SmartVET HighED

Co-funded by the European Union

RESULT 2

Module Handbook for Study Program

SmartVET–HighED
Development of a study program with an integrated master craftsman / bachelor's degree

2021-1-AT01-KA220-HED-000031165

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Table of Contents

Table of Contents *2*

Study Program *5*

Study Design 5

Notes / key data on the draft 6

Study Program 8

Phase planning / study structure 9

Curriculum / module structure / fields of vocational training 10

Curriculum / module structure of the Building Technology study program 11

Modules in the 1st semester *14*

Mathematics 1 (MTH1) 14

Chemistry / Materials science (CWK) 16

Construction management (BBL) 18

Key qualification 1 (SCQ1) 20

Modules in the 2nd semester *22*

Mathematics 2 (MTH2) 22

Electrical Engineering (ELE) 24

Computer Science (INF) 27

Business Administration A (BWLA) 29

Building Physics and technical expansion (BTA) 31

Modules in the 3rd semester *33*

Structural analysis (TWL) 33

Introduction to thermodynamics (TDY) 35

Lighting and illumination technology with EELA 37

Industrial Electronics 1 (IEL1) 40

Modules in the 4th semester *43*

Heat supply (WVG) 43

Automation technology (AUT) 45

Industrial Electronics 2 (IEL2) 48

Modules in the 5th semester *51*

Building construction (BKO) 51

CAD for BAU (CADB) 53

Energy and environmental technology (EUT) 55

Software for engineers (SFI) 58

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Ventilation, air conditioning and refrigeration technology (LKK) **60**
Technical English 1 (TEE1) **62**
Modules in the 6th semester ***63***
Private building law (PBR) **63**
Energy management (ENM) **64**
Natural resource management (WUA) **66**
BIM project (BIMP) **68**
Technical English 2 (TEE2) **70**
Compulsory elective subject 1 (WPF1) **72**
Compulsory elective subject 1 (WPF1) **72**
Compulsory elective subject 1 (WPF1) **74**
Compulsory elective subject 1 (WPF1) **76**
Compulsory elective subject 1 (WPF1) **78**
Compulsory elective subject 1 (WPF1) **80**
Modules in the 7th semester ***82***
Control and regulation technology (SRE) **82**
Gas and fire protection technology (GUB) **84**
TGA Project (TGP) **86**
Calculation in TGA (KTG) **88**
Regenerative heat utilization (RWN) **90**
Modules in the 8th semester ***92***
Project Management (PJM) **92**
Facility Management (FAM) **94**
Key qualification 2 (SCQ2) **96**
Compulsory elective subject 2 (WPF2) **98**
Compulsory elective subject 2 (WPF2) **100**
Compulsory elective subject 2 (WPF2) **101**
Compulsory elective subject 2 (WPF2) **103**
Compulsory elective subject 2 (WPF2) **105**
Compulsory elective subject 2 (WPF2) **107**
Compulsory elective subject 2 (WPF2) **109**
Compulsory elective subject 2 (WPF2) **111**
Practical phases ***113***
Bachelor thesis ***114***
Testing and evaluation ***115***

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Testing and evaluation of the developed design **115**
Initial situation **115**
Research Design **115**
Sampling strategy **116**
Questionnaire **117**
Sample **118**
Results **118**
Conclusion **124**
Sources ***125***

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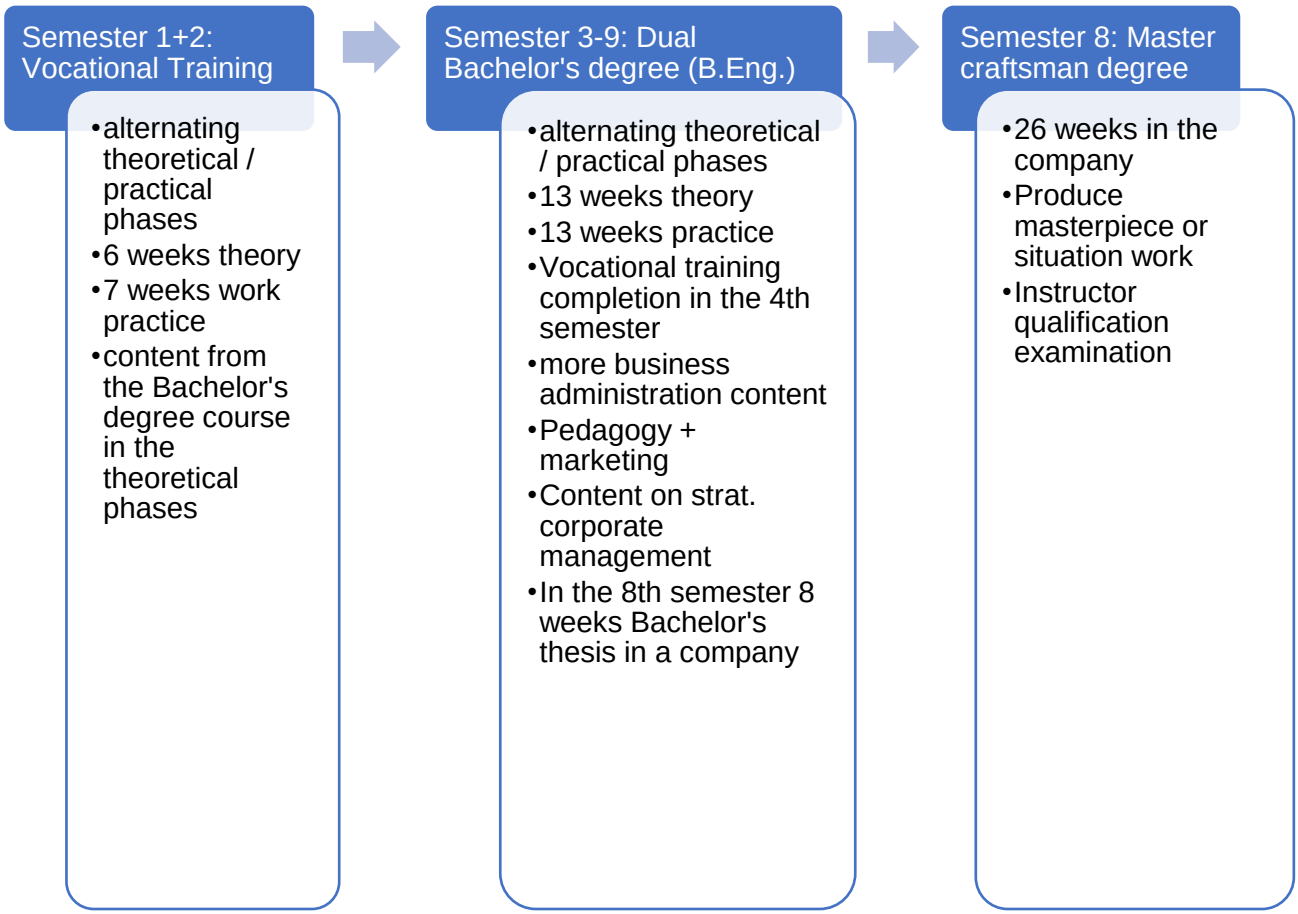
Study Program

Study Design



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X

Notes / key data on the draft

- People with a university entrance qualification receive a reduction in the time required for vocational training to 2 years.
- Therefore, as an integral part of the degree course, vocational training is carried out and completed in the first four semesters.
- The course of study takes place from the first semester onwards, so that in the first four semesters there are three places of learning: university, vocational school and company.
- In the first four semesters, course content can already be taught to the extent that around 80 credit points are acquired.
- From the fifth semester onwards, only the course content (including preparation for Part III Business Administration and Part IV Vocational Education and Training of the master craftsman examination) and the university and company learning locations are taught, so that 130 credit points are acquired from the 5th to 8th semester.
- Upon successful completion of the vocational training, all requirements for admission to the master craftsman examination are met. Therefore, admission to the master craftsman examination takes place at the beginning of the 5th semester.
- Spread over the three semesters (5th to 7th semester), the master's examination is taken in
    - Part I Situation task or creation of masterpiece (if the bachelor's thesis is not recognized in this respect)
    - Part III Business Administration
    - Part IV Trainer qualification
- This distribution over 1.5 years is not too demanding for the students.
- The bachelor's thesis and final Bachelor's examination are completed in the 8th semester. The bachelor's examination also leads to exemption from Part II of the master craftsman's examination, so that the master craftsman's qualification is acquired at the same time as the bachelor's degree.
- The entire study program lasts 4 years.
- Additional qualifications can be achieved through elective subjects and chamber examinations. For example, the EBA (extended concrete technology training), the master craftsman/master craftswoman and various apprenticeship qualifications.
- In cooperation with the Chamber of Crafts, some parts of the examination are recognized (specialist theory).
- Students obtain proof of specialist practice and theory (Parts I and II of the master craftsman examination) through the bachelor's degree.

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- Students can be exempted from Part III of the master craftsman examination (commercial knowledge and law) by taking certain modules:
    - Business Administration 1 (BWL 1) Compulsory module
    - Accounting / Annual Financial Statements (RWJ), Business Law
    - (WIR) and Private Building Law (PBR) from the Industrial Engineering Construction and Real Estate DUAL degree program
- Part IV AEVO (trainer aptitude) can be taken as a WPF (compulsory elective subject) or SQL (key qualification).
- As part of the “Key Qualifications” program, the university offers a preparatory course for all degree programs to obtain the instructor aptitude according to AEVO (Instructor Qualification Ordinance). The course content corresponds to examination part IV of the “Kaufmännische/r Fachwirt/in (HWK)”, - Vocational and occupational education.
- After passing the examination, this is also recognized by the university as an examination achievement with 2 ECTS points in the subject of key qualifications and is designated as such. The preparatory course for taking the examination in accordance with AEVO is offered under the subject title Key Qualifications.
- The registration corresponds to that of the “commercial business administrator (HWK)” Part IV of the master craftsman examinations corresponds to the trainer qualification examination according to AEVO. The trainer qualification examination is required for the training of apprentices. Part IV of the master craftsman examination is offered as a separate module at the university.

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Study Program

- Smart building
- Building technology and renewable energies
- Integrated vocational training (optional)
    - Heating engineer
    - Electrical engineer
    - Plumber (sanitary)
- Training in two years (4 semesters)
- B.Eng. Degree at the end of the 8th semester
- Master craftsman examination at the end of the 8th semester

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Phase planning / study structure

1st Semester September

CW Nr.	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11
Education	Dual training vocational school / practice																									
UoAS	Theory studies 3 days a week																									

2nd Semester March

CW Nr.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Education	Dual training vocational school / practice																									
University	Theory studies 3 days a week																									

3rd Semester September

CW Nr.	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11
Education	Dual training vocational school / practice																									
University	Theory studies 3 days a week																									

4th Semester March

CW Nr.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Education	Dual training vocational school / practice																									
University	Theory studies 3 days a week																									

5th Semester September

CW Nr.	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11
Education	Full-time study at the university																									
Practical														Practical phase												

6th Semester March

CW Nr.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Education	Full-time study at the university																									
Practical														Practical phase												

7th Semester September

CW Nr.	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11
Education	Full-time study at the university																									
Practical														Practical phase												

8th Semester March

CW Nr.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Education	Full-time study at the university																									
Bachelor thesis														Bachelor thesis / master craftsman examination												

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Curriculum / module structure / fields of vocational training

Dual training: Alternating vocational school / practice

Semester	*Module title*	*Learning Location*	*Teaching hours*	*Total teaching units*
1st Semester	Manufacturing components with hand-held tools	Vocational school / practice company	80	240 TU.
	Manufacturing components with machines	Vocational school / practice company	80	
	Manufacture and assemble components	Vocational school / practice company	80	
2nd Semester	Maintaining technical systems	Vocational school / practice company	80	240 TU.
	Installing drinking water systems	Vocational school / practice company	80	
	Installing heat distribution systems	Vocational school / practice company	80	
3rd Semester	Install drainage systems	Vocational school / practice company	60	280 TU.
	Equip sanitary rooms	Vocational school / practice company	60	
	Installing drinking water heating systems	Vocational school / practice company	80	
	Adjusting supply systems and optimizing energy efficiency	Vocational school / practice company	80	
4th Semester	Installing heat generation systems for gaseous fuels	Vocational school / practice company	60	260 TU.
	Installing heat generation systems for liquid and solid fuels	Vocational school / practice company	40	
	Installing resource-saving systems	Vocational school / practice company	40	
	Installing ventilation systems	Vocational school / practice company	60	
	Maintaining technical supply systems	Vocational school / practice company	60	
Apprenticeship examination / completion of training				

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Curriculum / module structure of the Building Technology study program

DUALE full-time degree course in Building Services Engineering at the university.

Semester	*Module title*	*Module code*	*Examination / academic achievement*	*Workload (P / S) [h]*	*ECTS*	*Sum ECTS*
1st Semester 3 days a week theoretical studies at the university (13 weeks)	Mathematics 1	MTH1	Written Exam (120 Min.)	100 / 70	6	19
	Chemistry / Materials science	CWK	Written Exam (90 Min.) + Homework	70 / 50	5	
	Construction management	BBL	Written Exam (90 Min.) + Homework	70 / 70	5	
	Key qualification 1	SCQ1	Publication incl. poster	40 / 30	3	
2nd Semester 3 days a week theoretical studies at the university (13 weeks)	Mathematics 2	MTH2	Written Exam (120 Min.)	100 / 70	6	20
	Electrical Engineering	ELE	Written Exam (90 Min.) + Laboratory	70 / 70	5	
	Computer Science	INF	Homework	60 / 80	5	
	Business Administration A	BWLA	Written Exam (90 Min.)	60 / 40	4	
3rd Semester 3 days a week theoretical studies at the university (13 weeks)	Structural analysis	TWL	Written Exam (90 Min.) + Homework	70 / 50	5	19
	Introduction to thermodynamics	TDY	Written Exam + Homework	70 / 30	5	
	Lighting and illumination technology with EELA	LUB / EELA	Written Exam (60 Min.) + Homework	50 / 50	4	
	Industrial Electronics 1	IEL1	Written Exam (90 Min.) + Laboratory	70 / 60	5	
4th Semester 3 days a week theoretical studies at the	Building Physics and technical expansion	BTAA	Written Exam (90 Min.) + Laboratory	60 / 60	5	19
	Heat supply	WVG	Written Exam (90 Min.) + Homework	70 / 70	5	
	Automation technology	AUT	Written Exam (90 Min.) + Homework	70 / 60	5	

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university (13 weeks)	Industrial Electronics 2	IEL2	Written Exam (60 Min.) + Homework	60 / 50	4	

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Semester	Module title	Module code	Examination / academic achievement	Workload (P / S) [h]	ECTS	Sum ECTS
5th Semester Full-time study Theory phase (13 weeks)	Building construction	BKO	Written Exam (60 Min.) + Homework	70 / 70	5	25
	CAD for BAU, WBI, GTA	CADB	Written Exam (60 Min.) + Laboratory	70 / 70	3	
	Energy and environmental technology	EUT	Written Exam (90 Min.) + Homework	70 / 70	5	
	Software for engineers	SFI	Homework + Elaboration	60 / 80	5	
	Ventilation, air conditioning and refrigeration technology	LKK	Written Exam (60 Min.) + Laboratory	70 / 40	5	
	Technical English 1	TEE1	Presentation (15 Min.)	40 / 20	2	
6th Semester Full-time study Theory phase (13 weeks)	Private building law	PBR	Written Exam (90 Min.) + Homework	60 / 80	5	25
	Energy management	ENM	Written Exam (60 Min.) + Laboratory	70 / 70	5	
	Natural resource management	WUA	Written Exam (60 Min.) + Homework	70 / 70	5	
	BIM project	BIMP	Oral exam (30 Min.) + Project work	70 / 80	5	
	Compulsory elective subject 1 (various options)	WPF1	Lecture or Presentation or Written Exam (45 Min.)	40 / 40	3	
	Technical English 2	TEE2	Written Exam (45 Min.)	40 / 20	2	
7th Semester Full-time study Theory phase (13 weeks)	Control and regulation technology	SRE	Written Exam (90 Min.) + Laboratory	70 / 70	5	24
	Gas and fire protection technology	GUB	Written Exam (60 Min.) + Homework	60 / 60	4	
	TGA project	TGP	Teamwork with results presentation	60 / 70	5	
	Calculation in TGA	KTG	Written Exam (90 Min.) + Homework	70 / 60	5	
	Regenerative heat utilization	RWN	Written Exam (90 Min.) + Homework	70 / 70	5	
8th Semester Full-time study Theory phase (13 weeks)	Project Management	PJM	Written Exam (90 Min.) + Homework	70 / 70	5	16
	Facility Management	FAM	Written Exam (90 Min.) + Homework	90 / 40	6	
	Key qualification 2	SCQ2	Oral Exam	40 / 20	2	
	Compulsory elective subject 2 (various options)	WPF2	Written Exam	40 / 40	3	
8th semester - Bachelor thesis			Lecture (20 Min.)	280	13	
Sum ECTS					**180**	

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Modules in the 1st semester

Mathematics 1 (MTH1)

Module title:	Mathematics 1
Submodule of:	-
Module level	High
Abbreviation	MTH1
Frequency of the offer	Start of each winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Mechatronics engineering, specialization AUT / KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching with exercises / 8 SWS 6 SWS lecture / 2 SWS exercises
Workload	Total attendance time: 8,0 h/Week Lectures: 6,0 h/Week Exercises: 2,0 h/Week Self-study: 4,8 h/Week Exam preparation (Sum): 12,0 h
Credit points	6 CP
Requirements according to examination regulations	None
Recommended prerequisites	Specialized or high school diploma knowledge
Intended learning outcomes	The mathematical foundation module forms the basis of every engineering course. In addition to the subject-specific mathematical content of analysis up to integral calculus, skills in approaching a problem step by step and breaking it down into interlinked and sequential sub-problems are developed. Solutions to the problems can be justified with arguments. This ensures confident handling of content and methods and their systematic classification in an overall context. After completing this module, students will be able to recognize relationships with other basic subjects and will have learned that mathematics also forms the basis for professional decision-making skills in other subjects. Students are able to deal confidently with terms from the subject areas of sets, mappings and real numbers. Furthermore, they can

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	deal with functions and their graphs as well as analyze functions and represent them through power series developments. You can differentiate and integrate functions. They can define points, straight lines and planes and set them in relationships or analyze such relationships. Furthermore, students will be able to calculate and work with vectors and matrices and master their areas of application, such as linear systems of equations.
Content	Sets, figures, real numbers; (in)equations; linear systems of equations of real variables; analysis of a real variable (real functions, differentiation, integration); power series development; vectors and matrix algebra (equally weighted)
Examination / coursework	120-minute written exam (100% of the total module)
Media forms	Blackboard, projector, flipchart
Literature	JUNG, D.: *Mathematische Grundlagen,* StudyHelp GmbH, 1. Auflage, 2017 JUNG, D.: *Mathematik 1 für Ingenieure,* StudyHelp GmbH, 1. Auflage, 2018 PAPULA, LOTHAR: *Mathematik für Ingenieure und Naturwissenschaftler Band 1 - Ein Lehr- und Arbeitsbuch für das Grundstudium,* 15. Auflage, Vieweg+Teubner, Wiesbaden, 2018 PAPULA, LOTHAR: *Mathematik für Ingenieure und Naturwissenschaftler Band 2 - Ein Lehr- und Arbeitsbuch für das Grundstudium,* 14. Auflage, Vieweg+Teubner, Wiesbaden, 2015 PAPULA, LOTHAR: *Mathematische Formelsammlung für Ingenieure und Naturwissenschaftler*, Vieweg-Verlag, 12. Auflage, 2017 FORSTER, 0.: *Analysis 1*, Springer Spektrum, 12. Auflage, 2016 HEUSER, H.: *Lehrbuch der Analysis Teil 1,* Vieweg-Teubner-Verlag, 17. Auflage, 2009 I. N. BRONSTEIN, K. A. SEMENDJAJEW, G. MUSIOL, H. MUEHLIG: *Taschenbuch der Mathematik,* 11. Auflage, Verlag Europa-Lehrmittel, Haan-Gruiten, 2020

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Chemistry / Materials science (CWK)

Module title:	Chemistry / Materials science
Submodule of:	-
Module level	Medium
Abbreviation	CWK
Frequency of the offer	CWK takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Mechatronics engineering, AUT and KS Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 4 SWS lecture with demonstrations / 2 SWS exercises
Workload	Total attendance time: 6,0 h/Woche Lectures: 4,0 h/Woche Exercises: 2,0 h/Woche Self-Study: 2,3 h/Woche Exam preparation (Sum): 10,0 h Academic performance: 27,5 h
Credit points	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	Specialized or high school diploma knowledge
Intended learning outcomes	The module serves to acquire the necessary basic knowledge of chemistry and materials for subject-specific training. In contrast to and in addition to the physics module, the structure and mechanical and electrical behavior of material matter, the thermodynamic and kinetic principles of chemical reactions and material transformations as well as relevant areas of electrochemistry are considered. The subject matter is largely geared towards the materials, production and energy technology aspects of the course. This is realized in the courses through the greatest possible use of subject-specific examples, exercises and laboratory experiments. Students will be able to use their basic knowledge of chemistry and materials science to interpret and explain reactions and phenomena in mechatronic systems and to improve existing systems or design new systems.

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	Students will be familiar with the most important steel materials, technical metals, plastics and ceramics and their properties and will be able to assign fields and conditions of use to specific applications.
Content	Atoms, molecules and solids; micro and macro properties of materials; conductor, semiconductor, doping, contact, resistance, magnetic and insulating materials; mechanical behavior of materials and especially metallic materials, load behavior, static and dynamic test methods, temperature influence, aggregate states; standards; service life behavior; chemical formula, reaction equations and stoichiometric calculations; structure and periodic table of the elements; chemical bonds; chemical reactions (equally weighted)
Examination / coursework	90-minute written exam (80% of the total module) / Elaboration on a topic (20% of the total module)
Media forms	Projector and blackboard
Literature	E. ROOS, K. MAILE: *Werkstoffkunde für Ingenieure: Grundlagen, Anwendung, Prüfung,* 3. Auflage, Springer, ISBN 978-3540683988, Berlin, 2008 SEIDEL, WOLFGANG: *Werkstofftechnik: Werkstoffe, Eigenschaften, Prüfung, Anwendung,* 7. Auflage, Hanser Fachbuch, ISBN 978-3446407893, Leipzig, 2006 OLAF JACOBS: *Werkstoffkunde*, ISBN: 9783834331526 (Vogel, 2009)

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Construction management (BBL)

Module title:	Construction management A
Submodule of:	-
Module level	Middle
Abbreviation	BBLA
Frequency of the offer	BBLA takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 4 SWS lecture incl. demonstrations / 2 SWS exercises
Workload	Total attendance time: 6,0 h/Week Lectures: 4,0 h/Week Exercises: 2,0 h/Week Self-Study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit points	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	None
Intended learning outcomes	After completing this course, students will be familiar with the basic areas, processes and procedures of construction management and will be able to assign these to practical areas in a meaningful way. Students will also know the basics of cost calculation and pricing. After completing the course, students will be able to carry out initial construction management analyses within specific areas and approach the respective problems independently. They will also be able to evaluate projects from a construction management perspective and recognize procedural applications for construction management processes and, depending on the problem, work on procedures as possible solutions. After completing the course, students will be able to use various tools to calculate deadlines and prices, calculate costs and develop solutions for construction site organization.
Content	Introduction to construction management, special features of construction production, construction project and players, construction participants, basic parameters of construction

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	processes, HOAI, construction project management, construction contract, construction management accounting, tendering, awarding, AVA, calculation of construction services.
Examination / coursework	90-minute written exam (80% of the total module) / Homework (20% of the total module)
Media forms	Projector and blackboard
Literature	FRITZ BERNER, BERND KOCHENDÖRFER, RAINER SCHACH, FRITZ BERNER: *Grundlagen der Baubetriebslehre 1: Baubetriebswirtschaft*, Springer Vieweg 3. Auflage (2019), ISBN-13: 978-3-658-27856-4. FRITZ BERNER, BERND KOCHENDÖRFER, RAINER SCHACH, FRITZ BERNER: *Grundlagen der Baubetriebslehre 2: Baubetriebsplanung (Leitfaden des Baubetriebs und der Bauwirtschaft)*, Springer Vieweg 2. Auflage (2014), ISBN-13: 978-3-658-03226-5. FRITZ BERNER, BERND KOCHENDÖRFER, RAINER SCHACH, FRITZ BERNER: *Grundlagen der Baubetriebslehre 3: Baubetriebsführung (Leitfaden des Baubetriebs und der Bauwirtschaft)*, Springer Vieweg 2. Auflage (April 2015), ISBN-13: 978-3-658-09037-.1.

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Key qualification 1 (SCQ1)

Module title:	Key qualification 1
Submodule of:	SCQ = SCQ1 + SCQ2
Module level	Middle
Abbreviation	SCQ1
Frequency of the offer	SCQ1 takes place in the winter semester
Duration of the module	1 semester for the SCQ module
Assignment to the curriculum	Mechatronics engineering, specialization AUT / KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching with exercises and presentations / 3 SWS 3 SWS Lecture with presentations by the students
Workload	Total attendance time: 3,0 h/Week Lectures: 2,5 h/Week Exercises: 0,5 h/Week Self-Study: 1,6 h Academic performance (total): 27,5 h
Credit points	3 CP
Requirements according to examination regulations	None
Recommended prerequisites	None
Intended learning outcomes	In this module, students acquire rhetorical skills in addition to the specialist skills of academic work, which are a decisive element for success in professional life. Students will be able to create various scientific documents and master the rules necessary for good scientific work. After completing the seminar, they will also be familiar with the procedures for carrying out scientific projects. You will be familiar with various research options far beyond the Internet and will be able to sort and evaluate the results. The seminar also shows what makes a good speech and a good presentation. Tools for optimal, targeted preparation are provided. This module enables students to present information of any kind in the form of a document and a presentation for different audiences. Students are familiar with the different ways of presenting information and using it for different purposes. Furthermore, they can express themselves both in the context of such presentations and in simple conversations so that the information reaches the addressee safely.

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Content	Practical implementation of scientific work; research; writing scientific texts; tools for writing; creation of scientific posters, visualization; presentation and moderation (equally weighted)
Examination / coursework	Writing a (fictitious) publication incl. poster for a scientific conference (50% of the total module)
Media forms	Projector and blackboard
Literature	BRINK, ALFRED: *Anfertigung Wissenschaftlicher Arbeiten: Ein Prozessorientierter Leitfaden zur Erstellung von Bachelor- Master- und Diplomarbeiten*, 5. Auflage, Springer Gabler, 2013 GUDRUN FEY: *Reden macht Leute : Vorträge gekonnt vorbereiten und präsentieren ; Trainingsbuch zur Rhetorik*, Metropolitan Verlag, 2003 LUTZ HERING; HEIKE HERING: *Technische Berichte: gliedern, gestalten, vortragen*, 8. Auflage, Springer Vieweg, 2019 KARMASIN, MATTHIAS: *Die Gestaltung wissenschaftlicher Arbeiten: Ein Leitfaden für Seminararbeiten, Bachelor-, Master- und Magisterarbeiten sowie Dissertationen*, 8. Auflage, Springer, 2014 KARMASIN, MATTHIAS; RIBING, RAINER: *Von der Idee zur Publikation: Erfolgreiches wissenschaftliches Arbeiten in der medizinischen Forschung*, 2. Auflage, Springer, 2012 KORNMEIER, MARTIN: *Wissenschaftlich schreiben leicht gemacht für Bachelor, Master und Dissertation*, 8. Auflage, UTB GmbH, 2018

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Modules in the 2nd semester

Mathematics 2 (MTH2)

Module title:	Mathematics 2
Submodule of:	-
Module level	High
Abbreviation	MTH2
Frequency of the offer	MTH2 findet immer statt im SS
Duration of the module	1 Semester
Assignment to the curriculum	Mechatronics engineering, specialization AUT / KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching with exercises / 8 SWS 6 SWS lecture / 2 SWS exercises
Workload	Total attendance time: 8,0 h/Woche Lectures: 6,0 h/Woche Exercises: 2,0 h/Woche Self-Study: 4,8 h/Woche Exam preparation (total): 12,0 h
Credit points	6 CP
Requirements according to examination regulations	None
Recommended prerequisites	Mathematics 1
Intended learning outcomes	The module continues the content of the Mathematics 1 module. After completing the Mathematics 2 course, students have advanced knowledge of differential and integral calculus with regard to the use of several real variables. They can calculate with complex numbers and apply them. Furthermore, students are able to carry out Fourier series analyses, which is important with regard to the electrical engineering modules in the area of signal analysis. Furthermore, students will be able to carry out Fourier and Laplace transformations in order to be able to carry out corresponding analyses in the frequency range (or s-range) in control engineering, for example. With a view to practical applications, an introduction to the definition and solution of ordinary differential equations of real variables is given. Solution methods for 1st and 2nd order differential equations

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	as well as higher order equations with constant coefficients are presented. In addition, students are enabled to apply the concepts of vector analysis, which is particularly important in theoretical electrical engineering. Due to the greater complexity, in-depth connections to other disciplines of the course are recognized and better understood. The ability to confidently recognize and use analogies to basic subjects and advanced subjects expands the basis for professional decision-making competence.
Content	Complex numbers (calculating with complex numbers, representation in the Gaussian number plane and in the Euler representation); Fourier series, Fourier and Laplace transformation; analysis of functions with several real variables including differential and integral calculus; solution of ordinary differential equations of 1st and 2nd order as well as higher order with constant coefficients
Examination / coursework	120-minute written exam (100% of the total module)
Media forms	Media forms blackboard, projector, flipchart
Literature	JUNG, D.: *Mathematik 2 für Ingenieure,* StudyHelp GmbH, 1. Auflage, 2019 FORSTER, 0.: *Analysis 2*, Springer Spektrum, 11. Auflage, 2017 HEUSER, H.: *Lehrbuch der Analysis Teil 2*, Vieweg-Teubner-Verlag, 14. Auflage, 2012 PAPULA, LOTHAR: *Mathematik für Ingenieure und Naturwissenschaftler Band 2 - Ein Lehr- und Arbeitsbuch für das Grundstudium*, 14. Auflage, Vieweg+Teubner, Wiesbaden, 2015 I. N. BRONSTEIN, K. A. SEMENDJAJEW, G. MUSIOL, H. MUEHLIG: *Taschenbuch der Mathematik*, 11. Auflage, Verlag Europa-Lehrmittel, Haan-Gruiten, 2020

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Electrical Engineering (ELE)

Module title:	Electrical Engineering
Submodule of:	-
Module level	High
Abbreviation	ELE
Frequency of the offer	ELE always takes place in the summer semester
Duration of the module	1 Semester
Assignment to the curriculum	Mechatronics engineering, AUT and KS Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises and laboratories / 6 SWS 3 SWS lecture / 1.5 SWS exercises / 1.5 SWS laboratory
Workload	Total attendance time: 6,0 h/Week Lectures: 3,0 h/Week Exercises: 1,5 h/Week Laboratory: 1,5 h/Week Self-Study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit points	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	-
Intended learning outcomes	The module teaches basic electrical engineering skills. The focus is on acquiring scientific ways of thinking on the one hand and on engineering application on the other. This creates skills in electrical engineering that are essential for later modules of the degree course. After completing the module, students will have knowledge of electrical and magnetic parameters for use in components and systems, as well as knowledge of the effects and characteristics of electromagnetic fields. Students have in-depth knowledge of the important passive components (R, L, C) as well as the different types of ideal and real sources. In the area of alternating current quantities in particular, the calculation and representation in complex numerical space learned in Mathematics 1 is applied.

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	They are also able to analyze direct current and alternating current networks in different ways. Harmonic and non-harmonic quantities are dealt with, as well as transformers and three-phase systems. Students are also able to handle electrical power and energy safely and to recognize and safely eliminate sources of danger.
Content	Current hazards, protective systems, protective measures and rules of conduct, basic concepts and basic relationships; types of generation and effects of electric current, forces and electric and magnetic fields; direct current circuits and their calculation; energy and power; magnetic circuits, law of induction, capacitance, inductance and transformers; energy and forces in the magnetic field; alternating current circuits and their calculation; active, reactive and apparent power, multi-phase systems; (equally weighted)
Examination / coursework	90-minute written exam (80% of the total module) / Laboratory exercises + protocol (20% of the total module)
Media forms	Projector and blackboard
Literature	WOLF-EWALD BÜTTNER: *Grundlagen der Elektrotechnik 1*, Oldenbourg Wissenschaftsverlag (3. Auflage 2011), ISBN 978-3486707069 WOLF-EWALD BÜTTNER: *Grundlagen der Elektrotechnik 2,* De Gruyter Oldenbourg (3. Auflage 2014), ISBN 978-3110377866 HAGMANN, GERT: *Grundlagen der Elektrotechnik für Studierende der Elektrotechnik und anderer technischer Studiengänge ab 1. Sem.,* AULA-Verlag (18. Auflage, 2020), ISBN 978-3891048306 HAGMANN, GERT: *Aufgabensammlung zu den Grundlagen der Elektrotechnik: Mit Lösungen und ausführlichen Lösungswegen,* AULA-Verlag (18. Auflage, 2019) ISBN 978-3891048283 KLAUS TKOTZ ET AL.: *Fachkunde Elektrotechnik,* Europa-Lehrmittel (32. Auflage, 2020), ISBN 978-3808537916 HERBERT BERNSTEIN: *Elektrotechnik/Elektronik für Maschinenbauer: Einfach und praxisgerecht,* Springer Vieweg (3. Auflage, 2018), ISBN 978-3658208370 HERBERT BERNSTEIN: *Formelsammlung: Elektrotechnik, analoge und digitale Elektronik, Messtechnik,* Springer Vieweg (2. Auflage, 2019), ISBN 978-3658181789 MARINESCU, MARLENE UND WINTER, JÜRGEN: *Basiswissen Gleich- und Wechselstromtechnik,* Vieweg+Teubner Verlag (2. Auflage, 2020), ISBN 978-3658288839 GEORG FLEGEL, KARL BIRNSTIEL, WOLFGANG NERRETER: *Elektrotechnik für Maschinenbau und Mechatronik,* Carl Hanser Verlag, (10. Auflage, 2016), ISBN 978-3446444966

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	ANDREAS BÖKER, HARTMUTH PAERSCHKE, EKKEHARD BOGGASCH: *Elektrotechnik für Gebäudetechnik und Maschinenbau,* Springer Vieweg (2. Auflage, 2019), ISBN 978-3658209704 WEIßGERBER, WILFRIED: *Elektrotechnik für Ingenieure 1: Gleichstromtechnik und Elektromagnetisches Feld,* Vieweg+Teubner (11. Auflage 2018), ISBN 978-3658218201 WEIßGERBER, WILFRIED: *Elektrotechnik für Ingenieure 2: Wechselstromtechnik, Ortskurven, Transformator, Mehrphasensysteme,* Vieweg+Teubner (10. Auflage 2018), ISBN 978-3658218225 WEIßGERBER, WILFRIED: *Elektrotechnik für Ingenieure 3: Ausgleichsvorgänge, Fourieranalyse, Vierpoltheorie,* Vieweg+Teubner (10. Auflage 2018), ISBN 978-3658218249 WEIßGERBER, WILFRIED: *Elektrotechnik für Ingenieure – Formelsammlung: Elektrotechnik kompakt*, Vieweg+Teubner (6. Auflage 2018), 978-3658218164

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Computer Science (INF)

Module title:	Computer Science
Submodule of:	
Module level	Middle
Abbreviation	INF
Frequency of the offer	INF always takes place in the summer semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 5 SWS 3 SWS lecture / 2 SWS laboratory exercises
Workload	Total attendance time: 5,0 h/Week Lectures: 3,0 h/Week Exercises: 2,0 h/Week (max. 16 h) Self-Study: 1,9 h/Week Academic performance (total): 55,0 h
Credit points	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	None
Intended learning outcomes	Understanding and designing programs and software systems is a key qualification in the job profile of a mechatronics engineer, especially with regard to microcontroller programming. After completing the module, students have basic skills in understanding the structure and use of the PC as a tool for software design. They also have basic theoretical and practical knowledge of the programming language C as an example of imperative programming, which they can use in a practical development environment (IDE) to develop software systems. Practical tasks and problems of information processing are carried out as exercises in the PC room.
Content	Fundamentals of programming; data and data structures; control structures; memory, variables and expressions; (also recursive) functions and procedures; types, modules; application-oriented introduction of the above content based on C

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Examination / coursework	Homework (100% of the total module)
Media forms	Projector, blackboard and PC
Literature	GERD KÜVELER: *C/C++ für Studium und Beruf,* ISBN 978-3-658-18580-0 (Springer 2017) HARTMUT ERNST: Grundkurs Informatik: *Grundlagen und Konzepte für die erfolgreiche IT-Praxis; eine umfassende, praxisorientierte Einführung,* ISBN 978-3-8348-0362-7 (Vieweg+Teubner, 2008) N. WIRTH: *Algorithmen und Datenstrukturen,* ISBN 978-3-5192-2250-7, Teubner Verlag; Auflage: 5. Aufl. 1998 BRIAN W. KERNIGHAN; DENNIS M. RITCHIE: *Programmieren in C,* ISBN 978-3-8348-0460-0 978-3-4461-5497-1 (Hanser Fachbuch 2001) DOINA LOGOFATU: *Einführung in C,* ISBN 978-3-658-12921-7 (Spinger 2016)

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Business Administration A (BWLA)

Module title:	Business Administration A
Submodule of:	BWL = EXA + BWLA
Module level	Middle
Abbreviation	BWLA
Frequency of the offer	BWLA always takes place in the summer semester
Duration of the module	1 semester for the SCQ module
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 5 SWS lecture / 1 SWS exercise
Workload	Total attendance time: 6,0 h/Week Lectures: 5,0 h/Week Exercises: 1,0 h/Week Self-Study: 2,0 h/Week Exam preparation (total): 10,0 h
Credit points	4 CP
Requirements according to examination regulations	None
Recommended prerequisites	None
Intended learning outcomes	After completing this course, students will have basic knowledge of the operational functional areas of corporate management, investment accounting, financing, cost and performance accounting, production, logistics, organization, human resources, marketing and sales, as well as knowledge of the approaches and procedures of cost and performance accounting, investment accounting and financing that goes beyond the basics. After successfully completing the course, students will be able to independently relate their basic knowledge of business administration and their in-depth knowledge of cost and performance accounting, capital budgeting and financing to typical job profiles in the construction and/or real estate industry. After completing the course, students will be able to apply their knowledge to relevant fields of application in the construction and real estate industry and independently carry out calculations in the areas of cost and performance accounting, investment accounting and financing.

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Content	BWLA: Introduction to Business Administration, i.e. - Corporate management, production and logistics, organization and personnel, marketing and sales, differentiation: internal and external accounting, basics of bookkeeping and accounting, financial mathematics basics of investment calculation and financing - Basics of cost and performance accounting - Fundamentals of investment accounting - Fundamentals of financing
Examination / coursework	90-minute written exam
Media forms	Beamer or blackboard
Literature	HARALD NAHRSTEDT: *Excel + VBA für Ingenieure: Programmieren erlernen und technische Fragestellungen lösen,* Springer Vieweg-Verlag (2021), ISBN-13: 978-3-658-32774-3 KEN BLUTTMAN: *Excel Formeln und Funktionen für Dummies,* Wiley-VCH; 4. Edition (Sep. 2019), ISBN-13: 978-3-527-71686-9.

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Building Physics and technical expansion (BTA)

Module title:	Building Physics and technical expansion A
Submodule of:	TME = TME1 + TME2
Module level	Middle
Abbreviation	BTA
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 4 SWS lecture / 2 SWS exercises
Workload	Total attendance time: 5,0 h/Week Lectures: 2,0 h/Week Exercises: 3,0 h/Week Self-study: 1,0 h/Week Exam preparation (total): 10,0 h Academic performance (total): (27,5)
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	BKO
Qualification objectives (knowledge, skills, competencies), intended learning outcomes:	After successfully completing this course, students will be familiar with the basic building physics principles of thermal and moisture protection and technical construction. After successfully completing the course, students will be able to prepare thermal and moisture protection certificates. After successfully completing this course, students will be able to assess buildings in terms of energy and moisture protection on the basis of the most important standards and the Energy Saving Ordinance.
Contents:	Basics of thermal insulation; winter thermal insulation; summer thermal insulation; system technology for compliance with EnEV (heating, drinking water heating and ventilation technology); energy-saving thermal insulation according to EnEV; moisture and condensation protection
Examination/ study achievements:	90-minute written exam (80% of the total module) / Laboratory exercises + protocol (20% of the total module)
Media forms:	Script, blackboard notes, PPT and OHP slides, Excel

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Literature:	HELMUT MARQUARDT: *Energiesparendes Bauen: Ein Praxisbuch für Architekten, Ingenieure und Energieberater: Wohngebäude nach GEG 2020,* Beuth-Verlag, 4. Auflage (Juni 2021), ISBN-13: 978-3-410-29904-2 Wolfgang M. Willems, Kai Schild, Diana Stricker, Alexandra Wagner: *Praxisbeispiele Bauphysik : Wärme - Feuchte - Schall - Brand - Aufgaben mit Lösungen,* Springer Vieweg 6. Auflage (2020), ISBN-13: 978-3-658-31617-4 Matthias Post, Peter Schmidt: *Lohmeyer Praktische Bauphysik : Eine Einführung mit Berechnungsbeispielen,* Springer Vieweg 9. Auflage (2019), ISBN-13: 978-3-658-16071-5

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Modules in the 3rd semester

Structural analysis (TWL)

Module title:	Structural analysis
Submodule of:	-
Module level	High
Abbreviation	TWL
Frequency of the offer	Start of each winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 4 SWS lecture / 2 SWS exercises
Workload	Total attendance time: 6,0 h/Week Lectures: 3,0 h/Week Exercises: 3,0 h/Week Self-study: 3,0 h/Week Exam preparation (total): 10,0 h
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	None
Qualification objectives (knowledge, skills, competencies), intended learning outcomes:	After completing this course, students will be familiar with the main load-bearing structures used in practice and will be able to develop the internal force areas on statically determined systems. They will have acquired knowledge of the principle of load transfer in structures and will know the main options for bracing structures. After completing the course, students will be able to use methods to identify the most unfavorable points of supporting structures and to find the optimal supporting structures for simple problems (support line constructions). After completing this course, students will be able to reformulate abstract engineering problems into design models. They will be able to make the necessary load assumptions for simple wooden supporting structures and statically verify the supporting structures. In addition, they are able to carry out preliminary measurements

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	and roughly estimate loads using simple methods, e.g. load application areas.
Contents:	Introduction; The central plane force system; The general plane force system; The statically determinate supported beam; Stiffening of structures; Determination of internal forces; Frames; Support line structures; Arch and roof structures; Trusses.
Examination/ study achievements:	PL (4 CP): 90-minute written examination (80% of the total module) SL (1 CP): Homework with tasks from the field of statics, special frame and truss task (duration: 27.5 h). Alternatively, participation in a bridge seminar is offered every 2 years.
Media forms:	Blackboard writing, PP presentation, zoom if necessary
Literature:	RUDOLF PITLOUN: *Tragwerksstrukturen - Tragwerke und andere Strukturen,* Springer Vieweg (2019), ISBN-13: 978-3-658-23124-8 WILFRIED B. KRÄTZIG: *Tragwerke 1: Theorie und Berechnungs-methoden statisch bestimmter Stabtragwerke,* Springer Vieweg 5. Auflage (2014), ISBN: 3 978-3-662-43626-4 WILFRIED B. KRÄTZIG: *Tragwerke 2 : Theorie und Berechnungs-methoden statisch unbestimmter Stabtragwerke,* Springer Vieweg 5. Auflage (2019), ISBN-13: 978-3-642-41722-1

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Introduction to thermodynamics (TDY)

Module title:	Introduction to thermodynamics
Submodule of:	-
Module level	Middle
Abbreviation	TDY
Frequency of the offer	TDY always takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 5 SWS 4 SWS lecture / 2 SWS laboratory exercises
Workload	Total attendence time: 6,0 h/Week Lectures: 6,0 h/Week Self-study: 2,0 h Academic achievement (total): 27,5 h
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	MTH1, MTH2
Qualification objectives (knowledge, skills, competencies), intended learning outcomes:	After successfully completing this course, students will be familiar with mathematical procedures and methods for solving thermodynamic and thermal engineering processes. After successfully completing this course, students will be able to apply and calculate the principles of thermodynamics to technical building processes and machines (e.g. heat pumps, chillers). After successfully completing this course, students will be able to apply, calculate and assess the fundamentals of heat transfer in building systems and optimize them in terms of energy efficiency.
Contents:	TDY: Introduction; basic concepts of thermodynamics, thermodynamic systems (open and closed, adiabatic systems), state variables (amount of matter, pressure, temperature, thermal equilibrium), thermodynamic changes of state, first and second law of thermodynamics, entropy, reversible and irreversible processes, ideal gases, types of heat transfer (heat flow, heat flux density, heat conduction, heat transfer), convection, circular processes, humid air, energy storage.

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Examination/ study achievements:	PL (4 CP): 80% of the total module SL (1 CP): 20% of the total module Term paper, 27.5 h
Media forms:	Blackboard notes, slides, PP presentation, zoom if necessary
Literature:	BAEHR, KABELAC:THERMODYNAMIK GRUNDLAGEN UND TECHNISCHE ANWENDUNGEN, SPRINGER-VERLAG (16. AUFLAGE, 2016), ISBN 978-3-662-49568-1 LANGEHEINECKE, KAUFMANN, LANGEHEINECKE, THIELKE: THERMODYNAMIK FÜR INGENIEURE, SPRINGER-VERLAG (11. AUFLAGE, 2020), ISBN 978-3-658-30644-1 HERWIG, KAUTZ, MOSCHALLSKI: TECHNISCHE THERMODYNAMIK: GRUNDLAGEN UND ANLEITUNG ZUM LÖSEN VON AUFGABEN, SPRINGER VIEWEG (2.AUFLAGE, 2016) ISBN 978-3-658-11888-4

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Lighting and illumination technology with EELA

Module title:	Light / lighting technology, introduction of electrical machines
Submodule of:	-
Module level	Middle
Abbreviation	LUB
Frequency of the offer	LUB always takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with practical exercises / 4 SWS 3 SWS lecture / 1 SWS exercise
Workload	Total attendance time: 4,0 h/Week Lectures: 3,0 h/Week Exercises: 1,0 h/Week Self-study: 1,2 h/Week Exam preparation (total): 5,0 h Academic performance (total): 27,5 h
Credit Points:	4 CP (PL 3 CP, SL 1 CP)
Requirements according to examination regulations	None
Recommended prerequisites	Electrical Engineering (ELE), Industrial Electronics (IEL)
Qualification objectives (knowledge, skills, competencies), intended learning outcomes:	After successfully completing this course, students will be familiar with the components of lighting systems. After successful completion of the course, students will be able to calculate the energy requirements of lighting systems. After successful completion of the course, students will be able to assess and develop lighting systems. After successfully completing this course, students will be familiar with the most important properties of electrical drives. After successful completion of the course, students will be able to estimate simple electric drives with the most important parameters and assess them with regard to their application. After successfully completing the course, students will be able to design simple electric drives themselves.
Contents:	LUB: Energy-efficient lighting: technical principles for the use of artificial light and daylight, components and systems for the use of

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	artificial light and daylight, light control, calculation of electrical evaluation power; various lighting systems, useful and final energy requirements for lighting. EELA: Introduction to drive technology, properties of electrical machines, actuators for electrical machines, gearboxes and converters, drive design, hydraulic and pneumatic drives, examples of "new" actuators, drive calculation and simulation with SciLab/XCos.
Examination/ study achievements:	PL: 60-minute written exam (75% of the total module) SL: Homework (25% of the total module)
Media forms:	Lecture notes, blackboard, (possibly Zoom), Power Point (OHP), Excel
Literature:	ROLAND BAER, MEIKE BARFUß, DIRK SEIFERT: *Beleuchtungstechnik: Grundlagen*, Huss-Medien; 5. Edition (März 2020), ISBN-13: 978-3-341-01648-0 PHILIPPE P. ULMANN: *Licht und Beleuchtung: Handbuch und Planungshilfe*, DOM publishers; New Edition (Okt. 2015), ISBN-13: 978-3834334060 TORSTEN BRAUN, MARKUS FELSCH, ROLAND GREULE: *Lichtplanung und Lichtdesign: Konzepte – Technik – Beispiele*, Rudolf-Müller-Verlag (Juli 2016), ISBN-13: 978-3-481-03366-8 HANS RUDOLF RIS: *Beleuchtungstechnik für Praktiker: Grundlagen, Lampen, Leuchten, Planung, Messung*, VDE VERLAG GmbH; 6., akt. u. überarb. Auflage (Juni 2019), ISBN-13: 978-3-800-74855-6 UWE SLABKE: *Lichtplanung und Lichtdesign: LED-Beleuchtungstechnik: Grundwissen für Planung, Auswahl und Installation*, VDE VERLAG GmbH; Neuerscheinung (Sep. 2018), ISBN-13: 978-3-800-74451-0 ROMAN SKOWRANEK: *Basics Lichtplanung*, Birkhäuser-Verlag; 1. Auflage (Mai 2017), ISBN-13: 978-3-035-60929-5. REINHARD MANSIUS: *Praxishandbuch Antriebsauslegung: Grundlagen, Formelsammlung, Beispiele*, Vogel - Verlag (2017), ISBN-13: 978-3-869-22350-6 JENS WEIDAUER: *Elektrische Antriebstechnik: Grundlagen, Auslegung, Anwendungen, Lösungen*, Publicis Publishing (2019), ISBN-13: 978-3895784835 KOMITEE 311 DER DKE (HERAUSGEBER): *Drehende elektrische Maschinen - Erläuterungen zu DIN VDE 60034 (VDE 0530)*, (VDE-Verlag, 9. Auflage 2020), ISBN-13: 978-3800750641 KLAUS FUEST, PETER DÖRING: *Elektrische Maschinen und Antriebe*, (Vieweg+Teubner 7. Auflage, Aug. 2007), ISBN: 978-3834800985 CARSTEN SCHUCHT, NORBERT BERGER: *Praktische Umsetzung der Maschinenrichtlinie*, (Carl Hanser Verlag, Feb. 2019), ISBN: 978-3446458796

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Industrial Electronics 1 (IEL1)

Module title:	Industrial Electronics 1
Submodule of:	IEL = IEL1 + IEL2
Module level	High
Abbreviation	IEL1 (IEL)
Frequency of the offer	IEL1 always takes place in the winter semester
Duration of the module	2 semesters for the IEL module
Assignment to the curriculum	Engineering Science Mechatronics, specialization AUT / KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching with exercises and laboratories / 9 SWS 4 SWS lecture / 2 SWS exercises / 3 SWS laboratory
Workload	Total attendance time: 6,0 h/Week Lectures: 3,0 h/Week Exercises: 1,5 h/Week Laboratory: 1,5 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	Electrical engineering
Intended learning outcomes:	In this module, students acquire basic knowledge of the assembly and connection technology of electronics, various components and circuits are covered, as well as the simulation and calculation of basic circuits. In analog electronics, switching technology with semiconductor components in a predominantly linear operating mode is considered. Computer-aided design and simulation programs are used to achieve practical results in a limited amount of time. A short introduction to digital electronics is given to be able to compare analog and digital signal processing. SPICE (LTspice) or similar is used to simulate simple electronic circuits. After successfully completing the module, students will be familiar with the structure, function and possible applications of all important electronic components in analog technology such as diodes,

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	bipolar transistors, field-effect transistors and operational amplifiers. They will also be able to use these components in basic circuits to realize various assemblies, which in turn are assembled into complex circuits. Students will be able to apply various methods of network theory in a problem-oriented manner. They will be able to calculate the behavior of analog, frequency-dependent circuits and dimension circuits. Electrical energy conversion with clocked converters is dealt with using various switching network topologies so that students can select and design suitable circuits at the end of the module. Furthermore, a program for the development of circuit boards (circuit diagram input, placement and routing) is presented and, if necessary, smaller projects are worked on with it.
Contents:	Structure and connection technology; semiconductor components and semiconductor circuits; characteristic curves and circuit calculation; small and large signal behavior; basic circuits and four-pole equations; oscillators and frequency mixers, operational amplifiers, linear analog circuits; broadband and power amplifiers; passive and active filters; introduction to digital electronics up to processor technology; oscillators and signal generators; linear and clocked power supply circuits; printed circuit board development, manufacture and assembly; electromagnetic compatibility; thermal equivalent circuit diagrams and cooling of electrical components; relays, switches and contactors; wires and cables; module technologies (equally weighted). -electromagnetic compatibility; thermal equivalent circuit diagrams and cooling of electrical components; relays, switches and contactors; wires and cables; module technologies (equally weighted)
Examination/ study achievements:	90-minute written exam (80% of the total module) / Laboratory exercises + protocol (20% of the total module)
Media forms:	Projector and blackboard
Literature:	HERING, BRESSELER, GUTEKUNST: *Elektronik für Ingenieure,* Springer-Verlag (7. Auflage, 2017), ISBN-13: 978-3662542132 ULRICH TIETZE, CHRISTOPH SCHENK, EBERHARD GAMM: *Halbleiter-Schaltungstechnik*, Springer-Verlag (16. Auflage, 2019), ISBN 978-3662485538 JOACHIM FEDERAU: *Operationsverstaerker: Lehr- u. Arbeitsbuch zu angewandten Grundschaltungen,* Vieweg+Teubner Verlag (2017), ISBN-13: 978-3658163723 WALT JUNG: *Op Amp Applications Handbook (Analog Devices Reference Book),* Publisher: Elsevier (2005), ISBN 13: 978-0750678445

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	ULRICH SCHLIENZ: *Schaltnetzteile und ihre Peripherie. Dimensionierung, Einsatz, EMV*, Vieweg-Verlag (7. Auflage, 2020), ISBN-13: 978-3658294892 JOACHIM SPECOVIUS: *Grundkurs Leistungselektronik: Bauelemente, Schaltungen und Systeme*, Vieweg+Teubner (10. Auflage, 2020), ISBN-13: 978-3658303983 KLAUS BEUTH, WOLFGANG SCHMUSCH: *Grundschaltungen Elektronik 3*, Vogel-Verlag (18. Auflage, 2018), ISBN-13: 978-3834334299 DIETMAR SCHMID ET AL.: *Fachkunde Industrieelektronik und Informationstechnik: Geräte- und Systemtechnik mit Automatisierungstechnik*, Europa-Lehrmittel (13. Auflage, 2020), ISBN-13: 978-3808537145 ANDRÉ KETHLER, MARC NEUJAHR: *Leiterplattendesign mit EAGLE 5*, mitp- Verlag (2009), ISBN-13: 978-3826617409 HERBERT BERNSTEIN: *Elektronik und Mechanik: Multisim™ und EAGLE*, Springer Vieweg (4. Auflage, 2020), ISBN-13: 978-3658307578 MARC NEUJAHR, ANDRÉ KETHLER: *Leiterplattendesign mit EAGLE 7*, mitp (August 2015), ISBN-13: 978-3958450646 GERALD ZICKERT: *Leiterplatten: Stromlaufplan, Layout und Fertigung - Ein Lehrbuch für Einsteiger*, Carl Hanser Verlag (2015), ISBN-13: 978-3446442894 HERBERT BERNSTEIN: *Digitaltechnik: TTL-, CMOS-Bausteine, komplexe Logikschaltungen (PLD, ASIC),* De Gruyter Oldenbourg (2019), ISBN-13: 978-3110583663 CHRISTOPHE P. BASSO: *Switch-Mode Power Supplies: SPICE Simulations and Practical Designs*, Mcgraw-Hill Professional (2014), ISBN-13: 978-0071823463 GILLES BROCARD: *Simulation in LTSpice IV: Handbuch, Methoden und Anwendungen*, Verlag: Swiridoff (2013), ISBN-13: 978-3899292572

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Modules in the 4th semester

Heat supply (WVG)

Module title:	Heat supply
Submodule of:	-
Module level	Middle
Abbreviation	WVG
Frequency of the offer	WVG always takes place in the summer semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 3.0 SWS lecture / 1.0 SWS exercises / 2.0 SWS laboratory (HWK)
Workload	Total attendance time: 6,0 h/Week Lectures: 3,0 h/Week Exercises: 1,0 h/Week Laboratory: 2,0 h (max. 20. h)/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	BTAA, TDY, MAT1
Intended learning outcomes:	After successfully completing this course, students will be familiar with the most important components of heating systems. After successfully completing this course, students will be able to plan and analyze simple heating systems and to dimension and assess the structure and function of different system components in accordance with standards. After successfully completing this course, students will be able to calculate energy conversion processes and describe their efficiency; they will also be able to calculate building-specific heating loads and dimension hot water supply systems. After successfully completing the course, students will be able to recognize and describe hydraulic systems and develop specific solutions.

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	After successfully completing the course, students will also be familiar with non-water-based heating systems and be able to use them correctly.
Contents:	Thermodynamics (free and forced convection), thermal radiation, condensation and evaporation Chemical reactions and bonding, combustion technology, oxidation, structure and properties of metallic materials (steel, alloys, cast iron, copper, aluminum), corrosion; combustion technology, chemical reactions, efficiency, emissions; Heating load calculation in accordance with DIN EN 12831, hot water preparation (systems, components and their mode of operation); design of static heating surfaces (radiators, EN 442, panel heating, EN 1264; plant technology and systems in the HVAC sector, components and their mode of operation; pipe network calculation, hydraulic balancing)
Examination/ study achievements:	90-minute written exam (80% of the total module) / Homework or laboratory (20% of the total module)
Media forms:	Projector, blackboard and PC, zoom if necessary
Literature:	WOLFGANG HEßE: *Energieeffiziente Wärmeversorgung von Gebäuden - Tatsächliche Versorgungsverhältnisse und Maßnahmen zur Effizienzsteigerung*, Springer Vieweg; 1. Auflage (Dez. 2019), ISBN-13: 978-3-658-27570-9 DIETMAR ALLMENDINGER: *Heizstrategie - Die Simulation von Heizungsanlagen*, Springer Vieweg; 1. Auflage (14. Jan. 2016), ISBN-13: 978-3-658-11939-3 WOLFRAM PISTOHL / CHRISTIAN RECHENAUER / BIRGIT SCHEUERER: *Handbuch der Gebäudetechnik - Band 2*, Reguvis Fachmedien; 9., überbearbeitete Edition (Nov. 2016), ISBN-13: 978-3-846-20589-1 KARL-JOSEF ALBERS (HERAUSGEBER): *Recknagel - Taschenbuch für Heizung und Klimatechnik*, ITM InnoTech Medien; 80. Edition (23. November 2020), ISBN-13: 978-3-961-43090-1 ELMAR BOLLIN: *Regenerative Energien im Gebäude nutzen*, Springer-Verlag (2. Auflage, 2016), ISBN-13: 978-3-658-12404-5 NICOLEI BECKMANN: *Wechselwirkungsanalyse zwischen dem Physikalischen Optimum, dem Betriebswirtschaftlichen Optimum und dem Carbon-Footprint-Optimum (PhO-BwO-CFO)*, Papier-flieger; New Edition (Feb. 2018), ISBN-13: 978-3-869-48616-1 STEFAN WIRTH: *Heizungsanlagen Teil 1*, Universität Duisburg / Essen?, https://www.wirth-ingenieure.de/downloads/, letzter Download: 30.07.2021

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Automation technology (AUT)

Modulbezeichnung:	Automation technology
Submodule of:	-
Module level	High
Abbreviation	AUT
Frequency of the offer	AUT always takes place in the summer semster
Duration of the module	1 Semester
Modulniveau:	High
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 4.0 SWS lecture / 1.0 SWS exercises / 1.0 SWS laboratory
Workload	Total attendance time: 6,0 h/Week Lectures: 4,0 h/Week Exercises: 1,0 h/Week Laboratory: 1,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit Points	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	ELE, IEL1, IEL2, INF1
Intended learning outcomes:	Students are able to assess the substantial interrelationships, operating principles and processes in automation technology. They know methods and techniques for acquiring new knowledge in the field of automation technology and are able to assess, apply and develop automation technology components in a practical manner in a mechanical environment. Students are familiar with the function and application of PLCs and BMS-DDCs, can program simple tasks, assess more complex problems and effectively use various fault diagnosis procedures themselves. They know the individual test stages and can estimate the effort required to test small systems. Students will also be familiar with centralized, decentralized and distributed structures and their advantages and disadvantages, as

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	well as the importance of communication for product, system and building automation, and will be able to plan networks efficiently.
Contents	Fundamentals: Goals and tasks of automation technology, continuous and discrete processes, real-time requirements, monitoring, control and regulation, automation device systems and structures; microcontrollers in AT; process peripherals, ADU and DAU; communication systems (field buses, Industrial Ethernet and building system buses); networking and data security, interfaces to power engineering (differentiation from NT); PLC technology (hardware and programming); building automation technology systems including DDC; planning of building automation and standardization; theory of security, redundancy and availability; examples: CMS and SCADA; Auto-ID and RFID; Labview for the automation of test sequences; Priva Blue with TC Engineer
Examination/ study achievements:	90-minute written exam (80% of the total module) / Homework or laboratory (20% of the total module)
Media forms:	Beamer or blackboard
Literature:	JÖRG BALOW: *Systeme der Gebäudeautomation: Ein Handbuch zum Planen, Errichten, Nutzen*, cci Dialog (2. Auflage, 2016), ISBN: 978-3922420323 GÜNTER WELLENREUTHER, DIETER ZASTROW: *Automatisieren mit SPS - Theorie und Praxis: Programmierung IEC 61131-3, CoDeSys, OPC …*, Springer Vieweg (6. Auflage, 2015), ISBN-13: 978-3540653189 BERND ASCHENDORF: *Energiemanagement durch Gebäudeautomation: Grundlagen - Technologien – Anwendungen*, Springer Vieweg (2013), 978-3834805737 RUDOLF LAUBER, PETER GÖHNER: *Prozessautomatisierung 1: Automatisierungssysteme u -strukturen, Computer- …,* Springer-Verlag (März 1999), ISBN-13: 978-3540653189 KARL HEINZ JOHN, MICHAEL TIEGELKAMP: *SPS-Programmierung mit IEC 61131-3: Konzepte und Programmiersprachen, Anforderungen an Programmiersysteme, Entscheidungshilfen,* Springer-Verlag (2009), ISBN: 978-3642002687 HANS BERGER: *Automatisieren mit SIMATIC: Controller, Programmierung, Bedienen/Beobachten …,* Publicis Publishing (2012), ISBN-13: 978-3895783869 DIETMAR SCHMID ET AL.: *Automatisierungstechnik: Eine praxisnahe Einführung*, Europa-Lehrmittel (2020, ISBN-13: 978-3808551646 GERHARD SCHNELL, BERNHARD WIEDEMANN: *Bussysteme in der Automatisierungs- und Prozesstechnik*, (Verlag: Vieweg Friedr. + Sohn, Mai 2019), ISBN-13: 978-3658236878 MIRIAM SCHLEIPEN: *Praxishandbuch OPC UA*, Vogel Communications Group (2. Auflage, 2019), ISBN-13: 978-3834334541

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	UWE BRACHT, DIETER GECKLER, SIGRID WENZEL: *Digitale Fabrik: Methoden und Praxisbeispiele*, Springer Vieweg (2. Auflage, 2018), ISBN-13: 978-3662557822 TORSTEN WEIß, MATTHIAS HABERMANN: *STEP7-Workbook für S7-1200/1500 und TIA-Portal*, MHJ-Software GmbH (2. Auflage, 2017), ISBN-13: 978-3981672084 KURT REIM: *LabVIEW-Kurs: Grundlagen, Aufgaben u. Lösungen*, Vogel Business Media (Mai 2014), ISBN-13: 978-3834332943 WOLFGANG A. HALANG, RUDOLF M. KONAKOVSKY: *Sicherheitsgerichtete Echtzeitsysteme (VDI-Buch)*, Springer Vieweg (3. Auflage, 2018), ISBN-13: 978-3662563687 KLAUS-RAINER MÜLLER: *IT-Sicherheit mit System*, Springer Vieweg (6. Auflage, 2018), ISBN-13: 978-3658220648 VALENTIN PLENK: *Angewandte Netzwerktechnik kompakt: Dateiformate, Übertragungsprotokolle und ihre Nutzung in Java-Applikationen*, Springer Vieweg (2. Auflage, 2019), ISBN-13: 978-3658245221 WILLY MEYER: *KNX/EIB Engineering Tool Software: Sicherer Einstieg und professionelles Arbeiten mit der ETS5 und ETS6*, Hüthig-Verlag (9. Auflage, 2021), ISBN-13: 978-3810105219 HERMANN MERZ, THOMAS HANSEMANN, CHRISTOF HÜBNER: *Gebäudeautomation: Kommunikationssysteme mit EIB/KNX, LON und BACnet*, Hanser Fachbuch (2021), ISBN-13: 978-3446462861

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Industrial Electronics 2 (IEL2)

Module title:	Industrial Electronics 2
Submodule of:	IEL = IEL1 + IEL2
Module level	Middle
Abbreviation	IEL2
Frequency of the offer	IEL2 always takes place in the summer semester
Duration of the module	2 semesters for the IEL module
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching with exercises / 5 SWS 3 SWS lecture / 2 SWS exercises
Workload	Total attendance time: 5,0 h/Week Lectures: 3,0 h/Week Exercises: 2,0 h/Week Self-study: 1,0 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h (Laboratory)
Credit Points:	4 CP
Requirements according to examination regulations	None
Recommended prerequisites	IEL1
Intended learning outcomes:	Students gain an understanding of the fundamentals of measurement and sensor technology, including error considerations. They are familiar with the technical and physical fundamentals of sensor principles and can select suitable components. The focus is on the electrical measurement of non-electrical variables. After completing the module, students will be familiar with strain sensors and the measurement methods derived from them for force, pressure, torque, acceleration and angular rate sensors, magnetic sensors, optical sensors, displacement and angle sensors, gas sensors, including electronic evaluation, and will be able to use them in a qualified manner. The coordination and integration of sensors and actuators is understood, including common interfaces. Students are familiar with the influence of sensor technology on control processes and can specify suitable sensors for cross-sectional mechatronic and building technology applications.

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	The module provides an understanding of the effects of measurement uncertainties. The importance of form, position and positional deviations and their tolerances for industrial production is taught and practical procedures for typical measurement tasks to determine these tolerances are demonstrated. After completing the module, students will be able to carry out simple statistical procedures for processing measured values independently and calculate suitable test and quality criteria. Sensor applications from building automation and process technology are primarily dealt with in a practical manner and taught in coordination with partner companies.
Contents:	Fundamentals and significance of measurement technology; static and dynamic system properties, systematic and random measurement uncertainties, statistical evaluation methods; Electrical metrology, measurement of non-electrical quantities; physical principles; analog and digital components and interfaces; mechanical transmission elements; geometric metrology; hierarchy of standards; measurement-testing-calibration-verification; test variables in production engineering; gauges and measuring instruments, optical metrology; intelligent components; industrial components and systems; (equally weighted)
Examination/ study achievements:	60-minute written exam (75% of the sub-module) / Exercises/homework/laboratory protocol (25% of the sub-module)
Media forms:	Beamer or PC
Literature:	SCHRÜFER, ELMAR: *Elektrische Meßtechnik: Messung elektrischer und nichtelektrischer Größen*, (Hanser-Verlag, 2018), ISBN-13: 978-3446456549 HOFFMANN, JÖRG, ADUNKA, FRANZ: *Handbuch der Messtechnik*, (Hanser-Verlag, 2021), ISBN: 978-3446461888 MICHAEL SACHS: Wahrscheinlichkeitsrechnung und Statistik: für Ingenieurstudenten an Fachhochschulen“, (Carl Hanser Verlag, 2018), ISBN: 978-3446451636 WOLFGANG DUTSCHKE, CLAUS P. KEFERSTEIN: *Fertigungsmess-technik*, (Teubner-Verlag, 2010), ISBN: 978-3834806925 STEFAN HESSE, GERHARD SCHNELL: *Sensoren für die Prozess- u. Fabrikautomation Funktion, Ausführung, Anwendung*, (Verlag: Vieweg+Teubner, 2018), ISBN-13: 978-3658211738 GERHARD SCHNELL, BERNHARD WIEDEMANN: *Bussysteme in der Automatisierungs- und Prozesstechnik*, (Verlag: Vieweg Friedr. + Sohn, Mai 2019), ISBN-13: 978-3658236878 EKBERT HERING, GERT SCHÖNFELDER: *Sensoren in Wissenschaft und Technik: Funktionsweise und Einsatzgebiete*, (Springer-Vieweg, Feb. 2018), ISBN-13: 978-3658125615

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	KLAUS BEUTH, WOLFGANG SCHMUSCH: *Elektronik 6 – Elektronische Messtechnik - Prinzipien, Verfahren, Schaltungen*, (Vogel-Verlag, 2005), ISBN: 978-3834330369

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Modules in the 5th semester

Building construction (BKO)

Module title:	Building construction
Submodule of:	Building construction
Module level	Middle
Abbreviation	BKO
Frequency of the offer	BKO always takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 3 SWS lecture / 3 SWS exercises
Workload	Total attendance time: 6,0 h/Week Lectures: 3,0 h/Week Exercises: 3,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	None
Intended learning outcomes:	After completing this course, students will be familiar with the basic design elements of building construction and the fundamentals of drawing and designing with a CAD system. After completing the course, students will be able to create construction drawings for building construction and use their CAD skills to complete simple construction tasks. After successfully completing the course, students will be able to design a simple detached house using a CAD system.
Contents:	Technical representation; dimensional order and tolerances; load-bearing and non-load-bearing walls; windows, ceilings, ceiling overlays, ceiling cladding and suspended ceilings; stairs; pitched roofs with roof coverings.

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Examination/ study achievements:	60-minute written exam (80% of the total module) / Homework (20% of the total module)
Media forms:	Beamer or blackboard
Literature:	HUBERT HINZEN; HELMUT GEUPEL: *Maschinenelemente 1,* Oldenbourg Wissenschaftsverlag GmbH 2007; ISBN:9783486580815 ROLOFF / MATEK; *Maschinenelemente Normung, Berechnung, Gestaltung,* Vieweg + Teubner Verlag; ISBN 978-3-8348-0689-5

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CAD for BAU (CADB)

Module title:	CAD for BAU
Submodule of:	Building Construction
Module level	Middle
Abbreviation	CADB
Frequency of the offer	CADB always takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 3.0 SWS lecture / 1.5 SWS exercises / 1.5 SWS laboratory
Workload	Total attendance time: 6,0 h Lectures: 3,0 h Exercises: 1,5 h Laboratory: 1,5 h Self-study: 2,3 h Exam preparation (total): 10,0 h Academic performance (total):: 27,5 h
Credit Points:	3 CP
Requirements according to examination regulations	None
Recommended prerequisites	None
Intended learning outcomes:	The module includes the acquisition of engineering skills for the design of components and assemblies of complex systems and equipment in the field of mechatronics. In the integrated CAD practical course, students acquire basic skills in the structure, possible applications and operation of modern 3D CAD systems using examples. Knowledge/skills for an interdisciplinary way of working as well as professional qualifications are acquired independently/across disciplines. After successfully completing the course, students will be able to apply design methodology and technology in practice. The scope of application includes the constructive design process as well as the specification sheet, detailed design, dimensioning and documentation as well as basic knowledge in the use of the CAD tool Solid Works and, in extracts, Catia V5.

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Contents:	Introduction; Design process; Solid and surface models; Hierarchical design principles; CAD-CAM coupling (equally weighted)
Examination/ study achievements:	60-minute written exam (80% of the total module) / Laboratory exercises + protocol (20% of the total module)
Media forms:	Beamer or blackboard
Literature:	DETLEF RIDDER: *AutoCAD 2010 : für Architekten und Ingenieure,* 1. Aufl. - Heidelberg [u.a.] : mitp, 2009 MICHAEL SCHABACKER: *SolidWorks - Kurz und Bündig: Grundlagen für Einsteiger,* Vieweg+Teubner Verlag; Auflage: 2., akt. Aufl. 2011 GERHARD ENGELKEN: *SolidWorks 2010: Methodik der 3D-Konstruktion,* Carl Hanser Verlag GmbH & Co. KG; Auflage: 2., aktualisierte Auflage (8. Juni 2010) VOLKER KRÄMER: *Praxishandbuch Simulationen in SolidWorks 2010 - Strukturanalyse (FEM), Kinematik/Kinetik, Strömungssimulation (CFD)*, Carl Hanser Verlag GmbH & Co. KG (8. Juni 2010)

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Energy and environmental technology (EUT)

Module title:	Energy and environmental technology
Submodule of:	-
Module level	Middle
Abbreviation	EUT
Frequency of the offer	EUT always takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching / 6 SWS 4 SWS lecture / 2 SWS exercises
Workload	Total attendance time: 6,0 h/Week Lectures: 4,0 h/Week Exercise: 2,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	-
Intended learning outcomes:	In addition to the physical behavior and system types of different energy generation and storage systems, the design, dimensioning as well as economic and ecological aspects are developed both on a local and global scale as well as under near and distant time aspects. On completion of the module, students will have knowledge of the structures of energy supply systems and their dimensioning. The entirety of the acquired knowledge ensures that both conventional and renewable energy systems can be introduced into existing grids and that the systems themselves comply with the state of the art in terms of electrical requirements. After completing the module, students will be able to analyze energy concepts and subject them to a technical and monetary evaluation, including life cycle costs. This applies to building technology (there are synergies here with the existing degree courses in Civil Engineering and Building in

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	Existing Contexts), but also to industrial systems with a large number of consumers.
Contents:	Energy and the environment; energy exchange, power peaks and average power, current and future energy consumption; energy transformations and their limits; world reserves of conventional energies; energy distribution, combined heat and power, technologies for storing energy, regenerative energy systems; (photovoltaics, solar thermal energy, wind power plants, hydroelectric power plants, geothermal energy / heat pumps, biomass and biofuels), fuel cells, possibilities for reducing energy demand; closed cycles and sustainable economic analyses; TCO/total cost of ownership and life cycle cost/LCC; emissions; solar power plants; high-voltage direct current transmission, electromobility; energy management / demand-side management; (equally weighted)
Examination/ study achievements:	90-minute written exam (80% of the total module) / Homework (20% of the total module)
Media forms:	Beamer or PC
Literature:	VOLKER QUASCHNING: *Regenerative Energiesysteme, Technologie - Berechnung – Simulation*, Hanser Fachbuch (9. Auflage, 2015), ISBN: 978-3446442672 HOLGER WATTER: *Nachhaltige Energiesysteme: Grundlagen, Systemtechnik und Anwendung*, Vieweg+Teubner (5. Auflage, 2019), ISBN-13: 978-3658234874 M. KALTSCHMITT, W. STREICHER, A. WIESE: *Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte*, Springer-Verlag (Juni 2013), ISBN-13: 978-3642032486 KLAUS HEUCK, KLAUS-DIETER DETTMANN, DETLEF SCHULZ: *Elektrische Energieversorgung: Erzeugung, Übertragung u. Verteilung el. Energie*, Vieweg+Teubner-Verlag (Sep. 2010), ISBN-13: 978-3834807366 H.-J. ALLELEIN, E. BOLLIN, H. OEHLER, U. SCHELLING, R. ZAHORANSKY: *Energietechnik: Systeme zur Energieumwandlung*, Vieweg+Teubner (8. Auflage, 2019), ISBN-13: 978-3658218461 SIEGFRIED HEIER: *Windkraftanlagen: Systemauslegung, Netzintegration und Regelung*, Vieweg+Teubner (6. Auflage, 2018), ISBN-13: 978-3834814265 K. SHARIFABADI, L. HARNEFORS, H.-P. NEE, S. NORRGA, R. TEODORESCU: *Design, Control, and Application of MMC Modular Multilevel Converters for HVDC Transmissions*,Wiley-IEEE Press; (1. Edition, 2016), ISBN-13: 978-1118851562 M. GEILHAUSEN, J. BRÄNZEL, D. ENGELMANN, O. SCHULZE: *Energiemanagement*, Springer-Verlag (2015), ISBN-13: 978-3658028343

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	MARTIN ZAPF: *Stromspeicher und Power-to-Gas im deutschen Energiesystem*, Springer-Verlag (2017), ISBN-13: 978-3658150723

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Software for engineers (SFI)

Module title:	Software for engineers
Submodule of:	-
Module level	High
Abbreviation	SFI
Frequency of the offer	SFI always takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching with exercises / 5 SWS 2 SWS lecture / 3 SWS exercises
Workload	Total attendance time: 5,0 h/Week Lectures: 2,0 h/Week Exercises: 3,0 h/Week Self-study: 1,9 h/Week Academic performance (total): 55 h
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	INF1
Intended learning outcomes:	After completing the module, students have advanced skills in understanding the structure and application of the PC as a tool for complex engineering software use and development They have dedicated theoretical and practical knowledge of different software (e.g. MATLab, GNU Octave, Sage, Ecxel/VBA, CAE tools, UML, Python, etc.), which they can use in practice-oriented development environments, especially for the application and simulation but also for the development of complex software systems. Practical tasks and problems of complex data processing are carried out as exercises on the PC. In addition, students acquire advanced skills in the area of modeling, in particular for specification in UML.
Contents:	Use of software tools and programming of data processing applications, application-oriented specialization based on imperative and/or object-oriented programming languages (VBA, C/C++, MATlab/Simulink, Scilab, GNU Octave, Sage, Python, etc.)

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Examination/ study achievements:	(Home) exercises (60% of the total module), elaboration (40% of the total module)
Media forms:	Projector, blackboard and PC
Literature:	HEIDE BALZERT: *Lehrbuch der Objektmodllierung,* ISBN 978-3-8274-2903-2 (Spektrum Akademischer Verlag, Nachdruck der 5. Auflage 2011) GERD KÜVELER; DIETRICH SCHWOCH: *Informatik für Ingenieure und Naturwissenschaftler,* ISBN 978-3-8348-0460-0 (Vieweg 2009) HARTMUT ERNST: *Grundkurs Informatik: Grundlagen und Konzepte für die erfolgreiche IT-Praxis; eine umfassende, praxisorientierte Einführung,* ISBN 978-3-8348-0362-7 (Vieweg+Teubner, 2008) N. WIRTH: *Algorithmen und Datenstrukturen,* ISBN 978-3-5192-2250-7, Teubner Verlag; Auflage: 5. Aufl. 1998 T. WIEDENHÖFER: *Community Usability Engineering – Prozesse und Werkzeuge zur In-situ Feedbackunterstützung*, Springer Vieweg 2015 D. LOUIS: *Visual C++ 2010,* ISBN 978-3-8272-4568-7, Markt und Technik; 2010 JESPER SCHMIDT HANSEN: *GNU Octave Beginner's Guide*, ISBN 978-1849513326 (Packt Publishing, 2011)

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Ventilation, air conditioning and refrigeration technology (LKK)

Module title:	*Ventilation, air conditioning and refrigeration technology*
Submodule of:	-
Module level	Middle
Abbreviation	LKK
Frequency of the offer	LKK always takes place in the winter semester
Duration of the module	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS	Seminar-style teaching with exercises / 6 SWS 4 SWS lecture / 2 SWS exercises
Workload	Total attendance time:: 6,0 h/Week Lectures: 4,0 h/Week Exercises: 2,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h
Credit Points:	5 CP
Requirements according to examination regulations	None
Recommended prerequisites	BTAA, BTAB, TDY
Intended learning outcomes:	After successfully completing this course, students will be familiar with the most important components of ventilation and air conditioning systems. After successfully completing this course, students will be able to plan and calculate ventilation and air conditioning systems in accordance with the applicable standards and regulations and determine the requirements for air conditions and air quality in buildings on the basis of physiological necessities. After successful participation, students will be able to assess different types and systems of ventilation and air conditioning systems and present customer-related recommendations.
Contents:	Introduction, components of ventilation and air conditioning systems, installation forms of ventilation and air conditioning systems, h/x diagram, system planning for ventilation and air conditioning systems, duct network calculation, energy concepts and their implementation within the framework of EnEV/GEG, software-supported system planning with CAD

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Examination/ study achievements:	90-minute written exam (80% of the total module) / Laboratory exercises + protocol (20% of the total module)
Media forms:	Beamer or blackboard
Literature:	LARS KELLER: *Leitfaden für Lüftungs- und Klimaanlagen,* ITM InnoTech Medien-Verlag, 5. Auflage (Juli 2021), ISBN-13: 978-3-961-43094-9. SEBASTIAN PALMER: *Kälte - Klima - Lüftung | KOMPAKT: Grundlagen der Gebäudeautomation für die Klima- und Lüftungstechnik,* VDE VERLAG GmbH; Neuerscheinung (Feb. 2017), ISBN-13: 978-3-800-73934-9. ANTON HÖß*: Welche Lüftung braucht das Haus? Gebäudelüftungssysteme und -konzepte,* Fraunhofer IRB Verlag; 3., überarbeitete und aktualisierte Auflage (Feb. 2020), ISBN-13: 978-3-738-80236-8. GUNTER LAUCKNER, JÖRN KRIMMLING: *Raum- und Gebäudeautomation für Architekten und Ingenieure: Grundlagen - Orientierungshilfen - Beispiele,* Springer Vieweg; 1. Auflage (Nov. 2020), ISBN-13: 978-3-658-30142-2 JOACHIM DOHMANN*: Thermodynamik der Kälteanlagen und Wärmepumpen - Grundlagen und Anwendungen der Kältetechnik,* Springer Vieweg; 1. Auflage (Nov. 2016), ISBN-13: 978-3-662-49110-2. WOLFRAM PISTOHL / CHRISTIAN RECHENAUER / BIRGIT SCHEUERER: *Handbuch der Gebäudetechnik - Band 2*, Reguvis Fachmedien; 9., überbearbeitete Edition (Nov. 2016), ISBN-13: 978-3-846-20589-1 KARL-JOSEF ALBERS (HERAUSGEBER): *Recknagel - Taschenbuch für Heizung und Klimatechnik*, ITM InnoTech Medien; 80. Edition (23. November 2020), ISBN-13: 978-3-961-43090-1

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Technical English 1 (TEE1)

Module title:	Technical English 1
Submodule of:	TEE = TEE1 + TEE2
Module level	Middle
Abbreviation	TEE1
Frequency of the offer	TEE1 always takes place in the winter semester
Duration of the module	2 semesters for the TEE module
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching form/SWS	Seminar-style teaching with exercises / 3 SWS 3 SWS lecture with exercises
Workload	Total attendance time: 3,0 h/Week Lectures: 3,0 h/Week Self-study: 1,2 h/Week Exam preparation (total): 5,0 h
Credit Points:	2 CP
Recommended prerequisites	None
Intended learning outcomes	The module is the introduction to a two-semester English course. In this first sub-module of this series, the focus is on enabling students to use the English language in spoken and written form in the form of listening, speaking, reading and writing. After completing this sub-module, they will be able to form correct sentences from a basic vocabulary, having learned both grammar and the correct use of tenses. They will also be able to read, understand and write simple technical documentation in English. Students will also be able to create and give simple presentations in English.
Contents	English language in spoken and written form (grammar, vocabulary, sentence formation); presentation and discussion of topics relevant to technical language (equally weighted)
Examination/ study achievements:	15-minütiges Referat (50% vom Gesamtmodul)
Media forms:	Beamer oder Tafel
Literature	*Professional English in Use, Engineering* (Klett Verlag)

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Modules in the 6th semester

Private building law (PBR)

Module title:	Private building law
Submodule of:	-
Module level	Middle
Abbreviation	PBR
Frequency:	PBR always takes place in the summer semester
Duration:	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS:	Seminar-style teaching with exercises / 5 SWS 5 SWS lecture
Workload:	Total attendance time: 5,0 h/Week Lectures: 5,0 h/Week Exercises: 0,0 h/Week Self-study: 2,0 h/Week Exam preparation (total): 10,0 h Academic performance (total): 55 h
Credits	5 CP
Prerequisites according to examination regulations	None
Intended learning outcomes:	After successfully completing this course, students will be familiar with the basics of private construction law. After successfully completing this course, students will be able to understand the context of construction law. After successful completion of the course, students will be able to assess legal building contexts.
Content:	General contract law, in particular the formation of contracts, rules of representation. Private construction contract law, in particular the client/contractor relationship, rights and obligations of the parties to the construction contract - relevant provisions of the BGB and the VOB/B. Consideration of case law. Practical examples and solutions.
Examination/study achievements:	90-minute written exam (60% of the total module) / Homework (40% of the total module)

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Media forms:	Script, blackboard notes, slides, PP presentation, panel discussions

Energy management (ENM)

Module title:	Energy management
Submodule of:	-
Module level	Middle
Abbreviation	ENM
Frequency:	GTA always takes place in the summer semester
Duration:	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching format/SWS:	Seminar-style teaching with exercises / 6 SWS 4.0 SWS lecture / 2.0 SWS exercises
Workload:	Total attendance time: 6,0 h/Week Lectures: 4,0 h/Week Exercises: 2,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credits:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	WVG, RWN, IEL
Intended learning outcomes:	After successful participation, students are able to assess the status and development of energy resources and their significance for national and international energy demand as well as the economic and ecological consequences of energy production and energy demand. After successful participation, students will be able to dimension multivalent energy sources for infrastructure-critical consumers.
Content:	Conventional energy resources, energy law and climate policy at national and international level (laws, recommendations, guidelines), development of energy concepts and their implementation within the framework of EnEV/GEG, emergency

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	power systems, UPS systems, multivalent system technology, energy management in the smart home.
Examination/ coursework:	90-minute written exam (80% of the total module) / Laboratory exercises + protocol (20% of the total module)
Media forms:	Projector, blackboard and PC
Literature:	JULIANE BRÄNZEL, DIRK ENGELMANN, MARKO GEILHAUSEN, OLAF SCHULZE: *Energiemanagement - Praxisbuch für Fachkräfte, Berater und Manager,* Springer-Verlag, 2. Auflage (Dez. 2019), ISBN-13: 978-3-658-26918-0 SIMONE BRUGGER-GEBHARDT, GÜNTER JUNGBLUT: *Die DIN EN ISO 50001:2018 verstehen: Die Norm sicher interpretieren und sinnvoll umsetzen*, Springer Gabler; 1. Auflage (Okt. 2019), ISBN-13: 978-3-658-26265-5 JÖRG PHILIPP, ERIC PETERMANN: *Erfolgreiches Energiemanagement im Betrieb*, Springer Vieweg; 1. Auflage (Sep. 2018), ISBN-13: 978-3-658-22479-0 JÖRG LÄSSIG, TINO SCHÜTTE · WILHELM RIESNER: *Energieeffizienz-Benchmark Industrie - Energieeffizienzkennzahlen 2017*, Springer Vieweg; 1. Auflage (Feb. 2020), ISBN-13: 978-3-658-29084-9 KARL STEPHAN STILLE: ***ENERGIEMANAGEMENT VON HAUSHALTSGROßGERÄTEN,*** Springer Vieweg; 1. Auflage (Juni 2018), ISBN-13: 978-3-662-56397-7 KAROLIN WISSER: ***GEBÄUDEAUTOMATION IN WOHNGEBÄUDEN (SMART HOME),*** Springer Vieweg; 1. Auflage (2018), ISBN-13: 978-3-658-23225-2

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Natural resource management (WUA)

Module title:	Natural resource management
Submodule of:	-
Module level	Middle
Abbreviation	WUA
Frequency:	GTA always takes place in the summer semester
Duration:	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching format/SWS:	Seminar-style teaching with exercises / 6 SWS 4 SWS lecture / 2 SWS exercises and CAD
Workload:	Total attendance time: 6,0 h/Week Lectures: 4,0 h/Week Exercises: 2,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credits:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	Thermodynamics (TDY), Automation Technology (AUT)
Intended learning outcomes:	After successfully completing this course, students will be familiar with the most important components of water and wastewater installations, both inside and outside buildings. After successful completion of the course, students will be able to dimension simple water and wastewater installations. After successful completion of the course, students will be able to assess water and wastewater installations in terms of safety, among other things. This also includes KRITIS components in particular.
Content:	Components of water and wastewater systems, forms of installation for water supply and wastewater technology, methods and processes for water and wastewater systems, recovery of recyclable materials and possible energy recovery, safety of water and wastewater systems, basics for planning sanitary systems, drinking water systems in buildings, building drainage, software-supported system planning with CAD

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Examination/ coursework:	90-minute written exam (80% of the total module) / Elaboration of a topic (20% of the total module)
Media forms:	Script, blackboard notes, Zoom, PPT and OHP slides, Excel
Literature:	WOLFRAM PISTOHL / CHRISTIAN RECHENAUER / BIRGIT SCHEUERER: *Handbuch der Gebäudetechnik - Band 1*, Reguvis Fachmedien; 9., überbearbeitete Edition (Nov. 2016), ISBN-13: 978-3-846-20588-4 FRANZ VALENTIN / WILHELM URBAN: *Wasserwesen, Siedlungswasserwirtschaft und Abfalltechnik*, Springer Vieweg; 3. Auflage (November 2020), ISBN-13: 978-3-658-29501-1 HUBERTUS MILKE / TILO SAHLBACH: *Siedlungswasserwirtschaft*, Reguvis Fachmedien; 2. aktualisierte Auflage (Sep. 2021), ISBN-13: 978-3-846-20712-3 A. BAUR / P. FRITSCH / W. HOCH / G. MERKL, J. RAUTENBERG, M. WEIß / B. WRICKE: *Mutschmann/Stimmelmayr - Taschenbuch der Wasserversorgung*, Springer Vieweg; 17. Auflage (Feb. 2019), ISBN-13: 978-3-658-23221-4 KARL-JOSEF ALBERS (HERAUSGEBER): *Recknagel - Taschenbuch für Heizung und Klimatechnik*, ITM InnoTech Medien; 80. Edition (23. November 2020), ISBN-13: 978-3-961-43090-1 F.-J.HEINRICHS / B. RICKMANN / K.-D. SONDERGELD / K.-H. STÖRLEIN: *Gebäude- und Grundstücksentwässerung*, Beuth-Verlag; 6. überarbeitete Edition (Dezember 2016), ISBN-13: 978-3-410-25794-3 T.KISTEMANN W.SCHULTE K.RUDAT W. HENTSCHEL D.HÄUßERMANN: *Gebäudetechnik für Trinkwasser*, Springer Vieweg; 2. Auflage (September 2017), ISBN-13: 978-3-662-54301-6 FRANZ-JOSEF HEINRICHS ET AL: *Ermittlung u. Berechnung der Rohrdurchmesser: Differenziertes u. vereinfachtes Verfahren Kommentar zu DIN 1988-300 und DIN EN 806-3*, Beuth; 1. Edition (November 2012), ISBN-13: 978-3-410-23380-0

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BIM project (BIMP)

Module title:	Building Information Modeling - Project
Submodule of:	-
Module level	Middle
Abbreviation	BIMP
Frequency:	BIMP always takes place in the summer semester
Duration:	1 Semester
Assignment to the curriculum	Focus: Production and automation technology
Teaching format/SWS:	Project work / 6 SWS
Workload:	Total attendance time: 6,0 h/Week Lectures: 3,0 h/Week Project: 3,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 41,0 h
Credits:	5 CP
Recommended prerequisites:	BKO, BTAA, CADB, ELE, LUB, LKK, WVG, RWN
Intended learning outcomes:	Almost every engineer's professional life involves working on projects. Engineers work here as team members and often also as project managers. The aim is to teach the basics of BIM with the introduction of colloborative collaboration.
Content:	Basics of the BIM process according to international and national standards and guidelines. Gradations of the BIM method. Cloud-based collaboration in the BIM workflow via project work with different BIM roles.
Examination/study achievements:	30-minute oral examination (60% of the total module) / Project work (40% of the total module)
Media forms:	Projector and blackboard as well as PCs with different programs
Literature:	BUNDESMINISTERIUM FÜR VERKEHR UND DIGITALE INFRASTRUKTUR (HRSG.): *Stufenplan Digitales Planen und Bauen*; 2015 BEATRICE MESSMER, GERRIT AUSTEN: *BIM – Ein Praxisleitfaden für Geodäten und Ingenieure*, Springer Vieweg; 1. Auflage, (26. Oktober 2012), ISBN: 978-3-658-30802-5

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	VDI-RICHTLINIEN (HRSG.): VDI 2552 *Building Information Modeling Blatt 1 – 11*; BEUTH; (2020)

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Technical English 2 (TEE2)

Module title:	Technical English 2
Submodule of:	TEE = TEE1 + TEE2
Module level	Middle
Abbreviation	TEE2
Frequency:	TEE2 always takes place in summer semester
Duration:	2 semesters for the TEE module
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching format/SWS:	Seminar-style teaching with exercises / 3 SWS 3 SWS lecture
Workload:	Total attendance time: 3,0 h/Week Lectures: 3,0 h/Week Self-study: 1,2 h/Week Exam preparation (total): 5,0 h
Credits:	2 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	TEE1
Intended learning outcomes:	The module is the second sub-module of the three-semester English course. This sub-module deepens the students' ability to use the English language in spoken and written form in the form of listening, speaking, reading and writing. After completing this module series, they will be able to form correct sentences from an extended vocabulary, whereby both grammar and the correct use of tenses will be further deepened. They will also be able to read, understand and write technical documentation in English. Students will also be able to create and give technical presentations in English and conduct subsequent discussions in English.
Content:	English language in spoken and written form (grammar, vocabulary, sentence formation) especially in the field of technology; presentation and discussion of technical language relevant topics; fluent conversation also on spontaneously chosen topics; detailed and clearly structured text production on technical topics (equally weighted)

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Examination/study achievements:	45-minute written exam (33% of the total module)
Media forms:	Beamer or blackboard
Literature:	*Englisch für technische Berufe*, Klett Verlag *Mechatronics Matters*, Cornelsen Verlag *Cambridge English for Engineering,* Cambridge University Press

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Compulsory elective subject 1 (WPF1)

Students select a compulsory elective module from the list of compulsory elective modules offered by the Building Services Engineering DUAL degree program, but above all also by other degree programs at the Hochschule 21, as an opportunity to develop a professional profile and specialization in selected areas of building services engineering, but also in other areas and topics. With this option, students design their studies in an independent qualification approach and prepare for their practical semester in a targeted and in-depth manner. The aim is also to broaden their subject knowledge and gain an insight into other engineering degree courses. In some cases, the scope of these modules is larger than the actual WPF1, with a corresponding allocation of credit points. This additional workload is organized in the students' timetable.

The following is a selection of possible elective options for compulsory elective 1. This offer varies in part due to varying demand and availability of LBs and is generally much broader.

(Note: WPF1 is offered in the 6th semester for MEC and in the 4th semester for GTA)

Compulsory elective subject 1 (WPF1)

Module title:	Compulsory elective subject 1 Option: Technical English 3
Submodule of:	WPF1 +WPF2 as a supplement to TEE = TEE1 + TEE2 + TEE3
Module level	Middle
Abbreviation	WPF
Frequency:	WPF1 always takes place in the summer semester
Duration:	2 semesters for the WPF module
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS (6th semester) Engineering Science Building Technology, general (4th semester)
Teaching format/SWS:	Seminar-style teaching with exercises / 3 SWS 3 SWS lecture
Workload:	Total attendance time: 3,0 h/Week Lectures: 3,0 h/Week Self-study: 1,2 h/Week Exam preparation (total): 5,0 h Academic performance: 27,5 h
Credits:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	TEE1, TEE2

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Intended learning outcomes:	This module is the third and final sub-module of the three-semester English course. This sub-module deepens the students' ability to use the English language in the form of listening, speaking, reading and writing, particularly in the fields of technology and business. After completing this module series, they will be able to form correct sentences from a wide range of vocabulary, whereby both grammar and the correct use of tenses will be further deepened. They will also be able to read, understand and write technical documentation in English. The same applies to financial and economic topics Students will also be able to prepare and give presentations in English in the fields of technology and business and conduct subsequent discussions in English. Students will also be prepared for the Cambridge English (or equivalent) language exam and will receive a DAAD language certificate at the end of the course, which they can use to apply for Erasmus+ programs abroad.
Content:	Presentation and discussion of topics relevant to technical language; fluent discussion of spontaneously chosen topics; detailed and clearly structured text production on technical topics; presentation of one's own point of view on a main technical topic, stating the advantages and disadvantages of different approaches. (equally weighted) Language tests (speaking, listening, reading and writing) from the Cambridge Language Assessment Program
Examination/ coursework:	Mdl. Lecture (15 min.) (34% of the total module)
Media forms:	Beamer or blackboard
Literature:	*Cambridge Professional English – Engineering*, (Cambridge University Press), *Cambridge Business English – Advanced*, (Cambridge University Press) *Cambridge English Exam Essentials*, (Cambridge University Press) *Cambridge English for Engineering*, (Cambridge University Press), *Technology 2,* (Oxford University Press)

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Compulsory elective subject 1 (WPF1)

Module title:	Compulsory elective subject 1 Option: Generative manufacturing
Submodule from:	WPF1 +WPF2
Module level	medium
Abbreviation	WPF1
Frequency:	WPF1 always takes place in summer semester
Duration:	2 semesters for the module WPF
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS (6th semester) Building Services Engineering, general (4th semester)
Teaching form/SWS:	Seminar-style teaching with exercises / 3 SWS 3 SWS Lecture
Workload:	Total attendance time 5,5 h/Week Lectures 3,0 h/Week Laboratory / Excursion 2,5 h/Week Self-study 1,0 h/Week Exam preparation (total): 5,0 h
Credit points:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	CWK, CAD
Intended learning outcomes:	Additive manufacturing processes are becoming increasingly important in production technology for prototypes and increasingly also for series parts made of plastic and metal. Students learn about the state of the art with the currently available processes, their possibilities and limitations, the achievable properties of the components, as well as the trends and developments. They will be able to assess when it makes technical and economic sense to use them and which companies and research institutes are trendsetters.
Content:	Process of adaptive manufacturing with process principle, material spectrum, component properties, design possibilities and limits, production times, plant and production costs, sample components, production facilities
Examination/ study achievements:	45-minute written exam

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Media forms:	Beamer or blackboard
Literature:	JANNIS BREUER, RALF BECKER: *Generative Fertigung mit Kunststoffen: Konzeption und Konstruktion für Selektives Lasersintern,* Springer-Verlag 2012 ALFRED HERBERT FRITZ: *Fertigungstechnik,* Springer-Verlag 2018 JULIAN ILG: *Systematische Eignungsanalyse zum Einsatz additiver Fertigungsverfahren: Anwendung am Beispiel der Medizintechnik*, (BestMasters) Springer-Verlag 2019

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Compulsory elective subject 1 (WPF1)

Module title:	Compulsory elective subject 1 Option: Applied cryptography + IT security
Submodule from	WPF = WPF1 + WPF2
Module level	High
Abbreviation	WPF1
Frequency	WPF1 always takes place in the summer semester
Duration	2 semesters for the WPF module
Assignment to the curriculum	Mechatronics engineering, AUT and KS (6th semester) Building Services Engineering, general (4th semester)
Teaching form/SWS	Seminar-style teaching / 3 SWS
Workload	Total attendance time: 3,0 h/Week Lectures: 2,0 h/Week Exercises: 1,0 h/Week (max. 20h) Self-study: 1,2 h/Week Exam preparation (total): 5,0 h Academic achievement (total): 27,5 h
Credit points	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites	INF1, INF3
Intended learning outcomes:	Understanding the application and implementation of encryption techniques is an essential additional qualification in the job profile of a mechatronics engineer. Starting with the general basics of symmetric and asymmetric (public-key) encryption, this is followed by an introduction to programming the corresponding algorithms. The second focus of the module is on the IT security requirements of companies. Furthermore, possible problems such as ransomware, phishing emails, etc. are discussed, but also which standards exist to evaluate or improve assets or processes in the company based on criteria/controls. After completing the module, students will have a basic understanding of symmetric and asymmetric encryption. Furthermore, they are confident in using the relevant tools for authentication, key exchange, key management and the use of algorithms. The PC serves as a tool for their use. Students also have basic skills in the field of IT security for companies.

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	Practical tasks and problems of cryptography are carried out as exercises in the PC room (OpenSSL, CrypTool).
Content:	Basics of symmetric and asymmetric encryption; programming of encryption algorithms; authentication, signature, hash values, CA hierarchies, practical exercises with CrypTool Fundamentals of IT security; in particular: ISO 27001
Examination/ study achievements	Presentation / paper / exercise / written exam
Media forms	Beamer or blackboard
Literature	BRUCE SCHNEIER: *Angewandte Kryptographie*, Addison-Wesley, 1997 (auch neuere Aufl.) NIELS FERGUSON, BRUCE SCHNEIER, TADAYOSHI KOHNO: *Cryptography Engineering: Design Principles and Practical Applications*, John Wiley & Sons 2010 Various freely available sources on the Internet.

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Compulsory elective subject 1 (WPF1)

Module title:	Compulsory elective subject 1 Option: Mathematics 3
Submodule from:	WPF = WPF1 + WPF2
Module level	Middle
Abbreviation	WPF1
Frequency:	WPF1 always takes place in the summer semester
Duration:	2 semesters for the WPF module
Assignment to the curriculum	Mechatronics engineering, AUT and KS (6th semester) Building Services Engineering, general (4th semester)
Teaching form/SWS:	Seminar-style teaching / 3 SWS
Workload:	Total attendance time: 4,0 h/Woche Lectures: 3,0 h/Woche Exercises: 1,0 h/Woche Self-study: 2,5 h/Woche Exam preparation (total): 5,0 h
Credit points:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	MTH1, MTH2
Intended learning outcomes:	The basic knowledge of the compulsory courses in Mathematics 1 and 2 is supplemented in this compulsory elective module by special topics in mathematics that are of outstanding importance in practical engineering mathematics. There is an introduction to the statistical methods of engineering. Students are familiar with important concepts of probability theory, combinatorics, frequency distribution and their key figures and can apply these in practice. This includes knowledge of statistical estimation procedures and test methods. In addition, there is an introduction to error and adjustment calculation as well as the calculation of error propagation. Furthermore, students are familiar with the statistical design of experiments according to Taguchi and Shainin.
Content:	Probability theory, combinatorics, distributions with key figures; statistics (estimation procedures and test methods); error and compensation calculation, error propagation, regression curves; statistical experimental design according to Taguchi and Shainin

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Examination/ study achievements:	45-minute written exam (100% of the total module)
Media forms:	Blackboard, projector, flipchart
Literature:	JUNG, D.: *Deskriptive Statistik*, StudyHelp GmbH, 1. Auflage, 2020 JUNG, D.: *Induktive Statistik*, StudyHelp GmbH, 1. Auflage, 2021 PAPULA, LOTHAR: *Mathematik für Ingenieure und Naturwissenschaftler Band 3 - Ein Lehr- und Arbeitsbuch für das Grundstudium*, 7. Auflage, Vieweg+Teubner, Wiesbaden, 2016 FAHRMEIER, L. u.a.: *Statistik,* Springer Spektrum, 8. Auflage, 2016 LEONHART, R.: *Statistik*, Hogrefe AG, 4. Auflage, 2017

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Compulsory elective subject 1 (WPF1)

Module title:	Compulsory elective subject 1 Option: Business Administration B
Submodule from:	WPF = WPF1 + WPF2
Module level	Middle
Abbreviation	WPF1
Duration:	2 semesters for the WPF module
Assignment to the curriculum	Mechatronics engineering, AUT and KS (6th semester) Building Services Engineering, general (4th semester)
Teaching form/SWS:	Seminar-style teaching
Workload:	Total attendance time:: 6,0 h/Week Lectures: 5,0 h/Week Exercises: 1,0 h/Week Self-study: 2,5 h/Week Exam preparation (total): 8,0 h
Credit points:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	BWLA
Intended learning outcomes:	After completing this course, students will have basic knowledge of the operational functional areas of corporate management, investment accounting, financing, cost and performance accounting, production, logistics, organization, human resources, marketing and sales as well as knowledge of the approaches and procedures of cost and performance accounting, investment accounting and financing that goes beyond the basics. After successfully completing the course, students will be able to independently relate their basic knowledge of business administration and their in-depth knowledge of cost and performance accounting, investment accounting and financing to typical job profiles in the construction and/or real estate industry. After completing the course, students will be able to apply their knowledge to relevant fields of application in the construction and real estate industry and independently carry out calculations in the areas of cost and performance accounting, investment accounting and financing.
Content:	Cost and performance accounting, investment accounting, financing:

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	Fundamentals of cost theory, cost element accounting, cost centre accounting, cost unit accounting (on a full and partial cost basis), standard and budgeted cost accounting, cost accounting systems with a focus on single and multi-level contribution margin accounting, process cost accounting, machine hourly rate costing, cost management - cost planning, modern budgeting approaches, project cost controlling, life cycle costing, target costing, overhead cost analysis Static investment methods, dynamic investment methods, visualization of financial implications, investment planning, investment theory, methods of investment calculation under certainty and uncertainty, Decisions under uncertainty and game-theoretical approaches, present value calculations, economic useful life and optimal replacement time Forms of financing and capital costs, internal financing, external financing, equity financing, debt financing, corporate financing
Examination/ study achievements:	90-minute written exam + homework on various topics
Media forms:	Presentations, blackboard work, group work under supervision, site visits, scripts, exercise instructions, PC work on your own PC (especially Excel) and in the IT lab

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Modules in the 7th semester

Control and regulation technology (SRE)

Module title:	Control and regulation technology 1
Submodule from:	-
Module level	High
Abbreviation	SRE
Frequency:	SRE always takes place in the winter semester
Duration:	1 Semester
Assignment to the curriculum	Mechatronics engineering, AUT and KS Building services engineering, general
Teaching form/SWS:	Seminar-style teaching with exercises / 6 SWS 3.0 SWS Lecture / 1.0 SWS Exercises / 2.0 SWS Laboratory
Workload:	Total attendance time: 6,0 h/Week Lectures: 3,0 h/Week Exercises: 1,0 h/Week Laboratory: 2,0 h/Week (max. 3h) Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit points:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	MTH1, MTH2, ELE, AUT
Intended learning outcomes:	The student acquires basic knowledge of structures for the analogue regulation and control of mechatronic systems as well as the necessary methodological knowledge for the analysis and parameterization of control loops and controllers. These are in particular the continuous controllers. Students are able to apply this knowledge in practical examples in a mechatronic environment. This is supported by the use of laboratory simulations during the course. After completing the module, students will be able to create their own models based on the theory of control engineering. The methods can be applied to a wide range of problems up to a

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	medium level of difficulty. This is an important prerequisite for working on complex systems and tasks in practice.
Content:	Concepts of control and regulation; concentrated components of electronics, electrical engineering and mechatronics as control loop components; introduction to control engineering; properties of control loops; description of control loop components, open control loops and closed control loops in the time and frequency domain; analysis of transfer elements; transfer behavior of control loop elements; time behavior of control loop elements; stability of control loops; Nyquist criterion; design of control loops; procedure for setting continuous controllers; discontinuous controllers
Examination/ study achievements:	90-minute written exam (80% of the total module) / Laboratory exercises + protocol (20% of the total module)
Media forms:	Projector, blackboard and PC
Literature:	PETER BUSCH: *Elementare Regelungstechnik*, (Vogel-Verlag 2012), ISBN: 978-3834332844 PETER F. ORLOWSKI: *Praktische Regeltechnik*, (Springer-Verl. 2013), ISBN: 978-3642412325 JAN LUNZE: *Regelungstechnik 1*, (Springer-Verlag 2020), ISBN: 978-3662607459 MANFRED REUTER, SERGE ZACHER: *Regelungstechnik für Ingenieure*, (Vieweg+Teubner-Verlag 2017), ISBN: 978-3658176327

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Gas and fire protection technology (GUB)

Module title:	Gas and fire protection technology
Submodule from:	-
Module level	Middle
Abbreviation	GUB
Frequency:	GUB always takes place in the winter semester
Duration:	1 Semester
Assignment to the curriculum	Building Services Engineering (general)
Teaching form/SWS:	Project work / 5 SWS
Workload:	Total attendance time: 5,0 h/Week Lectures: 5,0 h/Week Self-study: 2,3 h/Week Academic performance (total): 27,5 h
Credit points:	4 CP (3 CP PL + 1 CP SL)
Prerequisites according to examination regulations	None
Recommended prerequisites:	BTAA, BKO, LKK
Intended learning outcomes:	A fter successfully completing this course, students will be familiar with the most important components of gas and fire protection installations. This also includes fire alarm and smoke extraction systems. After successfully completing the course, students will be able to dimension simple gas and fire protection installations. After successfully completing the course, students will be able to assess gas and fire protection installations in terms of safety, among other things.
Content:	Introduction, components of gas and fire protection systems, special sensor technology, installation forms for gas and fire protection systems, system planning for gas and fire protection systems, safety of gas and fire protection installations, pipe network calculation, software-supported system planning with CAD
Examination/ study achievements:	60-minute written exam (75%) Homework (approx. 27.5 hours): Written elaboration on individual topics and questions from the lecture (25% of the total module)
Media forms:	Script, blackboard notes, Zoom, PPT and OHP slides, Excel

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Literature:	WOLFRAM PISTOHL / CHRISTIAN RECHENAUER / BIRGIT SCHEUERER: *Handbuch der Gebäudetechnik - Band 1*, Reguvis Fachmedien; 9., überbearbeitete Edition (Nov. 2016), ISBN-13: 978-3-846-20588-4 WOLFRAM PISTOHL / CHRISTIAN RECHENAUER / BIRGIT SCHEUERER: *Handbuch der Gebäudetechnik - Band 2*, Reguvis Fachmedien; 9., überbearbeitete Edition (Nov. 2016), ISBN-13: 978-3-846-20589-1 BENNO LENDT, GÜNTER CERBE: *Grundlagen der Gastechnik: Gasbeschaffung – Gasverteilung – Gasverwendung*, Carl Hanser Verlag GmbH&Co.KG; 8. Edition (Nov. 2016), ISBN-13: 978-3-446-44965-7 HORST NÜRNBERGER: *Gasinstallation*, Bauverlag (1. Januar 1993), ISBN-13: 978-3-7625-3012-1 LUTZ BATTRAN: *Einführung in den vorbeugenden Brandschutz: Das Lehrbuch für alle am Bau Beteiligten*, FeuerTRUTZ Network; 1. Edition (Dezember 2020), ISBN-13: 978-3-862-35387-3 WOLFGANG J. FRIEDL: *Der Brandschutzbeauftragte: Grundwissen für Ausbildung und Praxis*, Richard Boorberg Verlag; 4. Edition (Nov. 2019), ISBN-13: 978-3-415-06656-4 GERO GERBER: *Brandmeldeanlagen: Planen, Errichten, Betreiben (de-Fachwissen)*, Hüthig GmbH; 5. Edition (Dezember 2018), ISBN-13: 978-3-810-10464-9 PETER LEIN: *Brandschutztechnische Anlagen betreiben und instandhalten*, Springer Vieweg; 1. Auflage (März 2019), ISBN-13: 978-3-658-24490-3 GERD GEBURTIG: *Basiswissen Brandschutz: Band 1: Grundlagen*, Fraunhofer IRB Verlag; 1. Edition (Sep. 2019), ISBN-13: 978-3-738-80069-2 FRANK LUCKA: *Basiswissen Brandschutz: Band 2: Anlagentechnik*, Beuth; 1. Edition (Juni 2020), ISBN-13: 978-3-410-27401-8

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TGA Project (TGP)

Module title:	QM, law and technical standards 2 (QM, law, patent law)
Submodule from:	Technical building automation - project (with excursion)
Module level	Middle
Abbreviation	TGP
Frequency:	TGP always takes place in the winter semester
Duration:	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS:	Seminar-style teaching / 5 SWS 5 SWS Lecture with practical examples
Workload:	Total attendance time: 5,0 h/Week Lectures: 5,0 h/Week Exercises: 2,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance: 27,5 h
Credit points:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	Industrial Electronics (IEL), Automation Technology (AUT), Project Management (PJM)
Qualification objectives (knowledge, skills, competencies), intended learning outcomes:	After successful participation, students are familiar with the formal coordination of contributions in a joint document. After successful participation, students will be able to plan the objectives and schedule of a project, organize a team, hold recorded meetings including quality management within the team. After successful participation, students are able to work on a complex task in a team and submit a result as a report within a given deadline and present it professionally.
Content:	The contents vary and result from current project ideas in cooperation with partners of the university or, alternatively, fictitious projects such as feasibility studies, utility value analyses, project developments, market and demand studies, research or research projects.
Examination/study achievements:	Presentation of results 30 min Team work with preparation of a project folder including project exercise schedule, minutes of team

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	meetings and logbook on the performance and effort of the individual team members (approx. 48 h).
Media forms:	PP presentation, films, photos, project documents as PDF and CAD files if necessary
Literature:	HERMANN MERZ, THOMAS HANSEMANN, CHRISTOF HÜBNER: *Gebäudeautomation: Kommunikationssysteme mit EIB/KNX, LON und BACnet*, Carl Hanser Verlag GmbH&Co.KG; 4., neu bearbeitete Auflage (Feb. 2021), ISBN-13: 978-3-446-46286-1 KNX ASSOCIATION: *Handbuch Haus- und Gebäudesystemtechnik - Grundlagen*, Independently published (August 2018), ISBN-13: 978-1-718-02239-3 WILLI MEYER: *KNX/EIB Engineering Tool Software: Sicherer Einstieg und professionelles Arbeiten mit der ETS5 und ETS6*, Hüthig-Verlag; 9. völlig neu bearbeitete Auflage (Juni 2021), ISBN-13: 978-3-810-10521-9 JÖRG BALOW: *Systeme der Gebäudeautomation: Ein Handbuch zum Planen, Errichten, Nutzen*, cci Dialog; 2. Auflage (Sep. 2016), ISBN-13: 978-3-922-42032-3 KLAUS-RAINER MÜLLER: *IT-Sicherheit m. System: Integratives IT-Sicherheits-, Kontinuitäts- und Risikomanagement - Sichere Anwendungen - Standards*, Springer Vieweg; 6., erw. u. überarb. Auflage (Sep. 2018), ISBN-13: 978-3-658-22064-8 HEIKE HERING, LUTZ HERING, KLAUS-GEERT HEYNE: *Technische Berichte - gliedern, gestalten, vortragen*, Verlag: Springer Vieweg; 8. überarbeitete Auflage (Jan 2019), ISBN-13: 978-3-658-23483-6 NICOLAI ANDLER: *Tools für Projektmanagement, Workshops und Consulting: Kompendium der wichtigsten Techniken und Methoden*, Publicis Publishing; 6. überarbeitete Auflage (Jul. 2015), ISBN-13: 978-3-895-78453-8

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Calculation in TGA (KTG)

Module title:	Calculation in technical building services
Submodule from:	-
Module level	Middle
Abbreviation	KTG
Frequency:	KTG always takes place in the winter semester
Duration:	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS:	Seminar-style teaching with exercises / 6 SWS 4 SWS lecture / 2 SWS exercises
Workload:	Total attendance time: 6,0 h/Week Lectures: 4,0 h/Week Exercises: 2,0 h/Week Self-study: 2,3 h/Week Studienleistung (Summe): 27,5 h
Credit points:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	BBLA, BWL
Intended learning outcomes:	After successfully completing this course, students will be familiar with the basics of scheduling, construction site equipment and costing. After successfully completing the course, students will be able to plan simple construction site facilities, create schedules and carry out calculations for building technology services. After successfully completing the course, students will be able to recognize the calculation principles and take them into account in the calculation in a professional manner.
Content:	KTG: Introduction; definitions; construction project and players; client; tendering and awarding; construction companies; cost determination procedures; basics of accounting; construction contract accounting; working time values; costing process; special items; scheduling and influence on costing; construction site equipment.
Examination/ study achievements:	Written exam
Media forms:	Projector or PC

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Literature:	URBAN BACHER: *BWL kompakt: Praxiswissen der Bilanzierung, Investition und Finanzierung,* Wiesbaden: Deutscher Genossenschafts-Verlag, 2013 EKBERT HERING: *Taschenbuch für Wirtschaftsingenieure: mit zahlreichen Tabellen,* München: Hanser, 2013 JÜRGEN HÄRDLER: *BWL kompakt: Betriebswirtschaftslehre für Ingenieure: Lehr- und Praxisbuch für Ingenieure und Wirtschaftsingenieure,* München: Hanser, 2012 WOLFGANG WEBER; RÜDIGER KABST: *Einführung in die Betriebswirtschaftslehre,* Wiesbaden: Gabler, 2012 JÜRGEN HÄRDLER: *Betriebswirtschaftslehre für Ingenieure; Lehr- und Praxisbuch,* Ausgabe September 2010 Hanser- Verlag MARC HELMOLD: *Innovatives Lieferantenmanagement - Wertschöpfung in globalen Lieferketten,* Springer Gabler; 1. Auflage (April 2021), ISBN-13: 978-3-658-33059-0 DIETER JACOB, CLEMENS MÜLLER, MARTIN OEHMICHEN: *Kalkulieren im Ingenieurbau: Strategie - Kalkulation - Controlling,* Springer Vieweg 3. Auflage (2018), ISBN-13: 978-3-658-18108-6. WULFF PLINKE, B. PETER UTZIG: *Industrielle Kostenrechnung - eine Einführung,* Springer Vieweg 9. Auflage (2020), ISBN-13: 978-3-662-61871-4. WERNER H. ENGELHARDT, HANS RAFFÉE, BARBARA WISCHERMANN: *Grundzüge der doppelten Buchhaltung: mit vielen Aufgaben und Lösungen,* Springer Vieweg 9. Auflage (2020), ISBN-13: 978-3-658-18144-4. ARMIN PROPOROWITZ (HRSG.): *Baubetrieb - Bauwirtschaft,* Hanser Verlag 1. Auflage (2008), ISBN-13: 978-3-446-40679-7.

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Regenerative heat utilization (RWN)

Module title:	Regenerative heat utilization
Submodule from:	-
Module level	Middle
Abbreviation	RWN
Frequency:	RWN always takes place in the winter semester
Duration:	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS:	Seminar lessons with exercises / 3 SWS 2 SWS lecture / 1 SWS exercise
Workload:	Total attendance time: 6,0 h/Week Lectures: 4,0 h/Week Exercises: 2,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit points:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	BTAA, MTH1, TDY, WVG
Qualification objectives (knowledge, skills, competencies), intended learning outcomes:	After successfully completing the course, students will be familiar with other components of regenerative heating systems. After successful participation, students will be able to plan and analyze more complex regenerative heating systems and to dimension and assess the structure and function of different system components in accordance with standards; they will also be able to assess different types, systems and areas of application of heating and drinking water heating systems and offer customer-specific solutions. After successfully completing the course, students will be able to dimension and evaluate energy storage systems in combination with renewable energy sources/conversion units.
Content:	Standards and guidelines and legal requirements in the field of heating, air conditioning, ventilation (HVAC), standards and technical regulations, guidelines, legal regulations (in particular GEG, DIN DVGW); regenerative energy concepts and their implementation within the framework of EnEV/GEG, software-

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	supported system planning with CAD. Economic and ecological assessment methods for energy conversion and supply.
Examination/ coursework:	PL (4 CP): 90-minute written exam (80% of the total module) / SL (1 CP): Homework (20% of the total module)
Media forms:	Script, blackboard notes, PPT, Zoom, Excel if necessary
Literature:	FRIEDER HÄFNER, ROLF-MICHAEL WAGNER, LINDA MEUSEL: *Bau und Berechnung von Erdwärmeanlagen - Einführung mit praktischen Beispielen*, Springer Vieweg; 1. Auflage (Dez. 2015), ISBN-13: 978-3-662-48200-1 WOLFGANG HEßE: *Energieeffiziente Wärmeversorgung von Gebäuden - Tatsächliche Versorgungsverhältnisse und Maßnahmen zur Effizienzsteigerung*, Springer Vieweg; 1. Auflage (Dez. 2019), ISBN-13: 978-3-658-27570-9 DIETMAR ALLMENDINGER: *Heizstrategie - Die Simulation von Heizungsanlagen*, Springer Vieweg; 1. Auflage (14. Jan. 2016), ISBN-13: 978-3-658-11939-3 WOLFRAM PISTOHL / CHRISTIAN RECHENAUER / BIRGIT SCHEUERER: *Handbuch der Gebäudetechnik - Band 2*, Reguvis Fachmedien; 9., überbearbeitete Edition (Nov. 2016), ISBN-13: 978-3-846-20589-1 KARL-JOSEF ALBERS (HERAUSGEBER): *Recknagel - Taschenbuch für Heizung und Klimatechnik*, ITM InnoTech Medien; 80. Edition (23. November 2020), ISBN-13: 978-3-961-43090-1 ELMAR BOLLIN: *Regenerative Energien im Gebäude nutzen*, Springer-Verlag (2. Auflage, 2016), ISBN-13: 978-3-658-12404-5 NICOLEI BECKMANN: *Wechselwirkungsanalyse zwischen dem Physikalischen Optimum, dem Betriebswirtschaftlichen Optimum und dem Carbon-Footprint-Optimum (PhO-BwO-CFO)*, Papier-flieger; New Edition (Feb. 2018), ISBN-13: 978-3-869-48616-1 STEFAN WIRTH: *Heizungsanlagen Teil 1*, Universität Duisburg / Essen, https://www.wirth-ingenieure.de/downloads/, letzter Download: 30.07.2021 NICOLEI BECKMANN: *Energieeffizientes Bauen und wie es sich lohnt*, Springer-Verlag; 1. Auflage (Aug. 2020), ISBN-13: 978-3-658-28542-5 VOLKER QUASCHNING: *Regenerative Energiesysteme, Technologie - Berechnung – Simulation*, Hanser Fachbuch (9. Auflage, 2015), ISBN: 978-3446442672

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Modules in the 8th semester

Project Management (PJM)

Module title:	Project Management
Submodule from:	-
Module level	High
Abbreviation	PJM
Frequency:	PJM always takes place in the summer semester
Duration:	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS:	Presentations, blackboard work, guest lecture / 6 SWS 4 SWS lecture / 2 SWS exercise
Workload:	Total attendance time: 6,0 h/Week Lectures: 4,0 h/Week Exercises: 2,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h Academic performance (total): 27,5 h
Credit points:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	BWL
Intended learning outcomes:	After successfully completing this course, students will be familiar with the basic areas of project management. After successful participation, students will be able to recognize and process initial project-specific analyses with regard to the project-relevant areas of costs, qualities and deadlines. After successful participation, students will be able to create schedules for small projects, determine floor areas and room contents in accordance with DIN 277 and create simple cost calculations in accordance with DIN 276 as well as fee calculations in accordance with HOAI using a sample project.
Content:	General principles, definitions and delimitations Project management Project management

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	Project organization (setup, structure, process, information, communication, documentation) Schedule management (schedule types, detailing, control) Cost management (structure, types, procedures, cost control, control, outflow of funds) Quality management Project phases Project management tools Project management of the client and the contractor
Examination/ study achievements:	90-minute written exam (80% of the total module) / Homework (approx. 27.5 hours): Written elaboration on individual topics and questions from the lecture (20% of the overall module)
Media forms:	Blackboard writing, PP presentation, Zoom
Literature:	DIVERSE (PMI): *A Guide to the Project Management Body of Knowlegde - Das Original PM BOK* -, Project Management Institute; 5th edition (January, 2013), ISBN-13: 978-1-935-58967-9, deutsche Fassung: 978-1-628-25003-9 WALTER JAKOBY: *Projektmanagement für Ingenieure: Ein praxisnahes Lehrbuch für den systematischen Projekterfolg*, Springer Vieweg; 5. Auflage: 2021, ISBN-13: 978-3-658-32790-3 ROLAND FELKAI, ARNDT BEIDERWIEDEN: *Projektmanagement für technische Projekte: Ein prozess-orientierter Leitfaden für die Praxis*, Springer Vieweg; Auflage: 2., überarb. Aufl. 2013, ISBN-13: 978-3-658-10751-2 TOMAS BOHINC: *Projektmanagement - Softskills für Projektleiter*, (GABAL-Verlag 2006), ISBN: 978-3897496293 ROBERT SELL, RALF SCHIMWEG: *Probleme lösen, in komplexen Zusammenhängen denken*, (Springer-Verlag 1998), ISBN: 3540633812 STANLEY E. PORTNEY: *Projektmanagement für Dummies*, (Wiley-VCH Verlag 2001), ISBN-13: 978-3-527-70048-6 NICOLAI ANDLER: Tools für Projektmanagement, Workshops und Consulting: *Kompendium der wichtigsten Techniken und Methoden*, (Verlag: Publicis Publishing, 5. Auflage 2013), ISBN-13: 978-3-89578-430-9 TOM DE MARCO: *der Termin, ein Roman über Projektmanagement,* (Carl Hanser Verlag 1998), ISBN: 3-446194320 DAUD ALAM, UWE GÜHL: *Projektmanagement für die Praxis Ein Leitfaden und Werkzeugkasten für erfolgreiche Projekte*, Springer Vieweg; 2. Auflage (Jan. 2021), ISBN: 978-3-662-62169-1

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Facility Management (FAM)

Module title:	Facility Management
Submodule from:	-
Module level	Middle
Abbreviation	FAM
Frequency:	WBI always takes place in the summer semester
Duration:	1 Semester
Assignment to the curriculum	Building services engineering, general
Teaching form/SWS:	Seminar-style teaching with exercises / 7 SWS 5 SWS lecture / 2 SWS exercises
Workload:	Total attendance time: 7,0 h/Week Lectures: 4,0 h/Week Exercises: 3,0 h/Week Self-study: 2,3 h/Week Exam preparation (total): 10,0 h
Credit points:	6 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	BBLA
Qualification objectives (knowledge, skills, competencies), intended learning outcomes:	After completing this course, students will be familiar with the structures and fields of activity of operational and strategic facility management. After completing the course, students will be able to analyze FM processes and building structures with regard to FM. After completing this course, students will be able to create, structure and implement operational and facility management concepts for the utilization phase of real estate.
Content:	Introduction; standards and guidelines of FM; FM in the life cycle; levels of FM: operational, tactical, strategic; fields of activity in operational FM: space management, commercial, technical, infrastructural FM; fields of activity in strategic FM: strategy, procurement, implementation, analysis, disposal; FM in the context of real estate management; process management in FM; FM-compatible planning; legal principles and operator responsibility in FM; FM market and providers nationally and internationally
Examination/ coursework:	PL (5 CP): 90-minute written exam (83% of the total module)

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	SL (1 CP): FAM homework (approx. 40 hours): Written elaboration with presentation on a selected topic of facility management (17% of the total module)
Media forms:	Blackboard writing, PP presentation, zoom if necessary
Literature:	T. BERNHOLD, M. MAY, J. MEHLIS: *Handbuch Facility Management*, Loseblattsammlung, ecomed; 69. Aktualisierung (2021), ISBN: 978-3-609-75950-0 H. GONDRING, T. WAGNER: *Facility Management Handbuch für Studium und Praxis*, Vahlen; 3. Auflage (2018), ISBN: 978-3-8006-5590-8 C. KAISER, J. NUSSER, F. SCHRAMMEL: *Praxishandbuch Facility Management*, Springer Vieweg; 1. Auflage (Mai 2018), ISBN: 978-3-658-19313-3 J. KRIMMLING: *Facility Management – Strukturen und methodische Instrumente*, Fraunhofer IRB; 5. Auflage (2017), ISBN: 978-3-8167-9813-2 J. NÄVY: *Facility Management - Grundlagen, Informations-technologie, Systemimplementierung, Anwendungsbeispiele*, Springer Vieweg; 5. Auflage (Juli 2018), ISBN: 978-3-662-56229-1 J. NÄVY, M. SCHRÖTER: *Facility Services – Die operative Ebene des Facility Managements*, Springer; 1. Auflage (2013), ISBN: 978-3-642-39544-4

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Key qualification 2 (SCQ2)

Module title:	Key qualification 2
Submodule from:	SCQ = SCQ1 + SCQ2
Module level	Middle
Abbreviation	SCQ2
Frequency:	SCQ2 always takes place in the winter semester
Duration:	1 semester for the SCQ module
Assignment to the curriculum	Mechatronics engineering, AUT and KS (1st semester) Building Services Engineering, general (3rd semester)
Teaching form/SWS:	Seminar-style teaching with exercises / 3 SWS 3 SWS Lecture
Workload:	Total attendance time: 3,0 h/Week Lectures: 2,0 h/Week Exercises: 1,0 h/Week Self-study: 1,0 h/Week Exam preparation (total): 5,0 h
Credit points:	2 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	None
Intended learning outcomes:	By completing this module, students will be able to successfully apply various methodological skills in the area of self-management. These include effective time management as well as methods for creative problem solving and efficient learning. Students will be able to conduct negotiations confidently by acquiring advanced knowledge in the areas of communication, rhetoric and body language. They will also be able to take on management and leadership functions in their later working life with the help of the knowledge they acquire in conflict management, motivation and teamwork. In this module, students acquire personal and social skills as well as independence, a willingness to make decisions, a solution-oriented approach and an openness to new ideas in addition to their professional skills.
Content:	Methodological skills (time management, creativity and problem solving, decision-making, working methods, presentation and moderation); communication, rhetoric, negotiation techniques and body language; motivation, concentration and relaxation; efficient learning techniques; teamwork, conflict management and

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	mediation; leadership functions and leadership qualities; (equally weighted)
Examination/ study achievements:	Oral examination
Media forms:	Beamer or blackboard
Literature:	MARTIN-NILS DÄFFLER: *Relax – endlich stressfrei in fünf Schritten*, Springer Gabler, 2015 GUDRUN FEY: *Reden macht Leute : Vorträge gekonnt vorbereiten und präsentieren ; Trainingsbuch zur Rhetorik*, Metropolitan Verlag, 2003 MICHAEL FLEMMING: *Man muss nicht schlecht sein, um besser werden zu wollen: persönliche Höchstleistung macht Freude*, Metropolitan-Verl., 2001 PATRICK FORSYTH: *Erfolgreiches Zeitmanagement: effektiver arbeiten, mehr erreichen*, Falken, 1997 LUTZ HERING; HEIKE HERING: *Technische Berichte: gliedern, gestalten, vortragen*, 8. Auflage, Springer Vieweg, 2019 LOTHAR J. SEIWERT: *Selbstmanagement: persönlicher Erfolg, Zielbewusstsein, Zukunftsgestaltung*, GABAL, 2000; ISBN: 3-923984-45-6 REFA*: Den Erfolg vereinbaren : Führen mit Zielvereinbarungen*, Hanser, 1995

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Compulsory elective subject 2 (WPF2)

Students select a compulsory elective module from the list of compulsory elective modules offered by the Mechatronics Engineering DUAL degree program, but also by other degree programs at the University of Applied Sciences 21, as an opportunity to develop a professional profile and specialization in selected areas of mechatronics as well as other areas and topics. With this option, students can design their studies in an independent qualification approach and prepare for their practical semester in a targeted and in-depth manner. The aim is also to broaden their subject knowledge and gain an insight into other engineering courses. In some cases, the scope of these modules is larger than the actual WPF1, with a corresponding allocation of credit points. This additional workload is organized in the students' timetable.

The following is a selection of possible options for compulsory elective subject 2. This offer varies in part due to varying demand and availability of LBs and is generally much broader.

Module title:	Compulsory elective subject 2 Option: Programming with VBA - Visual Basics for Applications
Submodule from:	WPF = WPF1 + WPF2
Module level	Middle
Abbreviation	WPF1
Usability:	MEC, GTA
Frequency:	WPF2 always takes place in the winter semester
Duration:	2 semesters for the WPF module
Language:	German
Assignment to the curriculum	Mechatronics engineering, AUT and KS Building services engineering, general
Teaching form/SWS:	Seminar-style teaching with exercises / 3 SWS
Workload:	Total attendance time: 3,0 h/Woche Lectures: 3,0 h/Woche Self-study: 1,2 h/Woche Exam preparation (total): 5,0 h Academic performance (total): 27,5 h
Credit points:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	None
Intended learning outcomes:	With the help of the programming language Visual Basic for Applications (VBA), very complex solutions and evaluations of technical measurement problems as well as organizational problems can be solved, e.g. with the help of Microsoft Excel. After

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	completing the module, students will be able to implement complex programming with the help of VBA. To this end, they know the basic programming knowledge and skills required to develop such software modules.
Content:	Basics of programming; elements of the program interface; program objects; properties, methods, events; control elements and forms; procedures, functions, modules; language elements of VBA (variables, constants, branches, loops, data fields); troubleshooting (equally weighted)
Examination/ study achievements:	30-minute colloquium (50% of the total module)
Media forms:	Beamer or blackboard
Literature:	MONADJEMI, P.: *Office 2000 - Developer Edition - Programmieren mit VBA und den Office-Tools*, München 2000, Markt+Technik-Verlag *RZZN-Handbücher zu MS-Office und Programmierung unter VBA,* Regionales Rechenzentrum für Niedersachsen / Universität Hanover; http://www.rrzn.uni-hannover/buecher/.

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Compulsory elective subject 2 (WPF2)

Module title:	Compulsory elective subject 2 Option: SQL programming
Submodule of:	WPF = WPF1 + WPF2
Module level	Middle
Abbreviation	WPF2
Frequency:	WPF2 always takes place in the winter semester
Duration:	2 semesters for the WPF module
Language:	German
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching format/SWS:	Seminar-style teaching / 3 SWS
Workload:	Total attendance time: 3,0 h/Week Lectures: 2,0 h/Week Exercise: 1,0 h/Week (max. 20h) Self-study: 1,2 h/Week Exam preparation (total): 5,0 h Academic performance (total): 27,5 h
Credits:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	INF1
Intended learning outcomes:	Understanding the application and implementation of database techniques is an essential additional qualification in the job profile of a mechatronics engineer. Based on the general principles of database systems (DBMS), corresponding SQL statements are implemented for the creation and handling of databases. After completing the module, students will have basic skills in understanding SQL-based database systems. They will also be confident in designing ER diagrams and implementing them in SQL. The PC is used as a tool for this purpose. Practical tasks and problems of design and database programming are carried out as exercises in the PC room (PosgreSQL).
Content:	Basics of database design and database programming
Examination/study achievements:	Elaboration / Exercise (50% of the total module)

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Media forms:	Beamer or blackboard
Literature:	ALAN BEAULIEU: *Einführung in SQL*, O'Reilly, 2007

Compulsory elective subject 2 (WPF2)

Module title:	Compulsory elective 2 Option: Mathematics 4
Submodule of:	WPF = WPF1 + WPF2
Module level	Middle
Abbreviation	WPF2
Frequency:	WPF2 always takes place in the winter semester
Duration:	2 semesters for the WPF module
Language:	German
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching format/SWS:	Seminar-style teaching / 3 SWS
Workload:	Total attendance time:: 4,0 h/Week Lectures: 3,0 h/Week Exercises: 1,0 h/Week Self-study: 2,5 h/Week Exam preparation (total): 5,0 h
Credits:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	MTH1, MTH2
Intended learning outcomes:	The basic knowledge of the compulsory courses in Mathematics 1 and 2 is deepened in this compulsory elective module by topics that are independent of the compulsory elective module Mathematics 3. Participation in the compulsory elective module Mathematics 3 is therefore not a prerequisite. In addition to the matrix calculation of real variables in Mathematics 1, students learn how to handle and the purpose of complex matrices and their complex eigenvalues and eigenvectors. This includes the practical significance of special cases such as symmetric, hermitian and unitary matrices. In addition, students are familiar with the concept of classification. This includes the treatment of Bayes classification, the feature space, the estimation of density functions as well as the treatment of Markov processes/chains and their practical application.

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Content:	Complex matrices (conjugate complex matrix elements, symmetric, hermitian, unitary complex matrices); purpose and calculation of complex eigenvalues and the corresponding complex eigenvectors; classification (Bayes classification, distance/similarity measures, separating functions, feature space, estimation of density functions, Markov processes/chains)
Examination/study achievements:	45-minute written exam (100% of the total module)
Media forms:	Blackboard, projector, flipchart
Literature:	PAPULA, LOTHAR: *Mathematik für Ingenieure und Naturwissenschaftler Band 3 - Ein Lehr- und Arbeitsbuch für das Grundstudium*, 7. Auflage, Vieweg+Teubner, Wiesbaden, 2016 FAHRMEIER, L. u.a.: *Multivariate Statistische Verfahren*, De Gruyter Oldenbourg, 2. Auflage, 1996 HARTUNG, J.: *Multivariate Statistik*, De Gruyter Oldenbourg, 7. Auflage, 2006 I. N. BRONSTEIN, K. A. SEMENDJAJEW, G. MUSIOL, H. MUEHLIG: *Taschenbuch der Mathematik*, 11. Auflage, Wissenschaftlicher Verlag Harri Deutsch GmbH, Frankfurt am Main, 2020

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Compulsory elective subject 2 (WPF2)

Module title:	Compulsory elective 2 Option: Engineering tools
Submodule of:	WPF = WPF1 + WPF2
Module level	Middle
Abbreviation	WPF1
Frequency:	WPF2 always takes place in the winter semester
Duration:	2 semesters for the WPF module
Language:	German
Assignment to the curriculum	Mechatronics engineering, AUT and KS Building services engineering, general
Teaching format/SWS:	Seminar-style teaching / 3 SWS
Workload:	Total attendance time: 3,0 h/Week Lectures: 2,0 h/Week Laboratory: 1,0 h/Week (max. 36 h) Self-study: 1,2 h/Week Exam preparation (total): 5,0 h Academic performance (sum): 27,5 h
Credits:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	None
Intended learning outcomes:	After completing the module, the student will have an overview of 10 or more common software packages for processing technical problems and tracking projects. They will be familiar with the costs, benefits and limitations of these engineering tools and know how to classify them as aids for future tasks. This enables him to quickly make an effective selection of suitable tools in order to complete complex tasks effectively. When offering the various software packages, care is taken to present market leaders as well as non-commercial (open source, public domain, freeware, shareware) products.
Content:	A selection of the following SW packages is presented, costs, capabilities and limitations are shown: Spreadsheet, database, graphical 3D representation e.g. of measured values, RTOS overview, project management software, configuration management software, requirement tracing, CFD software, FMEA

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	tools, electrical project planning, PCB layout creation and routing, circuit simulation, FEM analysis, measurement data processing and measuring device control, process visualization, operating systems, CIM/CAE, interface monitors and data loggers (equally weighted).
Examination/study achievements:	Technical report (100% of the total module) or alternative examinations depending on the module
Media forms:	Beamer or blackboard
Literature:	TEXTBOOKS OF THE TOOLS PRESENTED IN EACH CASE.

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Compulsory elective subject 2 (WPF2)

Module title:	Compulsory elective 2 Option: Economics for Engineers
Submodule of:	WPF = WPF1 + WPF2
Module level	Middle
Abbreviation	WPF2
Frequency:	WPF2 always takes place in the winter semester
Duration:	2 semesters for the WPF module
Language:	German
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching format/SWS:	Seminar-style teaching / 5 SWS
Workload:	Total attendance time: 3,0 h/Week Lectures: 3,0 h/Week Self-study: 1,2 h/Week Exam preparation (total): 5,0 h Academic performance (total): 27,5 h
Credits:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	Project management
Intended learning outcomes:	After completing this module, students will be familiar with the micro- and macroeconomic organization and networking of the market-based economic system. They will be able to understand the business section of sophisticated daily or weekly newspapers and to take a well-founded position on current problems. They will be familiar with the opportunities and risks of globalization.
Content:	Fundamentals of application-oriented microeconomics'; practice-oriented economics; balance of payments, economic systems, economic order, fundamentals of macroeconomics I, fundamentals of macroeconomics II, introduction to the field of money, tasks of the ECB, money supply concepts, organizational structure of the ECB; economic and fiscal policy; economic policy, inflation, employment as a function of the business cycle, monetary policy and employment, financial constitution, legislative competence and revenue sovereignty, fiscal equalization, public debt, fiscal policy as distribution policy (equally weighted)

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Examination/study achievements:	90-minute written exam
Media forms:	Beamer or blackboard
Literature:	MANKIW, N.G.: *Grundzüge der Volkswirtschaftslehre*, Verlag Schäffer-Poeschel, 2004.

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Compulsory elective subject 2 (WPF2)

Module title:	Compulsory elective subject 2 Option: Adaptronics
Submodule of:	WPF= WPF1 + WPF2
Module level	High
Abbreviation	WPF2
Frequency:	WPF2 always takes place in the winter semester
Duration:	2 semesters for the WPF module
Language:	German
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching format/SWS:	Seminar-style teaching with exercises / 6 SWS 3 SWS lecture / 1 SWS exercise
Workload:	Total attendance time: 4,0 h/Week Lectures: 3,0 h/Week Exercises: 1,0 h/Week Self-study: 1,0 h/Week Academic achievement (total): 22,5 h
Credits:	3 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	None
Intended learning outcomes:	Students select a module from the list of specialization modules offered by the degree program as an opportunity to specialize and deepen their knowledge in selected areas of mechatronics. With this option, students design their studies in an independent qualification approach and prepare for their practical semester in a targeted and in-depth manner. Adaptronics is a special field of mechatronics and is always used where systems do not have sufficient inherent stability and require external compensation. In many modern areas of application, the necessary stability can be ensured by programmed sensors with the control of mechanical systems.
Content:	Fundamentals of adaptronics; sensor systems; examples of mechanical compensation systems; application examples with technical data; illustrating system limits

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Examination/study achievements:	Technical report (100% of the total module) or alternative examinations depending on the module
Media forms:	Beamer or blackboard
Literature:	HORST CZICHOS: *Mechatronik: Grundlagen und Anwendungen technischer Systeme,* Vieweg+Teubner Verlag; Auflage: 2., akt. u. erw. Aufl. 2008 (26. März 2008)

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Compulsory elective subject 2 (WPF2)

Module title:	Compulsory elective subject 2 Option: Business Administration C
Submodule of:	WPF= WPF1 + WPF2
Module level	High
Abbreviation	WPF2
Frequency:	WPF2 always takes place in the winter semester
Duration:	2 semesters for the WPF module
Language:	German
Assignment to the curriculum	Mechatronics engineering, AUT and KS Building services engineering, general
Teaching format/SWS:	Seminar-style teaching with exercises
Workload:	Total attendance time: 6,0 h/Week Lectures: 5,0 h/Week Exercises: 1,0 h/Week Self-study: 2,5 h/Week Academic achievement (total): 8 h
Credits:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	BWLA, BWLB
Intended learning outcomes:	After completing the course, students will have basic knowledge of business marketing approaches and basic knowledge of corporate management. After completing the course, students will be able to critically evaluate business marketing theory (in particular the Becker marketing concept) for its relevance to issues in the construction and/or real estate industry and transfer management knowledge to typical issues in the management of companies in the construction and real estate industry. After completing the course, students will be able to develop their own implementation ideas and concepts for marketing and corporate management in the construction and real estate industry.
Content:	Marketing Normative dimension of marketing; Strategic dimension of marketing; Operative marketing mix I: Product policy; Operative marketing mix II: Price policy; Operative marketing mix III: Distribution policy; Operative marketing mix IV: Communication policy; Marketing trends, city and location marketing; Marketing of retail and office real estate; Marketing of residential real estate;

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	Marketing of special and leisure real estate; Marketing and acquisition of construction companies and engineering offices
Examination/study achievements:	Written exam 90 min + homework on various topics
Media forms:	Presentations, blackboard work, group work under supervision, blackboard writing, PP presentation, script, exercise instructions, PC work on your own PC (especially Excel) and in the IT lab
Literature:	-

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Compulsory elective subject 2 (WPF2)

Module title:	Compulsory elective subject 2 Option: Business Administration D
Submodule of:	WPF= WPF1 + WPF2
Module level	High
Abbreviation	WPF2
Frequency:	WPF2 always takes place in the winter semester
Duration:	2 semesters for the WPF module
Language:	German
Assignment to the curriculum	Engineering Science Mechatronics, AUT and KS Engineering Science Building Technology, general
Teaching format/SWS:	Seminar-style teaching with exercises
Workload:	Total attendance time: 6,0 h/Week Lectures: 5,0 h/Week Exercises: 1,0 h/Week Self-study: 2,5 h/Week Academic achievement (Total): 8 h
Credits:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	BWLA, BWLB
Intended learning outcomes:	After completing the course, students will have basic knowledge of business marketing approaches and basic knowledge of corporate management. After completing the course, students will be able to critically evaluate business marketing theory (in particular the marketing concept according to Becker) for its relevance to issues in the construction and/or real estate industry and transfer management knowledge to typical issues in the management of companies in the construction and real estate industry. After completing the course, students will be able to develop their own implementation ideas and concepts for marketing and corporate management in the construction and real estate industry.
Content:	Corporate management and leadership Company foundation; Normative corporate management; Strategic corporate management; Organization; Process management; Quality

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	management; Change management; Knowledge management, personnel management, controlling, leadership
Examination/study achievements:	Written exam 90 min + homework on various topics
Media forms:	Presentations, blackboard work, group work under supervision, blackboard writing, PP presentation, script, exercise instructions, PC work on your own PC (especially Excel) and in the IT lab
Literature:	

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Practical phases

Module title:	Practical phases
Submodule of:	-
Module level	Middle
Abbreviation	PXP
Frequency:	Every semester
Duration:	1 semester per practical phase (3 months each in the Px company)
Assignment to the curriculum	Building services engineering, general
Teaching format/SWS:	-
Workload:	Attendance time in the company: 35,0 – 40,0 h/Week Academic achievement (total): 27,5 h
Credits:	5 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	SCQ1
Intended learning outcomes:	The students know the real, technical, organizational, economic and social conditions of the working world of the engineer and can apply these comparatively to concrete situations both during their studies and in their later professional life. They test their abilities and apply the knowledge and skills acquired during their studies under supervision to independently solve simple to complex engineering and technical tasks. Within a complex project coordinated with the university, which is comparable to industrial projects or even often is one, they prove their practical suitability in a solution-oriented manner. Practical work techniques, working methods and key qualifications independent of the subject, such as teamwork and task sharing, are acquired.
Content:	Appropriate guidelines and recommendations are available to the student and the company representatives for the design of the presentation and the report as well as for the implementation of the practical phases.
Examination/ coursework:	Presentation (project topic company) (80% of the total module) / Project report (20% of the total module)

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Bachelor thesis

Module title:	Bachelor thesis
Submodule of:	-
Module level	High
Abbreviation	BA
Frequency:	At the end of the study program
Duration:	In the last PX phase 8 weeks
Semester:	8.
Assignment to the curriculum	Building services engineering, general
Teaching format/SWS:	-
Workload:	Attendance time in the company: 35,0 – 40,0 h/Week Study performance (total): 330 h
Credits:	12 CP
Prerequisites according to examination regulations	None
Recommended prerequisites:	Modules from previous semesters
Intended learning outcomes:	The Bachelor's thesis demonstrates the extent to which students are able to solve practical problems scientifically. Students must apply and demonstrate the specialist and methodological knowledge they have acquired during their studies as well as the specialist and social skills they have acquired in the process. After completing this module, students are able to work scientifically to a certain extent. They can write up their work in the form of documentation and make it available to others as well as present it to colleagues, business partners or management in the form of a presentation.
Content:	Appropriate guidelines and recommendations are available to the student and the company representatives for the design of the presentation and the report as well as for the implementation of the practical phases.
Examination/study achievements:	Bachelor thesis (written elaboration) 40% Presentation (oral presentation) 30% Colloquium (after the presentation) 30%

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	(→100% of the total module)
Media forms:	-
Literature:	MATTHIAS KARMASIN; RAINER RIBING: *Die Gestaltung wissenschaftlicher Arbeiten: ein Leitfaden für Seminararbeiten, Bachelor-, Master- und Magisterarbeiten, Diplomarbeiten und Dissertationen,* ISBN 978-3-8252-2774-6 MARTIN KORNMEIER: *Wissenschaftlich schreiben leicht gemacht: für Bachelor, Master und Dissertation*, ISBN 3-8252-3154-2 BERND HEESEN: *Wissenschaftliches Arbeiten: Vorlagen und Techniken für das Bachelor-, Master- und Promotionsstudium,* ISBN 978-3-642-03375-9

Testing and evaluation

Testing and evaluation of the developed design

This chapter deals with the testing and evaluation of the developed design as well as the finalization of the product for Germany and a prototype product (i.e. not accredited due to the legal framework) for Austria and Lithuania.

Initial situation

After the module handbook was completed, ways were sought to design the testing in such a way that a meaningful evaluation of the completed design was possible. Following this basic idea, the framework conditions in all project partner countries of the SmartVET-HighED consortium were examined and the implementation of the developed dual training-integrated Bachelor's degree was considered.

Research Design

A central challenge in designing the evaluation was the question of which content or courses and which groups of people should be integrated into the evaluation and by which method. The module handbook is a draft. With the exception of some modules at Hochschule 21, the modules contained therein are not yet being implemented. Against the background of being able to use synergies between courses already offered at the universities involved and the modules envisaged in the module handbook, the decision was made to identify courses with relevant content and then evaluate them.

Potential courses were checked for suitability in terms of content. The final decision on which courses would also be suitable as modules for the dual study program was made by the learning location managers and finalized at the project meeting on 09.10.2023 and 10.10.2023 in Graz.

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This approach provides an accurate and meaningful impression of the future modules of the dual study program at the respective locations.

The following courses were selected for evaluation, sorted by educational institution (module name from module handbook/course name of the university):

Universität Graz (Austria):

1. Business administration A/introduction to business administration
2. Mathematics 1 or compulsory elective 1 option: mathematics 3 / business mathematics and statistics

WIFI Steiermark (Austria)

1. Key qualification - Pedagogy

Vytauto Didziojo University - Academy of Education (Lithuania):

1. Key qualification - Pedagogy / Pedagogy
2. Compulsory elective subject 2 option: Business Administration C/ Entrepreneurship & Business Administration 2
3. Compulsory elective subject 2 option: Business Administration D

Hochschule 21 (Deutschland):

1. Electrical Engineering/Electrical Engineering
2. Automation Engineering/Automatization Engineering
3. BIM Project/BIM Project
4. Facility Management/Facility Management
5. Compulsory elective subject 2 Option: Business Administration C/Entrepreneurship
6. CAD for BAU/CAD for BAU

This approach makes it possible to test around 10 modules (two double evaluations) of the module handbook. This is intended to ensure a comprehensive insight into the theoretical phase of the degree program.

Sampling strategy

Another key factor in the evaluation is the sampling strategy. The students were identified as essential stakeholders of the dual study program. They are the group for whom the course is being developed and who are to benefit from the course content. As ongoing courses are being tested, it was obvious that the students of the selected courses should also be included in the evaluation sample. This approach was followed after a consultation with the consortium.

Once suitable modules had been selected for evaluation and the decision had been made to focus the sampling strategy on the central group of students, the final step was to decide which method should be used to evaluate and test the handbook. To

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make this decision, some fundamental preliminary considerations had to be considered:

1. The modules to be evaluated are tested at different locations in different universities and countries. A method that is independent of time and place is therefore required.
2. To obtain as comprehensive a picture as possible, as many perspectives and thus students as possible should be reached.
3. To improve the comparability of the modules, a standardized tool should be used that provides answers that can be compared.
4. To be able to test as many modules as possible, the evaluation should run for at least one year so that courses that are only offered in the winter or summer semester can also be considered.
5. User-friendliness should also be taken into account when designing the tool to achieve the highest possible response rate.

In order to meet the requirements described, a quantitative research approach is used. The quantitative research method in the form of a survey was chosen in order to be able to examine a large number of test subjects.[1] The aim in creating the survey questionnaire was to ensure a standardized survey in order to meet the three criteria of reliability (dependability), validity (validity) and objectivity in the best possible way.

The standardized survey is also intended to ensure the generalizability of the results[2] In order to create a survey that uses as few resources as possible, the survey questionnaire was created using the survey program LimeSurvey and made available to the survey participants or those responsible for the learning location via a link. They then took care of the processing in the above-mentioned courses.

Questionnaire

After a short information text about the project and an explanation of the process, the structure of the survey form requires approval of the privacy policy at the beginning. Without this approval, participants are not able to take part in the survey.

Subsequently, the central information on the university attended and the course in which the course was held was requested and personal data (gender and age) was collected. This was followed by content-related and personal statements about the course in which the evaluation was carried out.

As already mentioned, a standardized design with easily comparable results was essential. For this reason, a four-point Likert scale was used for the evaluation statements. The value 1 always corresponds to the highest level (agree), while the value 4 corresponds to the lowest level (disagree). This approach was chosen for all

[1] Vgl. Flick (2014), 27
[2] Vgl. Flick (2014), 23.

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questions. The Likert scale is a psychometric scale designed to enable a theoretical concept to be recorded at interval scale level.[3]

In order to ensure a proven but high-quality survey that also takes into account preliminary considerations such as user-friendliness, the statements were derived from the evaluation procedure for quality assurance of courses at the University of Graz. The evaluations there are carried out at the end of each semester. The evaluation procedures of the University of Graz, which were adapted for the project, resulted in nine statements, which are intended to provide information on tasks, quality of content, equipment, teaching staff or personal motivation.

The questionnaire was sent to the entire project consortium for testing. Suggestions for changes and improvements were incorporated before the first test. No further changes were made to the questionnaire after the first test.

Sample

The evaluation of the above-mentioned courses took place over several surveys. The first surveys started in Q2 2024, the last survey took place in December 2024. There were six surveys in total. Three of these were conducted in German and three in English. The surveys all contained the same statements and were structured in the same way.

A total of around 250 people took part in the survey. 192 surveys were completed in full. Only the results of the fully completed questionnaires are considered for the survey. Of the 192 people, 100 are female. 133 people are between 20 and 28 years old. 42 people are over 31 years old. The rest are between 17 and 19 or between 29 and 31 years old.

76 people are students at Vytauto Didziojo University. A total of 67 people from Hochschule 21 took part. The University of Graz accounted for 18 participants, while 31 participants were from the WIFI Steiermark.

Within the courses tested, there were large differences in the number of participants. In nine of the twelve modules tested, the number of completed surveys was eight or more people. Here, there was a great dependence on the course instructor and their willingness to demand participation from the students. Less well-attended courses resulted in a low response rate.

Results

The results of the evaluation are presented below based on the individual statements. The results are presented across all courses, as the aim of the evaluation was to obtain an overview of the suitability of the course for the training-integrated dual study program.

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[3] Vgl. Döring/Bortz (2016), 269.

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- **Statement 1: I am able to deal with typical questions/problems/tasks from the subject area of this course.**

Statement 1 shows that, from the students' point of view, the courses tested make it possible to deal with typical problems in this field. 186 people agree or tend to agree with this statement.

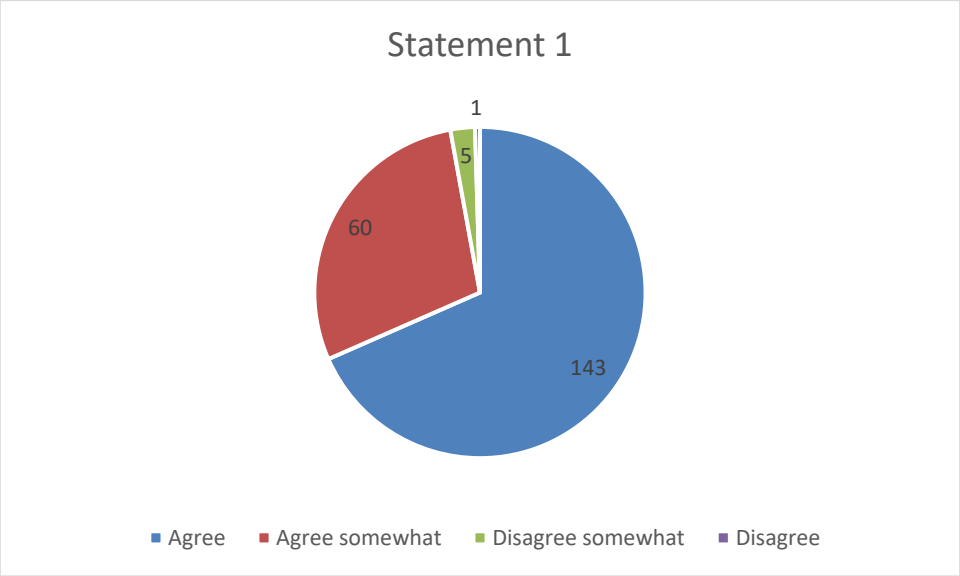

Figure 1: Evaluation Statement 1

- **Statement 2: I was motivated to participate in the course (actively listening, asking questions, reading texts, doing research, preparing presentations, solving exercises, completing assignments, etc.)**

Figure 2 shows that the students were also intrinsically highly motivated to participate in the courses. 172 people were motivated to participate.

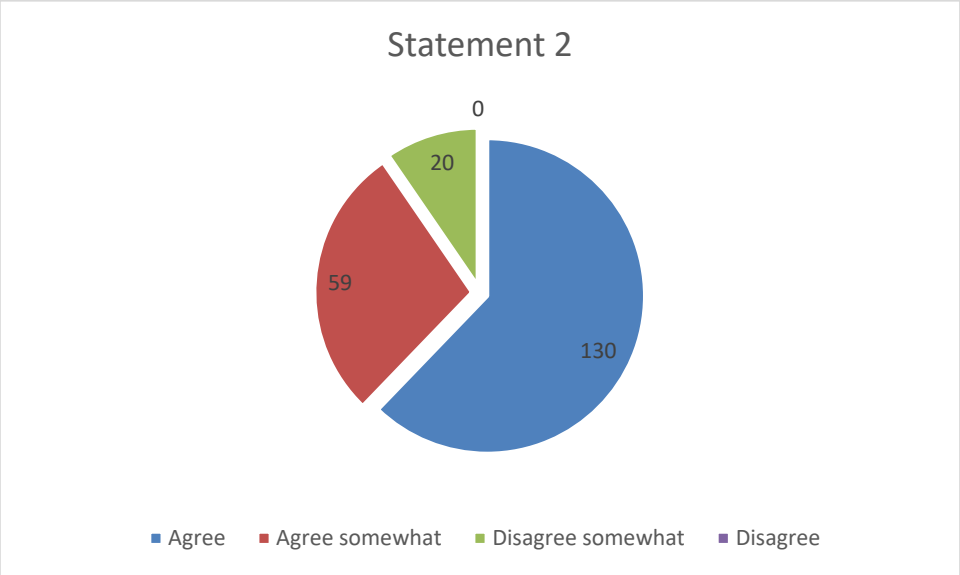

Figure 2: Evaluation Statement 2

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- **Statement 3: The trainers conveyed the course content in such a way that I understood it.**

The role of the teacher is also predominantly rated positively. A large proportion (130 people) are very satisfied with the teaching content. Figure 3 also shows that only 15 people disagreed or strongly disagreed with the statement.

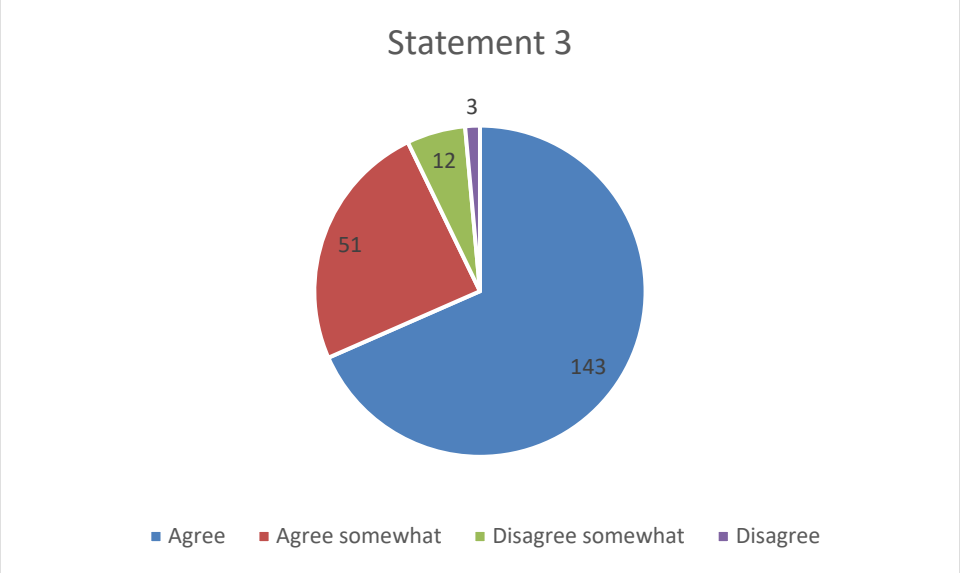

Figure 3: Evaluation Statement 3

- **Statement 4: There was a pleasant atmosphere between the teacher(s) and the students.**

The atmosphere between the students and the teacher is also rated very positively. Only seven people tended to disagree with the statement, as Figure 4 shows.

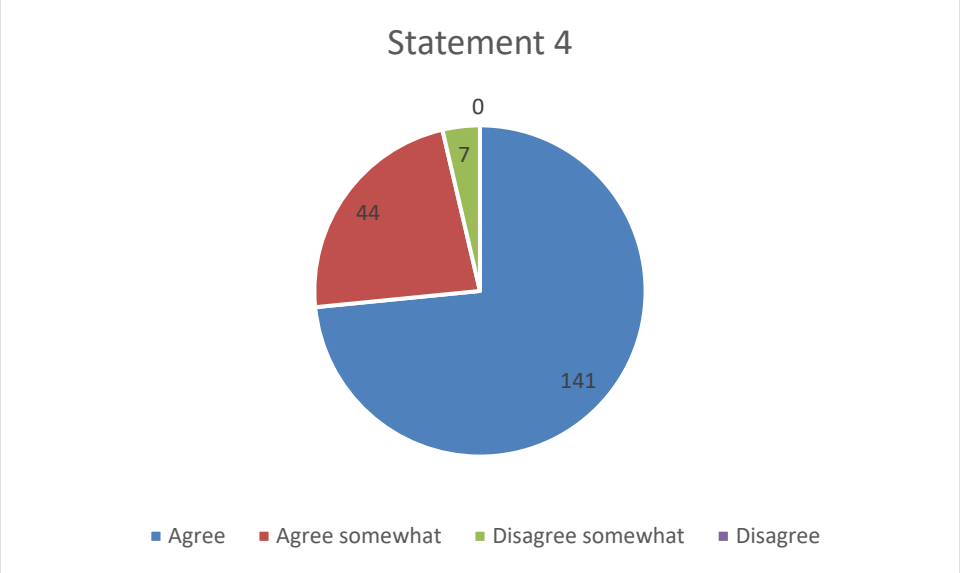

Figure 4: Evaluation Statement 4

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- **Statement 5: The learning materials provided by the teacher (e.g. exercises, literature, references, script) were useful for my learning process.**

The learning materials provided were also suitable for the majority of students. Figure 5 shows that 180 people agreed or tended to agree with the statement above.

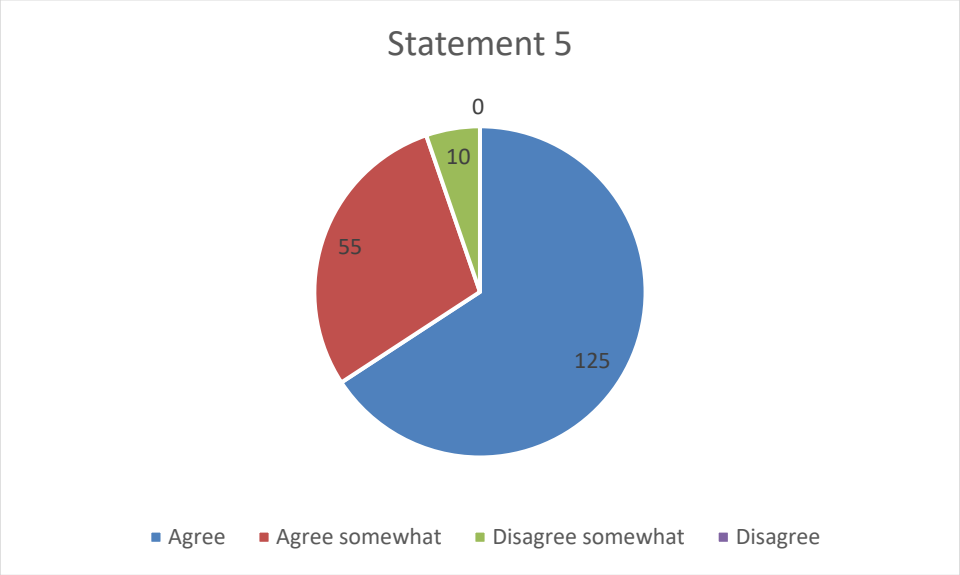

Figure 5: Evaluation Statement 5

- **Statement 6: The rooms and their equipment were well suited for the purposes of the course.**

Figure 6 shows that the students were also largely satisfied with the spatial resources and equipment.

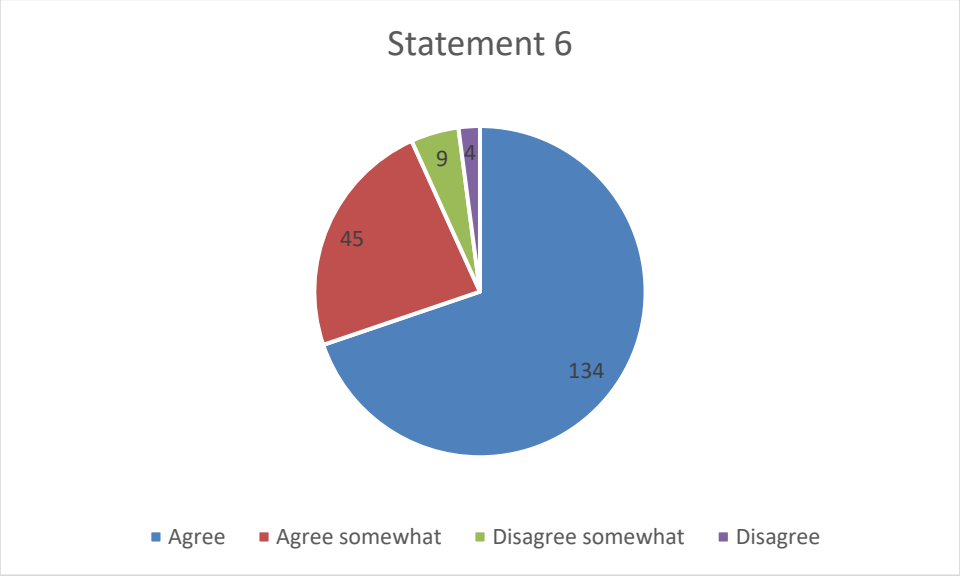

Figure 6: Evaluation Statement 6

- **Statement 7: I can recommend attending this course to the trainer.**

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The next statement also shows that the tested modules were predominantly rated positively by the students. Figure 7 shows that 180 people would recommend the course to others.

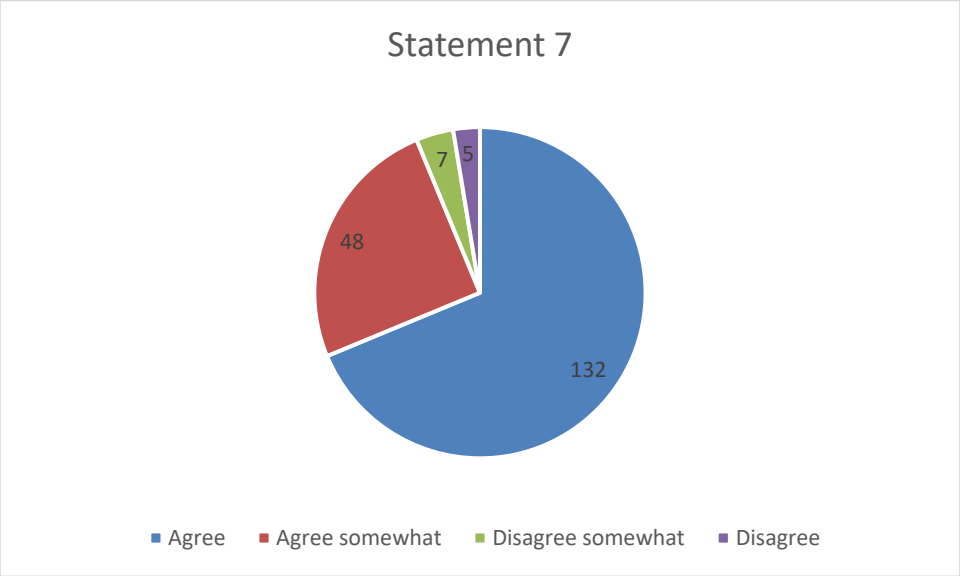

Figure 7: Evaluation Statement 7

- **Statement 8: The knowledge acquired in the course is relevant for commercial professions.**

Statements 8 and 9 were intended to determine the relevance for students of the central areas of business and technology for the dual study program that has been developed. Different results can be seen here, which can be attributed to the orientation of the individual courses. Figure 8 shows that around a third of the students are of the opinion that the tested modules have no or rather no relevance to their economic profession.

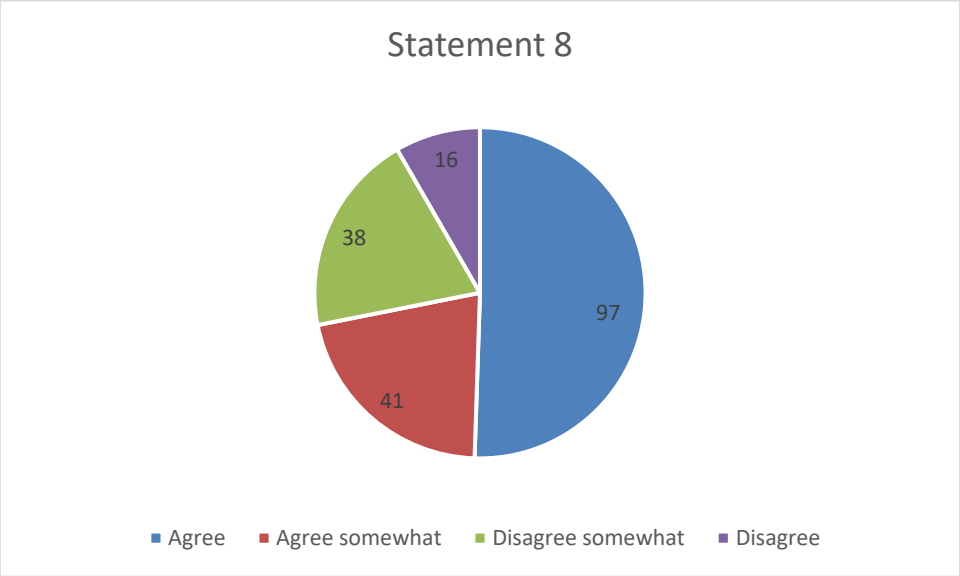

Figure 8: Evaluation Statement 8

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- **Statement 9: The knowledge acquired in the course is relevant for technical professions (e.g. building technicians).**

Figure 9 shows that slightly less than half see no relevance of the courses in the technical field. In the case of statement 9, this can also be explained by the fundamental focus of the courses, which are either more economically or more technically oriented.

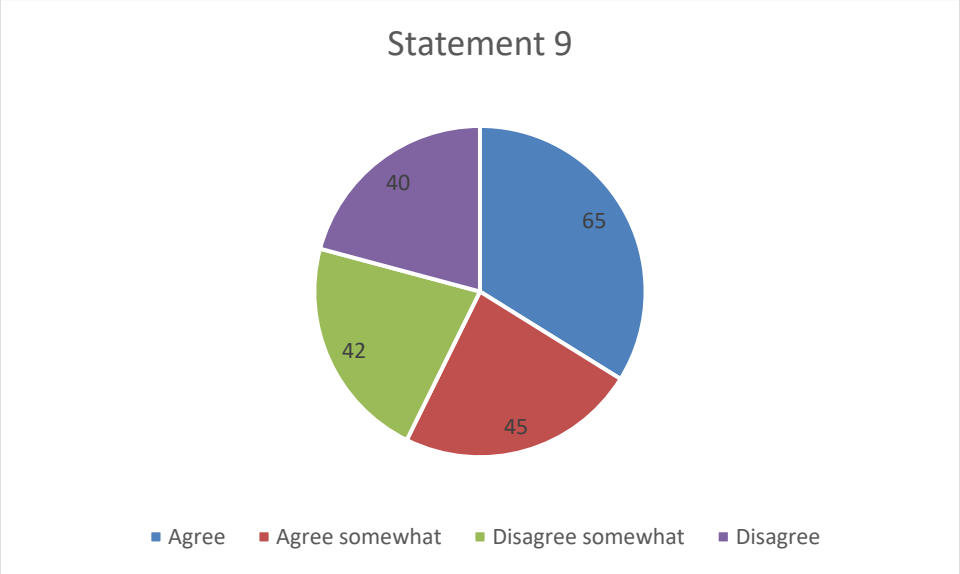

Figure 9: Evaluation Statement 9

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Conclusion

The evaluation was carried out on the basis of existing courses whose content (or parts thereof) the consortium felt were very suitable as modules for the dual study program that was developed.

The students of the courses were consulted for the study. The study took place in all three project countries, as formulated as an objective in the project application.

An online survey was used to ensure that the survey could be conducted regardless of time and place. There was a response rate of 192 completed surveys in the eleven courses.

The results show that the courses were predominantly perceived as very positive by the students in terms of factors such as the teacher, learning content, motivation and resources (e.g. facilities).

With these results, it can be concluded that the tested course is suitable for the dual study program that integrates vocational training.

Student satisfaction is an important indicator for the module handbook. The consortium feels encouraged in its selection of courses.

The findings of the evaluation are seen as an indicator that it appears to be possible to implement the training-integrated dual study program in all three project countries.

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