a certain number of credit points. Study programs and thus also modules are consistently designed from the qualification goals (learning outcomes) to be achieved. In the fields of

- Knowledge and Understanding,
- Use, application and generation of knowledge,
- Scientific self-conception/professionalism and
- Communication and Cooperation

competencies are acquired during the course of study in the respective subject-specific context. Not all competencies or their characteristics are acquired in every module; what is relevant is that at the end of the program students have acquired all competencies.
The basis for this is the Qualifications Framework for German Higher Education Qualifications (Qualifikationsrahmen für Deutsche Hochschulabschlüsse, HQR) and the model legal regulation in accordance with Article 4 Paragraphs 1 - 4 of the State Treaty on Study Accreditation of the Conference of Ministers of Education and Cultural Affairs.



Bachelor-Level

Program Objectives

The Physical Engineering program is characterized by a broad, interdisciplinary scientific and technical education and a combination of research, technical development and industrial application.

Qualification goals:
- Understanding of mathematical and scientific fundamentals
- Learning of common methods from the field of digitization
- Deepening of knowledge in the fields of photonics, mechatronics and robotics
- Understanding of the learned basics for relevant technical applications in industry

Content Modules

Basic studies

Analysis 1
Lineare Algebra
Analysis 2
Analysis 3
Physik 1
Physik 2
Physik 3
Physik 4
Chemie
Professional English Niveau B2 für deutschsprachige Studierende
Deutsch als Fremdsprache B2 für nicht deutschsprachige Studierende
Werkstoffe
Konstruktion 1
Konstruktion 2
Elektrotechnik
Elektronik 1
Elektronik 2
Informatik
Softwareentwicklung

Main studies

Physikalische Messtechnik
Regelungstechnik
Digitale Technologien
Entwicklung 1
Entwicklung 2
Betriebswirtschaft
Modellierung und Simulation
Mikrocontroller
Vertiefung
Wahlmodul Technik
Wahlmodul Nichttechnik
Projekt
Praktisches Studiensemester mit Seminar
Bachelorarbeit und Bachelorandenseminar
Abbildung und Spektroskopie wird ersetzt durch Technische Optik
Technische Optik
3D und Bildverarbeitung
Wahl Modul aus Vertiefungsrichtung Mechatronik
Mechatronik
Robotik
Mikrosysteme / Optoelektronik
Wahl Modul aus Vertiefungsrichtung Bildgebende Verfahren

Wahlprojekt

Module: Analysis 1

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE01
Module title:	Analysis 1
Module responsible:	Prof. Dr. rer. nat. Stefan Elser
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	1. basics: Introduction of basic concepts such as sets, Cartesian product, relations, and functions. 2. numbers and induction: Introduction of natural, whole, rational, real and complex numbers, proof by induction. 3. sequences and series: Convergence criteria, sine, cosine, exponential functions as series. 4. functions: Continuity, polynomials, trigonometric functions. 5. differential calculus: Product, quatient and chain rule, extreme points and their criteria, Taylor polynomials. 6. integral calculus: Riemann integral, fundamental theorem of calculus, partial fraction decomposition, numerical integration.
Courses:	288 Analysis 1 mit Übungen
Teaching and learning forms:	Lecture with exercises Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	Good knowledge of school mathematics
Applicability of the module:	Elektromobilität und regenerative Energien Elektrotechnik und Informationstechnik Informatik/Elektrotechnik PLUS Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	approx. 50h for lectures, approx. 100h for self-study (preparation and follow-up, exam preparation)
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Omar Hijab: "Introduction to Calculus and Classical Analysis", Springer Sterling K.Berberian: "A First Course in Real Analysis", Springer Peter Hartmann: "Mathematik für Informatiker", Vieweg und Teubner Lothar Papula: "Mathematik für Ingenieure und Naturwissenschaftler Band 1", Springer
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates have expanded their knowledge in the following areas and can also reproduce this knowledge:
Mathematical basics from the areas of number ranges, sequences and series as well as functions of real numbers and their continuity, differentiability and integration.

Focus:
Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates will be able to practically apply the knowledge from the following topics:
Abstract modeling of simple problems and basic mathematical solution procedures in the above areas.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Lineare Algebra

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE02
Module title:	Lineare Algebra
Module responsible:	Prof. Dr. rer. nat. Stefan Elser
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	1. basics: Introduction of basic concepts such as sets, Cartesian product, relations and functions. 2. vector spaces: The real vector space, groups, solids, general vector spaces, basis and dimension, coordinate representation, scalar product and norm. 3. systems of linear equations: Setting up systems of equations and Gaussian elimination method. 4. linear mappings: Linear mappings and matrices, the Gauss-Jordan method, determinants, eigenvalues and eigenvectors, base changes in mappings, diagonalization.
Courses:	3000 Lineare Algebra mit Übungen
Teaching and learning forms:	Lecture with exercises Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	Good knowledge of school mathematics
Applicability of the module:	Elektrotechnik und Informationstechnik Elektrotechnik/Physik PLUS Elektromobilität und regenerative Energien Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	approx. 50h for lectures, approx. 100h for self-study (preparation and follow-up, exam preparation)
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	David Poole: "Linear Algebra: A Modern Introduction", Cengage Learning Peter Hartmann: "Mathematik für Informatiker", Hartmann, Springer Vieweg Lothar Papula:"Mathematik für Ingenieure und Naturwissenschaftler", Band 1 - 2
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates have expanded their knowledge in the following areas and are able to reproduce this knowledge:
Mathematical basics, vector spaces, linear systems of equations and determination of solution sets, linear mappings as matrices.

Focus:
Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates will be able to practically apply the knowledge from the following topics:
Abstract modeling of simple problems and basic mathematical solution procedures in the above areas.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Analysis 2

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE03
Module title:	Analysis 2
Module responsible:	Prof. Dr.-Ing. Frank Fechter
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	The following subfields of calculus will be covered: - Real functions of several variables, differential and integral calculus - Differential equations - Vector analysis
Courses:	1396 Analysis 2 mit Übungen
Teaching and learning forms:	Lecture Exercises Language: in winter semester in English, in summer semester in German.
Prerequisites for participation:	Mastery of topics from mathematics 1
Applicability of the module:	Elektrotechnik und Informationstechnik Elektrotechnik/Physik PLUS Elektromobilität und regenerative Energien Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Papula L.: Mathematik für Ingenieure und Naturwissenschaftler Band 2. Vieweg Verlag, Braunschweig, Wiesbaden. Papula L.: Mathematik für Ingenieure und Naturwissenschaftler Band 3. Vieweg Verlag, Braunschweig, Wiesbaden. Brauch, W.; Dreyer, H.-J.; Haacke, W.: Mathematik für Ingenieure. Teubner Verlag, Stuttgart. Burg, K.; Haf, H.; Wille, F.: Höhere Mathematik für Ingenieure. Band 1 Analysis. Teubner Verlag, Stuttgart. Stroud, K. A.; Booth, D. J.: Engineering mathematics. Palgrave Macmillan 2007. Jeffrey, A.: Mathematics for engineers and scientists. Chapman & Hall/CRC, 2005. Croft, A.; Davison, R.; Hargreaves, M.: Engineering mathematics: A foundation for electronic, electrical, communication and system engineers. Prentice Hall 2001.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to reproduce the basic mathematical principles that belong to the topics mentioned in the contents.

Focus:

Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates are able to apply the methods of analysis they have learned. They can solve problems from differential and integral calculus of several variables, as well as vector analysis. They can calculate solution functions of the treated classes of differential equations.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Analysis 3

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE04
Module title:	Analysis 3
Module responsible:	Prof. Dr.-Ing. Samuel Vogel
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	The following areas are covered: - Power series, especially Taylor series - Fourier series - Fourier transform - Laplacian transformation
Courses:	2111 Analysis 3: Reihenentwicklungen und Transformationen
Teaching and learning forms:	Lecture with exercises. Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	Mastery of the topics from mathematics 1 and 2
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Papula, L.: Mathematik für Ingenieure und Naturwissenschaftler Band 1, Vieweg Verlag, Wiesbaden. Papula, L.: Mathematik für Ingenieure und Naturwissenschaftler Band 2, Vieweg Verlag, Wiesbaden. Koch, J., Stämpfle, M.: Mathematik für das Ingenieurstudium, Hanser, München Fischer, H., Kaul, H.: Mathematik für Physiker 1, Teubner Verlag, Wiesbade Fischer, H., Kaul, H.: Mathematik für Physiker 2, Teubner Verlag, Wiesbaden. Stöcker, H. (Hrsg.); Mathematik – der Grundkurs (3 Bände), Verlag Harri Deutsch, Frankfurt am Main Burg, K., Haf, H., Wille, F.: Höhere Mathematik für Ingenieure (5 Bände), Teubner Verlag, Wiesbaden.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to reproduce the basic mathematical principles that belong to the topics mentioned in the contents.

Focus:

Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates can calculate power and Fourier series and apply the methods to technical and scientific problems. They can perform Fourier and Laplace transformations and interpret the results.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Physik 1

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE05
Module title:	Physik 1
Module responsible:	Prof. Dr. Frank Ermark
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	1. kinematics of the mass point 2. dynamics of the mass point, force, force impact, momentum 3. energy, law of conservation of energy, friction 4. law of conservation of momentum, impact processes 5. law of gravity, motion of a body around a center of gravity 6. kinematics and dynamics of rigid bodies, angular momentum, torque 7. law of conservation of angular momentum, application to rolling and gyroscopic motions 8. free and forced oscillations, damping 9. coupled oscillators Substantial portions of this course significantly exceed in level that prevails in a general education or vocational school.
Courses:	7805 Physik 1: Mechanik
Teaching and learning forms:	Lectures Tutorials Demonstration experiments Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	School Mathematics
Applicability of the module:	Elektromobilität und regenerative Energien Physical Engineering
Prerequisites allocation ECTS:	Module accompanying written exam 120 min. Part 1 (MidTerm): 45 min. Part 2: 75 min. Corona-conditional alternative form of examination: Written exam 90 minutes (K90)
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Tipler, "Physik" Halliday, "Physik" Böge, „Physik“ Dobrinski, „Physik für Ingenieure“ Gerthsen,„Physik“ Weber, „Physik“
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to reproduce and explain formulaic relationships in classical mechanics.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates are able to apply these formulaic relationships in simple situations.

Focus:
Use and transfer

Communication and cooperation

Students have the opportunity to discuss solution approaches in a voluntary tutorial in small groups.

Scientific / artistic self-image and professionalism

Module: Physik 2

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE06
Module title:	Physik 2
Module responsible:	Prof. Dr. rer. nat. Eckehard Klemt
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Electrostatics: charges and Coulomb force, energy of charge distributions Electric field, field concept, field line concept, examples, conductors in electric field Work and energy in the electric field, energy density Electric flux and Gauss' theorem, Electrostatic potential and voltage Capacitors: capacitance C, charge Q, voltage U, geometry Influence; dielectrics and polarization; dipole in electric field Electric current, networks, current, current density, Kirchhoff rules Magnetic field (B-field): basic facts, definitions, Lorentz force Motion of charged particles in magnetic field, particles on circular paths Magnetic dipoles in B-field Properties of B-fields, B-fields of current distributions Magnetic field of a current: Biot-Savart law, Ampere's law Magnetic flux and induction, key experiments Faraday's law of induction, Lenz's rule Eddy currents, induced electric fields, inductance, self-induction Magnetism in matter; Hall effect, electron microscope Mechanical waves, examples and mathemat. Description Superposition of plane waves: Interference, standing waves, beating Electromagnetic waves, Maxwell's equations and light Generation and propagation of electromagnetic waves Ray optics: reflection and refraction of light rays; image formation Complements (divergence, gradient, rotation of fields)
Courses:	1418 Physik 2: Elektrodynamik
Teaching and learning forms:	Lectures Tutorials Demonstration Experiments Language: in winter semester in English, in summer semester in German.
Prerequisites for participation:	Physik 1, Mathematik 1, parallel zu Mathematik 2
Applicability of the module:	Energie- und Umwelttechnik Physical Engineering
Prerequisites allocation ECTS:	Module exam 120 minutes (MKB120): Midterm exam K45 during the semester and exam K75 during the exam period. Date for midterm exam will be announced at the beginning of the semester. Corona-conditional alternative form of examination: Written exam 90 minutes (K90)
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Tipler, Mosca: Physik für Wissenschaftler und Ingenieure Halliday, Resnick, Walker: Halliday Physik (Bacheler Edition) Gerthsen, Meschede: Gerthsen Physik
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to list formulas from the field of electrostatics and electrodynamics. Graduates are able to reproduce and explain the formulaic relationships of electrostatics and electrodynamics.

Focus:
Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates are able to apply these formulaic relationships in simple situations.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Physik 3

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE07
Module title:	Physik 3
Module responsible:	Prof. Dr. rer. nat. Eckehard Klemt
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Physics III builds on Physics I and II and introduces modern physics: - Special Relativity - optical and acoustic waves - geometrical optics
Courses:	
Teaching and learning forms:	Lectures, demonstration experiments Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	Physik I+II
Applicability of the module:	Physik I+II+IV
Prerequisites allocation ECTS:	Module exam 90 minutes (consists of: 60 min physics III and 30 min physics IV (quantum); there are separate grades)
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	Tipler (jeweils neueste Auflage): Physik Tipler (jeweils neueste Auflage): Moderne Physik Halliday (jeweils neueste Auflage): Physik
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to name subject-specific formulas. Graduates are able to reproduce and explain formulaic relationships in modern physics.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates are able to apply these formulaic relationships in simple situations.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Physik 4

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE08
Module title:	Physik 4
Module responsible:	Prof. Dr. rer. nat. Eckehard Klemt
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	The courses include specific deepening of physics - Wave properties of particles - Schrödinger equation and a deepening of the areas 'Mechanics, Heat, Optics' from the lecture Physics I-III by means of practical experiments.
Courses:	
Teaching and learning forms:	Lectures with exercises, practical course Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	Module-accompanying written exam 90 minutes (Quantum is examined together with module "Physics 3" event "Optics and Waves", weighting 30/60) Practical course in physics: ungraded laboratory work
ECTS credits:	5
Grading:	graded / ungraded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to reproduce and explain formulaic relationships of the specified subject areas.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates are able to apply these formulaic relationships in simple situations.They are able to identify electronic and physical measuring instruments for the verification of the theoretically acquired knowledge.Graduates are able to set up and carry out electrical engineering and physical experiments independently.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Chemie

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE09
Module title:	Chemie
Module responsible:	Prof. Dr. rer. nat. Daniel Kolacyak
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Contents are the basics of chemistry. - Forms of appearance of matter - atomic models - Periodic table - The chemical bond - The chemical reaction - Chemistry of aqueous solutions - Electrochemistry - further see LSF and Moodle
Courses:	Exercises are integrated into the lecture
Teaching and learning forms:	Lecture and exercises Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	Admission to the study and the exam
Applicability of the module:	A technical foundation is laid for further study
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	K 90
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Literatur: P. W. Atkins: Physikalische Chemie, Wiley-VCH, 2013 G. Wedler: Lehrbuch der Physikalischen Chemie, Wiley-VCH, 2012 H. Beyer und W. Walter: Lehrbuch der organischen Chemie, Hirzel-Verlag, 2004 C. E. Mortimer: Basiswissen der Chemie, Thieme-Verlag, 2015 R. Pfestorf: Chemie - Ein Lehrbuch für Fachhochschulen, Europa-Lehrmittel, 2013
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to describe the basic principles of electrochemistry. Graduates can explain the basics of atomic structure and chemical bonding.
They understand the behavior of acids, bases and salts in aqueous solution and can deal with the law of mass action.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Professional English Niveau B2 für deutschsprachige Studierende

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE10
Module title:	Professional English Niveau B2 für deutschsprachige Studierende
Module responsible:	Dipl.-Soz. Wiss. Fabienne Ronssin
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	1) As working life is mostly communication - with the main objectives 'Inform-Influence-Persuade' - communication is also the focus of the seminar. During the course, students will develop and deepen the skills to successfully present, engage critically and creatively with business and technical issues, and communicate. 2) Listening and reading comprehension with special attention to technical terminology from the fields of working life will be trained. 3) The formation of intercultural awareness accompanies the learning process. 4) The development of writing skills for typical job-related situations is also part of the module.
Courses:	8020 PE3 Professional English Niveau B2 zweimal 2 SWS = 4 SWS
Teaching and learning forms:	Seminar + Exercise: The course uses an interactive teaching method with a focus on 'speaking' and 'independent learning activities'. An active participation in discussions and varied classroom activities, whether in individual or group work, is encouraged. is encouraged.
Prerequisites for participation:	Solid prior knowledge of at least level B1-B2 according to the Common European Framework of Reference for Languages.
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	The portfolio consists of several performances in various relevant skills: 1) Conduct Negotiation: 2) Writing Email 3) Presentation/ Pitching/ Intercultural Competence 4) Portfolio submission Depending on course days
ECTS credits:	5
Grading:	graded
Workload:	150h (ca.60h presence+ 90h own work)
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	Teaching materials will be provided.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Focus:

Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates will be able to: - communicate spontaneously and fluently with native speakers and users of English as a lingua franca, according to level B2, without major effort on either side, - contribute constructively in a multicultural environment: work towards results (understand and solve tasks appropriately), explain a point of view, respond to other opinions and formulate compromises if necessary, and name mistakes or advantages and disadvantages, - recognize intercultural differences, address them if necessary and offer solutions.

Focus:

Use and transfer

Communication and cooperation

Graduates can, according to level B2, - communicate adequately in different social and intercultural contexts: accept and adapt to some extent to different linguistic and communication styles, - understand the main contents of complex texts on concrete and abstract topics and, in their own field of specialization, also technical discussions, - express themselves clearly and in detail on a wide range of topics, explain a point of view on a topical issue and indicate the advantages and disadvantages of different options.

Scientific / artistic self-image and professionalism

Graduates can, - building on level B1-B2, evaluate the structure of the target language and classify themselves, - assess which criteria are relevant for vocabulary, grammar, pronunciation and different text forms (corresponding to level B2) as well as cultural differences. - appreciate, compare, weigh and classify different values of at least two languages and selected cultures.

Module: Deutsch als Fremdsprache B2 für nicht deutschsprachige Studierende

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE10b
Module title:	Deutsch als Fremdsprache B2 für nicht deutschsprachige Studierende
Module responsible:	Dipl.-Soz. Wiss. Fabienne Ronssin
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	1. a wide range of authentic texts on current and relevant topics from everyday life, work and science, 2. training of all skills (reading, writing, listening and speaking) embedded in realistic situations and occasions. 3. intercultural awareness of the differences between different cultures and living and working in Germany.
Courses:	4631 Deutsch als Fremdsprache B2
Teaching and learning forms:	Seminar + Exercise: The selection of teaching materials and activities will focus on learner autonomy, social learning, and action orientation. Active participation in discussions and varied classroom activities on the part of the students is necessary for the success of the course.
Prerequisites for participation:	Solid prior knowledge of at least level B1 according to the Common European Framework of Reference for Languages. Prior knowledge certified by a placement test or by passing the B1+ course at RWU.
Applicability of the module:	Physical Engineering 3 Elektrotechnik und Informationstechnik 4 Elektromobilität und regenerative Energien 4
Prerequisites allocation ECTS:	The portfolio consists of several performances in different relevant skills: 1) Presentation: date in consultation with the teacher. 2) Discussion: date in consultation with the teacher 3) Intermediate tests: 2021-04-21 + 2021-06-30 4) Intercultural Competence essay and final reflection :2021-06-16
ECTS credits:	5
Grading:	graded
Workload:	150h
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Textbooks for German as a foreign language B2
Compulsory attendance:	yes
Reason:	Students can basically not acquire the complex knowledge material in self-study. Moreover, the language course thrives on debate and discourse. Therefore, compulsory attendance is necessary for the success of the course. A maximum of 4 hours of absence without justification will be tolerated per semester. In case of illness, a doctor's certificate is requested. Additional absences for good cause must be approved in a timely manner by the Language Center Director.

Competence dimensions

Knowledge and understanding

Focus:

Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates can, according to level B2, - communicate spontaneously and fluently with native speakers, - without major effort for both sides, - make a constructive contribution: work towards results (understand tasks and solve them appropriately), explain a point of view, respond to other opinions and, if necessary, formulate compromises and name mistakes or advantages and disadvantages, - recognize intercultural differences, address them if necessary and offer solutions.

Focus:

Use and transfer

Communication and cooperation

Graduates can, according to level B2, - communicate adequately in different social and intercultural contexts: accept and adapt to some extent to different linguistic and communication styles, - understand the main contents of complex texts on concrete and abstract topics and, in their own field of specialization, also technical discussions, - express themselves clearly and in detail on a wide range of topics, explain a point of view on a topical issue and indicate the advantages and disadvantages of different options.

Scientific / artistic self-image and professionalism

Graduates can, - evaluate the structure of the target language and classify themselves, - assess which criteria are relevant for vocabulary, grammar, pronunciation and different text forms (each corresponding to level B2) as well as cultural differences, - appreciate, compare, weigh different values and classify at least two languages and selected cultures.

Module: Werkstoffe

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE11
Module title:	Werkstoffe
Module responsible:	Prof. Dr. rer. nat. Daniel Kolacyak
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Overview of the most important materials, properties, manufacturing processes and areas of application. - Chemical basics - Crystallographic basics - Metals & Alloys - Iron-carbon system - Heat treatment of steel - Ceramics - plastics - Semiconductors, superconductors - composite materials - Materials testing
Courses:	7409 Werkstoffe
Teaching and learning forms:	Lecture Language: in winter semester in English, in summer semester in German.
Prerequisites for participation:	
Applicability of the module:	
Prerequisites allocation ECTS:	K60
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	[1] Shackelford, Introduction to Materials Science for Engineers (Pearson Verlag) [2] Callister Jr., Materialwissenschaften und Werkstofftechnik (Wiley-VCH Verlag) [3] Bergmann, Werkstofftechnik 2: Anwendung (Carl Hanser Verlag) [4] Askeland, Materialwissenschaften (Spektrum Akad. Verlag) [5] Peters, Materialrevolution Bd. 2, Neue nachhaltige und multifunktionale Materialien für Design und Architektur (Birkhäuser Verlag)
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to state the relationships between chemical-physical structure and corresponding material properties. They can describe the most important material testing methods.

Focus:
Broadening of prior knowledge

Use, application and generation of knowledge/art

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Konstruktion 1

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE12
Module title:	Konstruktion 1
Module responsible:	Prof. Dr.-Ing. Benedikt Reick
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	The module is a supplement to the module "Machine Design". It includes basic knowledge of engineering mechanics from the field of statics and its application to engineering problems, as well as the design of simple construction elements and the derivation of technical drawings. Subject area Engineering Mechanics - Systems of forces - Focus on - equilibrium conditions - Friction Subject area CAD - Functionality of a CAD program - Design of three-dimensional geometries - Derivation of standard- and production-compliant technical drawings
Courses:	7957 CAD 2166 Technische Mechanik
Teaching and learning forms:	Lectures E-Learning Lab exercises Language: in winter semester in English, in summer semester in German.
Prerequisites for participation:	Mathematik, Technisches Zeichnen, darstellende Geometrie, Fertigungstechnik
Applicability of the module:	Physical Engineering Wirtschaftsingenieurwesen (Technik-Management)
Prerequisites allocation ECTS:	Portfolio: Documentation (7957 CAD) Written exam, 45 min (2166 Engineering Mechanics)
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Holzmann, Meyer, Schumpich: Technische Mechanik, Teil 1-3, Teubner Assmann: Technische Mechanik, Band 1-3, Oldenburg Gummert/Reckling: Mechanik, Band 1-3, Vieweg Szabo: Einführung in die Technische Mechanik, Springer Magnus/Müller: Grundlagen der Technischen Mechanik, Teubner Brommundt/Sachs: Technische Mechanik, Springer Pestel: Technische Mechanik, Band 1-3, B I Wissenschaftsverlag Gross, Hauger: Technische Mechanik, Band 1-4, Springer Bruhns/Lehmann: Elemente der Mechanik, Vieweg Berger: Technische Mechanik für Ingenieure, Vieweg Böge: Mechanik und Festigkeitslehre, Vieweg Böge/Schlemmer: Aufgabensammlung der Technischen Mechanik, Vieweg Hardtke/Heimann/Sollmann: Lehr- u. Übungsbuch der Techn. Mechanik, Hanser
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Focus:

Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates are able to apply basic knowledge from the field of structural analysis to engineering problems. Graduates are able to use a CAD program to model simple construction elements and to create technical drawings in accordance with standards and production requirements.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Konstruktion 2

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE13
Module title:	Konstruktion 2
Module responsible:	Prof. Dr. sc. techn. Michael Pfeffer
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	The students will be made aware of the complexity of the design process and will be taught basic knowledge and the fundamental procedure and the basic approach to systematic design. - Introduction to design theory - The design process - Basics of mechanical engineering - Basic principles of strength of materials - Selected machine elements
Courses:	7086 Maschinenkonstruktion
Teaching and learning forms:	Lecture with integrated exercises Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	
Applicability of the module:	Elektromobilität und regenerative Energien Physical Engineering
Prerequisites allocation ECTS:	Written exam 90 minutes (K90).
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	[1] Grote, Bender, Göhlich, Dubbel – Taschenbuch für den Maschinenbau [2] Avallone, Baumeister, Sadegh, Marks' Standard Handbook for Mechanical Engineers [3] Steinhilper, Sauer, Konstruktionselemente des Maschinenbaus 1 und 2 [4] Roloff, Matek, Maschinenelemente [5] Budynas, Nisbett, Shigley's Mechanical Engineering Design [6] Pahl, Beitz, Konstruktionslehre [7] Pahl, Beitz, Engineering Design (english version of [6])
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to explain the basic principles of shape, position and dimensional tolerancing.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Based on this, the design-related cost influence of the industrial production of goods will be applied. Graduates will be able to apply fundamentals of component design/selection in terms of function, strength and assembly.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Verschiedene grundlegende Maschinenelemente können vorgestellt und diskutiert werden.

Module: Elektrotechnik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE14
Module title:	Elektrotechnik
Module responsible:	Prof. Dr.-Ing. Samuel Vogel
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	-Current, voltage, power -Grounding and circuit protection -Calculating resistor networks and resistivity -Solving complex networks with Kirchhoff's laws, superposition theorem, Norton/Thevenin theorems -current and voltage measurement -ideal/real current and voltage sources -AC current -capacitors and coils in DC and AC networks
Courses:	6886 Elektrotechnik
Teaching and learning forms:	Lecture with exercise Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Scherz, Monk: Practical Electronics for Inventors, McGraw-Hill Educations. Hering, Bressler, Gutekunst: Elektronik für Ingenieure und Naturwissenschaftler, Springer Vieweg. Zastrow: Elektrotechnik - Lehr- und Arbeitsbuch, Springer Vieweg. ---------- Führer, u.a.: Grundgebiete der Elektrotechnik, Carl Hanser Verlag Ameling, W.: Grundlagen der Elektrotechnik, Vieweg Moeller/Frohne u.a.: Grundlagen der Elektrotechnik, Teubner Ose, Rainer: Elektrotechnik für Ingenieure, Fachbuchverlag LeipzigWeißgerber, Wilfried: Elektrotechnik für Ingenieure 1, 2, Vieweg
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to recognize different network types and select suitable calculation methods.

Focus:
Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates are able to calculate direct and alternating current networks.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Elektronik 1

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE15
Module title:	Elektronik 1
Module responsible:	Prof. Dr.-Ing. Samuel Vogel
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- Complex calculation of combined resistor/capacitor/coil networks at alternating currents. - Passive filters - Transient behavior of resistor/capacitor/coil networks - (Ideal) operational amplifier: basics and applications - Active filters This is supplemented by laboratory experiments on the following topics - Application and operation: Multimeter - Application and operation: Oscilloscope - Passive filters: high/low pass - Transient behavior of capacitors - Circuits with diodes - Simple transistor circuits
Courses:	6052 Elektronik TE1 2218 Praktikum Elektrotechnik / Elektronik
Teaching and learning forms:	Lecture with exercises and laboratory experiments. Language: in winter semester in English, in summer semester in German.
Prerequisites for participation:	Elektrotechnik
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	6052 Electronics TE1: K90 (60 %) and 2218 Practical Course Electrical Engineering / Electronics: Practical Work (Laboratory Experiments) (40 %) For successful participation, at least 50% of the points must be achieved in each of the two module examination parts.
ECTS credits:	5
Grading:	K90
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Scherz, Monk: Practical Electronics for Inventors, McGraw-Hill Educations. Hering, Bressler, Gutekunst: Elektronik für Ingenieure und Naturwissenschaftler, Springer Vieweg. Zastrow: Elektrotechnik - Lehr- und Arbeitsbuch, Springer Vieweg.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Students will be able to explain the principles of operational amplifier circuitry and switching operations.

Focus:
Broadening of prior knowledge

Use, application and generation of knowledge/art

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Elektronik 2

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE16
Module title:	Elektronik 2
Module responsible:	Prof. Dr.-Ing. Samuel Vogel
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	-Function and shading of diodes and LEDs. -Introduction to the operation of bipolar transistors: basic circuits - Design of basic and amplifier circuits using bipolar transistors - Practical application of transistor (circuits)
Courses:	
Teaching and learning forms:	Lectures with exercises. Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	Elektrotechnik Elektronik 1
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	Written exam 90 minutes (K90)
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Scherz, Monk: Practical Electronics for Inventors, McGraw-Hill Educations. Hering, Bressler, Gutekunst: Elektronik für Ingenieure und Naturwissenschaftler, Springer Vieweg. Zastrow: Elektrotechnik - Lehr- und Arbeitsbuch, Springer Vieweg. ----------
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to explain how transistors work and demonstrate their frequency and temperature behavior.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates are able to calculate various transistor circuits.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Informatik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE17
Module title:	Informatik
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Mediation and deepening of computer science knowledge, which are relevant in the context of the engineering activity. - Hardware / structure of a PC - Binary number systems - Boolean algebra and logic gates - operating systems - networks - Data structures and algorithms
Courses:	198 Grundlagen Informatik 1420 Informatik Praktikum
Teaching and learning forms:	Lectures accompanied by an internship Language: in winter semester in German, in summer semester in English.
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	• Grundlagen der Technischen Informatik, D. Hoffmann, Carl Hanser Verlag, ISBN: 9783446406919 • Technische Informatik 3: Grundlagen der PC-Technologie (Springer-Lehrbuch), Wolfram Schiffmann, Helmut Bähring, Udo Hönig, ISBN: 978-3642168116 • Rechnernetze: Grundlagen - Ethernet - Internet, W. Riggert, Carl Hanser Verlag. ISBN: 978-3446431645
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to describe the structure of PCs, the hardware used, operating systems and networks. Graduates are able to state the basic binary number representations and the structure of simple switching logics.

Focus:

Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates apply basic knowledge about the structure of IT hardware and use it, for example, to independently plan a network.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Softwareentwicklung

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE18
Module title:	Softwareentwicklung
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Imparting and deepening knowledge of software development with the programming language Python, which is relevant in the context of the engineering activities. - Basic concepts of programming - Syntactic structure of the language PYthon - Case distinctions - iterations - Strings and lists - functions - files - containers - Numerical Computation - 2D Plots with Python
Courses:	6053 Softwareentwicklung 6054 Softwareentwicklung Praktikum
Teaching and learning forms:	Lecture accompanied by practical exercises. Language: in winter semester in English, in summer semester in German.
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	Practical work in the form of software to be developed
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	K. Zeiner, Programmieren lernen mit C M. Dausman et. al., C als erste Programmiersprache RRZN Hannover, "Die Programmiersprache C"
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to describe the structure of the programming language 'C' and name the most important operators. Graduates are able to explain the basic programming techniques sequence, iteration and selection.

Focus:

Knowledge Comprehension

Use, application and generation of knowledge/art

Graduates will be able to apply basic programming skills to independently create simple structure diagrams and/or 'C' programs.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Physikalische Messtechnik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE19
Module title:	Physikalische Messtechnik
Module responsible:	Prof. Dr. rer. nat. Eckehard Klemt
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	The entire measurement chain from sensor to digital conversion is covered - Introduction - Measurement Uncertainties - Analog measuring instruments - Digital measuring instruments - Different types of sensors together with matching circuit.
Courses:	
Teaching and learning forms:	Lectures Experiments Exercises Project orientation based on measurement tasks
Prerequisites for participation:	Basic subjects: physics, mathematics and electrical engineering
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	J. Niebuhr, G.Lindner: Physikalische Meßtechnik mit Sensoren
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates learn about the uncertainties associated with measurement technology and are able to estimate them. Graduates are able to explain the physics of the measurement chain.

Focus:

Knowledge Comprehension

Use, application and generation of knowledge/art

Graduates are able to apply the physics of the measurement chain in concrete cases. They can determine and discuss measurement uncertainties.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Graduates can learn about their professional fields of action through practical examples.

Module: Regelungstechnik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE20
Module title:	Regelungstechnik
Module responsible:	Prof. Dr.-Ing. Gerd Thieleke
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	- Basic concepts - Mathematical description of control systems in the time, Laplace and frequency domain Elementary and standard transfer elements - The linear single-loop control loop Components, requirements, stability, steady-state and transient behavior Controller design, control loop synthesis Controller design in the BODE diagram
Courses:	2155 Regelungstechnik
Teaching and learning forms:	Lecture, Internship Project orientation: On the basis of technical tasks
Prerequisites for participation:	Differential equations, Laplace transform
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Unbehauen, Heinz: Regelungstechnik Bd. 1, Vieweg Braunschweig Leonhard, Werner: Einführung in die Regelungstechnik, Vieweg, Braunschweig Mann/Schiffelgen/Froriep: Einführung in die Regelungstechnik (MATLAB-Beispiele), Carl Hanser, München Lutz/Wendt: Taschenbuch der Regelungstechnik, Harri Deutsch, Frankfurt/M. Föllinger, Otto: Regelungstechnik Elitera, Berlin Leonhard, / Schnieder: Aufgabensammlung zur Regelungstechnik Vieweg, Braunschweig Pestel / Kollmann: Grundlagen der Regelungstechnik Vieweg, Braunschweig (mit Übungsaufgaben) Mann / Schiffelgen / Froriep: Einführung in die Regelungstechnik (mit MatLab-Beispielen) Carl Hanser, München Dörrscheidt / Latzel: Grundlagen der Regelungstechnik Teubner, Stuttgart Lutz / Wendt Taschenbuch der Regelungstechnik Harri Deutsch, Frankfurt /M. Glattfelder / Schaufelberger Lineare Regelsysteme, Eine Einführung mit MATLAB, Hochschulverlag ETH Zürich Bode, Helmut MATLAB in der Regelungstechnik Teubner, Stuttgart Walter, Hildebrand Kompaktkurs Regelungstechnik Vieweg, Braunschweig
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to describe linear transmission elements as they occur in control engineering in terms of systems theory.

Focus:
Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates are able to apply these models for the realization of a controller design. They can apply these transfer elements to obtain a mathematical model of the controlled system in an experimental or theoretical way. Graduates are able to examine a control loop for its steady-state and dynamic behavior, discussing stability behavior.

Focus:
Scientific innovation

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Digitale Technologien

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE21
Module title:	Digitale Technologien
Module responsible:	Prof. Dr.-Ing. Samuel Vogel
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	"How can products be designed efficiently using digital methods?" >Digitalization of methods: CAD, Simulation, Virtual Reality, Optimization. >Design process: philosophy, product life cycle, systems engineering, model driven systems engineering, automation >Complexity: structuring of the design process, intelligent algorithms Practical implementation of the digitization of the design process using practical examples.
Courses:	
Teaching and learning forms:	Lecture with exercises. The design process of an example product selected by the students is implemented and digitized during the lecture.
Prerequisites for participation:	Basics of computer science
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. Thus results in a workload of 150 h (60 h for lectures, 90 h for lectures, 90 h for self-study (preparation and follow-up work, preparation for exams).
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	J. Sobieszczanski-Sobieski; Multidisciplinary Design Optimization Supported by Knowledge Based Engineering; Wiley. T. Weilkiens; Systems Engineering with SysML/UML; Elsevier. J. M. Borky, T. H. Bradley; Effective Model-Based Systems Engineering; Springer. B. P. Douglass, Agile Systems Engineering; Elsevier.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to explain challenges and solution strategies for the successful digitization of the design process. They are able to reproduce the concept of model-based systems engineering.

Focus:

Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates will be able to model and implement simple applications to automate the design process.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Entwicklung 1

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE22
Module title:	Entwicklung 1
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Introduction to scientific work and writing. - Basics of technical documentation - Information development - Research, media - Formatting, design and layout - Professional German - Multimedia elements and e-learning - Communication, rhetoric and presentation
Courses:	3132 Technische Dokumentation 5142 Wissenschaftliches Arbeiten
Teaching and learning forms:	Lectures, Exercises Project orientation: Creating operating instructions
Prerequisites for participation:	
Applicability of the module:	Physical Engineering Wirtschaftsingenieurwesen (Technik-Management)
Prerequisites allocation ECTS:	Dokumentation
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester

Literature:	Juhl, Dietrich, Technische Dokumentation. Praktische Anleitungen und Beispiele (Berlin/Heidelberg, 2007), ISBN: 978-3540238133 Kühn, Cornelia, Handlungsorientierte Gestaltung von Bedienungsanleitungen (Lübeck, 2004), ISBN: 978-3795070083 Ferlein, Jörg und Hartge, Nicole, Technische Dokumentation für internationale Märkte (Renningen, 2008), ISBN: 978-3816925804 Hoffmann Walter/Hölscher Brigitte G./Thiele, Ulrich, Handbuch für Technische Autoren und Redakteure. Produktinformation und Dokumentation im Multimediazeitalter (Erlangen, 2002), ISBN: 978-3895781872 Hennig, Jörg/Tjarks-Sobhani, Marita (Hrg.), Verständlichkeit und Nutzungsfreundlichkeit von technischer Dokumentation (Lübeck, 1999), ISBN: 978-3795007508 Hennig, Jörg/Tjarks-Sobhani, Marita (Hrg.), Lokalisierung von Technischer Dokumentation (Lübeck, 2002), ISBN: 978-3795007898 Drewer, Petra/Ziegler, Wolfgang, Technische Dokumentation – Übersetzungsgerechte Texterstellung und Content Management (Würzburg, 2010), ISBN: 978-3834331014 Kothes, Lars: Grundlagen der Technischen Dokumentation (Berlin Heidelberg, 2011), ISBN: 978-3-642-14667-1 Kerres, Michael: Mediendidaktik (München, 2013), ISBN: 978-3-486-73602-1 Hasler Roumois, Ursula. Studienbuch Wissensmanagement. Orell Füssli. 2007. Lehner, Franz. Wissensmanagement. Hanser. 2009. Remus, Ulrich. Prozessorientiertes Wissensmanagement. 2002. Thiesse, Frédéric. Prozessorientiertes Wissensmanagement. 2001. Willke, Helmut. Systemisches Wissensmanagement. Lucius & Lucius. 1998.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to explain the options for researching and developing content.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates can structure this content. They can use various media to extract relevant information from it.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Entwicklung 2

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE23
Module title:	Entwicklung 2
Module responsible:	Prof. Dr. rer. nat. Daniel Kolacyak
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Basic principles for the protection of intellectual property - Technical inventions - Design - Trademark - software as well as the conceptual foundations and methodological tools for successful project management. - Basics of project management - Problem solving processes - project foundation - project organization - Project planning (structure, process and schedule planning) - risk management - project control - Project completion - The human being in the project - Practical problems and practical experience in project management
Courses:	5900 Technisches Projektmanagement 1446 Patente
Teaching and learning forms:	Lectures, exercises
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Jakoby, W., Projektmanagement für Ingenieure Felkai, R., Beiderwieden A., Projektmanagement für technische Projekte
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates can summarize the most important framework data of a project in the form of a project definition and explain the significance of a project order. They can demonstrate the basics of industrial property protection.

Focus:

Deepening of individual components of knowledge

Use, application and generation of knowledge/art

You can describe the basic rules about the structure and process of projects and create work breakdown structures and the project plans derived from them.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Betriebswirtschaft

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE24
Module title:	Betriebswirtschaft
Module responsible:	Prof. Dr. Jörg Eberhardt/Angelika Lehn
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	On the one hand, the prospective engineers should be able to apply business management contexts and tools and, on the other hand, through become 'survivable' through an appropriate understanding of the structures in the companies: - Basics of general business administration - What is business administration and why business administration for engineers? - Selected topics of business administration - Accounting - External accounting (balance sheet) - Internal accounting (cost accounting) - Investments and financing - Financial planning - Investment planning
Courses:	7003 Grundlagen BWL und QM
Teaching and learning forms:	Lecture, exercise, discussion of current events, examples from personal environment
Prerequisites for participation:	Ideally, the practical semester has already been completed!
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	Written elaboration of a scientific paper and participation in a colloquium.
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Lecture accompanying reprint, further references in lecture.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to critically evaluate the behavior and needs of companies, as well as managers and employees. Graduates understand the fundamental interrelationships between markets, companies and employees and can react accordingly to the situation.

Focus:

Deepening of individual components of knowledge

Use, application and generation of knowledge/art

The basic calculation methods in cost and investment accounting can be applied with confidence.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Modellierung und Simulation

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE25
Module title:	Modellierung und Simulation
Module responsible:	Prof. Dr.-Ing. Konrad Wöllhaf
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	The module includes knowledge and methods for modeling and simulation of technical systems. This includes: - Objectives Benefits and limitations of simulation models - Overview of simulation methods - Approach to modeling projects - Formal mathematical description forms - Functionality of simulation algorithms - Modeling examples from the fields of: Mechanics, electrical engineering, process engineering, ecology - Introduction to the simulation tool Matlab/Simulink
Courses:	3410 Modellierung und Simulation
Teaching and learning forms:	Lecture, Exercises Project work
Prerequisites for participation:	Control engineering, Laplace transform, differential equations
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Winter semester only

Literature:	A. Angermann, M. Beuschel, M. Rau, and U. Wohlfarth. Matlab-Simulink-State_ow. Oldenbourg, 2002. L. V. Ātkinson and P. J. Harley. An Introduction to Numerical Methods with Pascal. Addison-Wesley, 1983. Dieter Ammon. Modellbildung und Systementwicklung in der Fahrzeugdynamik. Teubner Stuttgart, 1997. Hartmut Bossel. Modellbildung und Simulation. Vieweg, 1994. F. E. Cellier. Continuous system modeling. Springer, 1992. Horst Czichos and Manfred Hennecke. Hütte, Die Grundlagen der Ingenieurwissenschaften. Springer-Verlag, 1991. Helga Dankert and Jürgen Dankert. Technische Mechanik. Teubner Stuttgart, 2004. H. Elmqvist. A structured model language for large continuous systems. PhD thesis, Department of Automatic Control Lund Institute of Technology, 1978. Gisela Engeln-Müllges and Frank Uhlig. Numerical algorithms with C. Springer, 1996. H.-M. Hanisch. Petri Netze in der Verfahrenstechnik. Oldenbourg, 1992. Martin Hanke-Bourgeois. Grundlagen der numerischen Mathematik und des wissenschaftlichen Rechnens. 2006. Wilhelm Kley. Numerische Methoden in Physik und Astrophysik. Universität Tübingen,http://www.tat.physik.uni-tuebingen.de/∼kley/lehre/numerik/ws2005/inhalt.html. Dean C. Karnopp, Donald L. Margolis, and Ronald C. Rosenbert. System Dynamics. John Wiley & Sons, New York, 2000. Dean C. Karnopp and Ronald C. Rosenberg. Analysis and Simulation of Multiport Systems - The Bond Graph Approach to Physical System Dynamics. M.I.T. Press, 1968. Hubertus Murrenho_. Grundlagen der Fluidtechnik, Teil1: Hydraulik. ShakerVerlag, 2005. Wolf Dieter Pietruszka. MATLAB in der Ingenieurpraxis (Modellbildung, Berechnung und Simulation). Teubner, 2005. Helmut E. Scherf. Modellbildung und Simulation dynamischer Systeme. Oldenbourg, 2007. Michael Tiller. Introduction to Physical Modeling with Modelica. Kluwer Academic Publishers Group, 2001. Heinrich Voss. Numerische Methoden für Differentialgleichungen, 2001. Michael Glöckler. Simulation mechatronischer Systeme. Springer-Verlag, 2014. Reiner Nollau. Modellierung und Simulation technischer Systeme. Springer Verlag, 2009.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to outline the approach to creating simulation models. They understand the basic functioning of simulation tools and can thus avoid errors when creating simulation models. Graduates know the benefits and application areas of simulation techniques. They can outline the most important simulation algorithms for simulating ordinary differential equations. They can also list and explain other simulation techniques.

Focus:
Knowledge Comprehension

Use, application and generation of knowledge/art

Graduates are able to use the simulation tool Matlab/Simulink. They can derive models for simple systems, formulate the equations appropriately and convert these into an executable simulation model. They can carry out simulation studies and use the results for practical applications.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Mikrocontroller

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE26
Module title:	Mikrocontroller
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Imparting knowledge on the use of microcontrollers for metrological applications. The theoretical lecture units are accompanied by practical laboratory work. Topics: - Basics of microcontrollers - Use of microcontrollers with practical examples
Courses:	185 Mikrocontroller 542 Mikrocontroller Praktikum
Teaching and learning forms:	Lectures accompanied by exercises in the laboratory and practical course.
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	Practical work
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	Mikrocomputertechnik mit Controllern der Atmel AVR-RISC-Familie, Dipl.-Ing. Günter Schmitt, ISBN 978-3-486-58790-6 In unserer Hochschulbibliothek ausleihbar.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates have knowledge of the structure of the microprocessors of the ATMega series from ATMEL.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates are able to independently create basic microcontroller software using the 'C' programming language. They are able to calculate circuits and compare them with the measurement.

Focus:
Scientific innovation

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Vertiefung

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE27
Module title:	Vertiefung
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	The compulsory elective module offer (specialization) consists of modules of the main topics imaging processes as well as mechatronics (cf. Table 3 §47 SPO). The students select one of the two main topics by the end of the third semester. In addition to the three modules of one of the two focal points, one module of the respective other focal point must be taken.
Courses:	
Teaching and learning forms:	
Prerequisites for participation:	The implementation of an elective module may be made dependent on a minimum number of participants.
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	
ECTS credits:	20
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	two semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

A range of elective modules as well as individual elective modules are available to students for profile formation.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Focus:

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Wahlmodul Technik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE28
Module title:	Wahlmodul Technik
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Elective module
Undergraduate/Major:	Main studies
Module Content:	Contents and competencies correspond to the respective module.
Courses:	
Teaching and learning forms:	
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	In order to develop an individual profile, students must complete a total of 10 ECTS in the seventh semester from other courses offered by Ravensburg-Weingarten University or another university. Of these, 5 ECTS must be taken in the area of natural science/technology and a further 5 ECTS from a non-technical area.
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Students can choose from a range of technical elective modules to build their profile.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Focus:

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Wahlmodul Nichttechnik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE29
Module title:	Wahlmodul Nichttechnik
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Elective module
Undergraduate/Major:	Main studies
Module Content:	Contents and competencies correspond to the respective module.
Courses:	
Teaching and learning forms:	
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	In order to develop an individual profile, students must complete a total of 10 ECTS in the seventh semester from other courses offered by Ravensburg-Weingarten University or another university. Of these, 5 ECTS must be taken in the area of natural science/technology and a further 5 ECTS from a non-technical area.
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Students can choose from a range of non-technical elective modules to build their profile.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Focus:

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Projekt

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE30
Module title:	Projekt
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Knowledge and methods acquired in the course of study that are applied to a project work.
Courses:	Module Entwicklung 1 und Entwicklung 2
Teaching and learning forms:	Project seminar that accompanies the execution of a technical project work. The project work serves as preparation for the Bachelor's thesis.
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	Project work in connection with a written elaboration and/or presentation.
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Focus:

Use, application and generation of knowledge/art

Focus:

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Praktisches Studiensemester mit Seminar

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE31
Module title:	Praktisches Studiensemester mit Seminar
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	The mandatory Internship semester includes a practical activity in a company, the contents of which must be designed in accordance with the job profile of the study program. The competencies acquired during the course of study are to be applied and deepened by working on suitable projects in the company. The students should get to know the technical requirements, the working methods and the operational environment in practice and work on applied projects as independently as possible as well as jointly responsible, taking into account the operational conditions.
Courses:	
Teaching and learning forms:	
Prerequisites for participation:	The compulsory Internship semester must be completed in the sixth semester for students who began their studies in the summer semester and in the fourth semester for students who began their studies in the winter semester. It can only be taken up if the intermediate examination according to § 7 paragraph 2 has been passed.
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	During the Compulsory Internship Semester, students are supervised by the Internship Office. For the recognition of the Compulsory Internship Semester, various achievements must be made. The Internship Office determines these achievements (e.g. preparation of an interim and a final report) and specifies when and in what form they must be completed. The students are informed about this on the intranet and in an information event. At the end of the obligatory internship semester, internship days are held in which the obligatory internship semester is followed up and a final presentation is to be given. Participation in the internship days is mandatory. In exceptional cases, after special approval by the head of the Internship Office, a final presentation set to music may be made instead of participation in the Internship Days, which may be shown on the Internship Days. The student must arrange for approval of the final presentation by the company. After completion of the practical work in the company, a record of the work done in the company must be submitted to the Internship Office. On the basis of the services rendered and the proof of activity, the head of the Internship Office decides whether the student has successfully completed the obligatory internship semester.
ECTS credits:	30
Grading:	ungraded
Workload:	
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Focus:

Knowledge Comprehension

Use, application and generation of knowledge/art

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

The mandatory internship semester comprises a practical activity in a company, the contents of which must be designed in accordance with the job profile of the degree program. The competencies acquired during the course of study are applied and deepened by working on suitable projects in the company. Graduates get to know the technical requirements, the working methods and the operational environment in practice and are able to work on applied projects as independently as possible as well as jointly responsible, taking into account the operational conditions.

Module: Bachelorarbeit und Bachelorandenseminar

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE32
Module title:	Bachelorarbeit und Bachelorandenseminar
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	
Courses:	
Teaching and learning forms:	Bachelor's thesis with accompanying bachelor's seminar
Prerequisites for participation:	The bachelor's thesis can only be started if all course achievements of the first four semesters and the practical semester have been successfully completed.
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	The thesis must be submitted to the examination office of RWU no later than 6 months after the date of issue.
ECTS credits:	
Grading:	
Workload:	The topic, task and scope of the Bachelor's thesis are to be limited by the task-setter in such a way that the thesis can be completed in approx. 360 working hours, corresponding to 12 ECTS. The thesis must be handed in to the examination office of RWU no later than 6 months after the date of issue.
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Focus:

Knowledge Comprehension

Use, application and generation of knowledge/art

Focus:

Scientific innovation

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Abbildung und Spektroskopie wird ersetzt durch Technische Optik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE33
Module title:	Abbildung und Spektroskopie wird ersetzt durch Technische Optik
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	Basics of imaging Advanced imaging concepts (Scheimpflug, telecentric...) Optical instruments Basics of lighting technology The imaging chain Hyper- and multispectral imaging Computer exercises: Laser Optics Color correction with achromats A simple zoom optics
Courses:	Cross connection to module Physics 3
Teaching and learning forms:	Lectures, exercises, practical courses on the computer
Prerequisites for participation:	
Applicability of the module:	
Prerequisites allocation ECTS:	Practical work (PA)
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (of which 60 h for lectures lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates can explain the basics of imaging and color. They can calculate optical instruments using optical design programs.

Focus:
Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates are able to design optical systems based on catalog lenses and evaluate their properties.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Technische Optik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE34
Module title:	Technische Optik
Module responsible:	Prof. Dr. sc. techn. Michael Pfeffer
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	1 Light, light propagation and optical imaging 1.1 Properties of light 1.2 Wave optics 1.3 Quantum optics 1.4 Optical imaging 2 Imaging components 2.1 Materials 2.2. plane surfaces, plane plates, reflection prisms and beam splitters 2.3 Prisms with bundle deflection by refraction 2.4. spherical surfaces, lenses, multilevel systems in the Gaussian domain 2.5 Single lenses and systems in air 2.6 Thin lenses 2.7. aberrations 2.8. special lens shapes 2.9.beam path in non-paraxial region 2.10. Reflection reduction 3 Bundle Limitation 3.1 Effect of bundle limiting 3.2. limitation of the aperture angle 3.3 Limitation of the field angle 3.4 Properties of pupils and magnifiers 3.5 Shading apertures, vignetting 3.6 Telecentric systems 4 Specification of optical elements according to ISO 10110 4.5 Scope of application 4.2 Terms 4.3 Basic specifications 4.4 Representation and dimensioning 4.5 Additional information for optical design drawings
Courses:	
Teaching and learning forms:	Lecture, Exercises
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Summer semester only

Literature:	Schröder, G., Treiber K.H.: Technische Optik, 11. Auflage, Vogel Fachbuch (Kamprath-Reihe), (2014). Saleh, B.E.A., Teich, M.C.: Optik und Photonik, 3. Auflage, WILEY-VCH, (2019). DIN – Deutsches Institut für Normung e.V. (Hrsg.) : Technische Produktdokumentation - Erstellung von Zeichnungen für optische Elemente und Systeme, DIN-Taschenbuch 304; 5. Auflage, Beuth-Verlag, (2019). Gross, H. (Hrsg.): Handbook of Optical Systems - Volume 1: Fundamentals of Technical Optics, 1. Auflage, WILEY-VCH, (2005). Flügge, J., G. Hartwig, G., W. Weiershausen, W.: Studienbuch zur technischen Optik, UTB Vandenhoeck, Göttingen, (1985). Flügge J.: Geometrische Optik, Gebundene Ausgabe, Vandenhoeck & Ruprecht (1962). Flügge J.: Leitfaden der geometrischen Optik und des Optikrechnens, Vandenhoeck & Ruprecht, Göttingen (1956). Haferkorn H.: Optik - Physikalisch-technische Grundlagen und Anwendungen, 4. bearb. und erw. Auflage, WILEY-VCH, (2002). Haferkorn H.: Bewertung optischer Systeme, VEB-Verlag, Leipzig, (1996). Haferkorn H.: Synthese optischer Systeme, VEB-Verlag, Leipzig, (1996). Haferkorn, H. (Hrsg.): Lexikon der Optik, W. Dausien-Verlag, Hanau, (1988). Slevogt H.: Technische Optik (Sammlung Göschen, Band 9002), Verlag DeGruyter, Reprint Auflage 2011, (1974).
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates will be able to explain the fundamentals of technical optics and will be able to both specify and draw an optical element.

Focus:
Knowledge Comprehension

Use, application and generation of knowledge/art

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: 3D und Bildverarbeitung

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE35
Module title:	3D und Bildverarbeitung
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	- Structure and operation of 2D cameras - Image formation and imaging - Illumination techniques for optimal image acquisition - 3D methods - Methods of image processing - Current trends
Courses:	Physik 3, Grundlagen der Informatik
Teaching and learning forms:	Lecture accompanied by exercises
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	Pedrotti F., Pedrotti, Bausch, Schmidt: Optik für Ingenieure, Springer, 2007 Tönnies K.: Grundlagen der Bildverarbeitung, Pearson, 2005 Erhardt A.: Einführung in die digitale Bildverarbeitung, Vieweg+Teubner, 2008
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates have knowledge of 2D and 3D cameras, as well as illumination and imaging techniques.

Focus:
Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates will be able to identify the methods and procedures learned in industrial image processing for evaluating camera data.

Focus:
Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Wahl Modul aus Vertiefungsrichtung Mechatronik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE36
Module title:	Wahl Modul aus Vertiefungsrichtung Mechatronik
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	Contents and competencies correspond to one of the modules from the specialization in mechatronics.
Courses:	
Teaching and learning forms:	
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Focus:

Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Mechatronik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE37
Module title:	Mechatronik
Module responsible:	Prof. Dr.-Ing. Konrad Wöllhaf
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	- Features and characteristics of mechatronic system - Description of mechatronic systems with formal models - Methods of parameter determination - Evaluation and design of systems with methods of control engineering - Design of systems with methods of control engineering
Courses:	129 Mechatronik Grundlagen
Teaching and learning forms:	Lectures Exercises
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	Rolf Isermann. Mechatronische Systeme. Springer, Berlin, 1998. Ekbert Hering and Heinrich Steinhart. Taschenbuch der Mechatronik. Fachbuchverlag Leipzig im Carl Hanser Verlag, 2015. ISBN 978-3-446-43857-6. Wolfgang Wendt Holger Lutz. Taschenbuch der Regelungstechnik. Harry Deutsch, Frankfurt am Main, 2005. Jürgen P. Bläsing and Daniel Eiche. Workbook Effects Analysis. TQU Verlage Ulm, 2002. Heimann, B.; Gerth, W. & Popp, K. Mechatronik Hanser Leipzig, 2015 Berthold Heinrich, Peter Döring, Lutz Klüber, Stefan Nolte, and Rolf Simon. Mechatronik, Grundlagen und Komponenten. Vieweg, 2004. ISBN 3-528-03957-4.
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates know the advantage of the mechatronic approach and can describe this using practical examples. They know different methods for modeling mechatronic systems. They know which methods can be used to determine the parameters of these systems and can list statements about the behavior of the systems.

Focus:

Broadening of prior knowledge

Use, application and generation of knowledge/art

Graduates can apply models for mechatronic systems. They know the methods to investigate and improve mechatronic systems. They can apply their knowledge to simple systems.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Robotik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE38
Module title:	Robotik
Module responsible:	Prof. Dr.-Ing. Konrad Wöllhaf
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	This module deals primarily with industrial robots although mobile robots are also addressed. The contents are: - History, classification, applications, social aspects. - Transformations in 3D and kinematics of industrial robots - Path planning Collision analysis - dynamics - Programming, simulation and control of industrial robots - Laboratory exercises Programming, simulation and control of industrial robots and simple mobile robots
Courses:	5761 Robotik Cross-connection to control engineering as well as to modeling and simulation
Teaching and learning forms:	Lectures Exercises Internships Project work
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	Portfolio Exam: K60 Exam/graded Internship/ungraded
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	Robert J. Schilling. Fundamentals of robotics: analyisis and control. Prentice-Hall, 1990. John J. Craig. Introduction to robotics: mechanics and control. Addison-Wesley, New York, 1 edition, 1989. Weber, W. Industrieroboter Hanser-Verlag, 2019 Behrens, R. Biomechanische Grenzwerte für die sichere Mensch-Roboter-Kollaboration Springer Vieweg, 2018 Hesse, S., Greifer-Praxis: Greifer in der Handhabungstechnik Vogel, 1991 DIN EN ISO 10218-2 Industrieroboter - Sicherheitsanforderungen - Teil 2: Robotersysteme und Integration (ISO 10218-2:2011) Beuth Verlag, Betlin, 2012 Hesse, S. & Malisa, V. (Eds.) Taschenbuch Robotik - Montage - Handhabung Carl Hanser Verlag GmbH & Co. KG, 2016 Buxbaum, H.-J. (Ed.) Mensch-Roboter-Kollaboration Springer-Verlag, 2020
Compulsory attendance:	yes
Reason:	For the robotics internship, work must be done on the robots.

Competence dimensions

Knowledge and understanding

Graduates are familiar with the different types of robots. They can name different areas of application. They know how robot motion is described. Graduates understand the problems that arise when programming robots, such as reachability, collisions, singularities and compliance with cycle times. They can explain where the use of industrial robots makes sense.

Focus:

Deepening of individual components of knowledge

Use, application and generation of knowledge/art

Graduates can apply their knowledge of robots in creating simple robot programs. They can describe the kinematics of different types of robots using Denavit-Hartenberg parameters and calculate the position and orientation of the robot hand.

Focus:

Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Mikrosysteme / Optoelektronik

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE39
Module title:	Mikrosysteme / Optoelektronik
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	Not offered in the 2021 summer semester.
Courses:	7560 Mikrosysteme/Optoelektronik Cross-connection to computer science and software development
Teaching and learning forms:	Lecture Exercises Laboratory test
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures and lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	Menz, Mikrosystemtechnik für Ingenieure, VCH Büttgenbach, Mikromechanik, Teubner Winstel,Optoelektronik I u. II, Springer
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Graduates are able to explain the functioning of microtechnical and optoelectronic components.

Focus:
Knowledge Comprehension

Use, application and generation of knowledge/art

Focus:

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Wahl Modul aus Vertiefungsrichtung Bildgebende Verfahren

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE40
Module title:	Wahl Modul aus Vertiefungsrichtung Bildgebende Verfahren
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	Contents and competences correspond to one of the modules from the specialization Imaging Techniques.
Courses:	
Teaching and learning forms:	
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed.
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Focus:

Use, application and generation of knowledge/art

Focus:

Communication and cooperation

Scientific / artistic self-image and professionalism

Module: Wahlprojekt

Course of study:	Physical Engineering
Degree:	Bachelor of Science (B.Sc.)
Module number:	PEE41
Module title:	Wahlprojekt
Module responsible:	Prof. Dr. Jörg Eberhardt
Typ of module:	Elective module
Undergraduate/Major:	Main studies
Module Content:	Project seminar that accompanies the implementation of a technical project work.
Courses:	
Teaching and learning forms:	Seminar
Prerequisites for participation:	
Applicability of the module:	Physical Engineering
Prerequisites allocation ECTS:	The scope and type of examination, graded or ungraded, is to be determined by the examiner at the beginning of the project.
ECTS credits:	bis max. 5 ECTS
Grading:	graded/ungraded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of max. 150 h (60 h for lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	
Compulsory attendance:	no

Competence dimensions

Knowledge and understanding

Focus:

Use, application and generation of knowledge/art

Focus:

Communication and cooperation

Scientific / artistic self-image and professionalism

Valid from: SoSe21 (Deadline 15.02.2021)
SPO: 03.12.2020
Print date: 15.03.2021