Module Guide
Energy Systems Engineering

Faculty European Campus Rottal-Inn

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ESE-01 ANALYTICAL PRINCIPLES OF ENGINEERING

Module code	ESE-01
Module coordination	Ibrahim Bader
Course number and name	ESE-01 Analytical Principles of Engineering
Lecturer	Ibrahim Bader
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Type of Examination	written ex. 90 min.
Duration of Examination	90min.
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Module Objective

This module provides students with fundamental knowledge of mathematical principles and methods that are essential for engineering applications. Students will develop a solid understanding of mathematical concepts, enhance their problem-solving skills, and apply analytical techniques to engineering-related problems.

Professional Competence

Expertise

Upon successful completion of the module, students will get to:

- Recognize and retrieve fundamental mathematical concepts, including set theory, real number fields, and logarithms.
- Identify and apply standard mathematical procedures for solving engineering-related problems.
- Interpret and analyze mathematical symbols, formulas, and objects, demonstrating an understanding of their significance in engineering contexts.

- Apply numerical and graphical solution methods to mathematical and engineering problems.
- Evaluate and manipulate complex numbers, matrices, and vector operations in engineering applications.
- Solve systems of linear equations using various mathematical techniques.
- Determine the convergence or divergence of sequences and series of real numbers.

Methodological Competence

Students will be able to:

- Execute vector operations and perform calculations with matrices and determinants.
- Implement numerical methods to obtain solutions for engineering-related problems.
- Transfer theoretical knowledge into practical applications through computational exercises and problem-solving tasks.
- Demonstrate proficiency in software-based mathematical computation tools.
- Organize and structure mathematical problem-solving strategies efficiently.
- Apply mathematical modeling techniques to represent engineering systems and analyze their behavior.

Personal Competence

Students will:

- Develop an analytical and structured approach to problem-solving in mathematical contexts.
- Enhance their ability to think critically and logically when tackling engineering problems.
- Strengthen their ability to work independently and self-organize mathematical learning processes.
- Gain confidence in using mathematical tools and techniques for engineering applications.

Social competence

Students will:

- Collaborate in small, multicultural teams to solve mathematical problems, enhancing teamwork and intercultural communication skills.
- Discuss and communicate mathematical concepts effectively within a group setting.
- Engage in peer discussions to verify and refine mathematical solutions.

Practical Components

To ensure hands-on learning, the module includes:

Students work collaboratively in small groups during tutorial sessions to solve structured worksheets and engineering-related mathematical problems. Through numerical and graphical methods, they analyze mathematical structures, verify solutions, and enhance their problem-solving skills in a cooperative learning environment

Applicability in this and other Programs

Mathematics is a fundamental requirement for most engineering and scientific studies. This module establishes a strong base for further coursework in engineering and applied sciences.

Entrance Requirements

Students are recommended to have prior knowledge of high school-level mathematics, including algebra, trigonometry, and elementary calculus.

Learning Content

- Basics: set theory, field of real numbers, logarithms, sums, inequalities and coordinate systems
- Complex numbers
- Vectors and Vector Algebra
- Systems of Linear Equations, Matrices and Determinants
- Sequences and Series of Real Numbers
- Functions with one real variable
- Curves and their Mathematical Representation
- Introduction to Functions in more than variable

Teaching Methods

- Lectures, tutorials, and problem-solving sessions.
- Hands-on exercises involving computational tools
- Weekly practical assignments and group discussions.
- Online learning resources (iLearn) for supplementary material and self-study.
- Interactive tutorial sessions integrating theory with real-world applications.

Remarks

This module includes a significant amount of practical applications to strengthen students understanding of engineering mathematics through hands-on experience.

Recommended Literature

- Stroud, Kenneth A, Engineering mathematics, 7th edition, Palgrave Macmillan, 2013
- Gilbert Strang., Introduction to linear algebra / 4th ed. Wellesley-Cambridge Press, c2009
- Sterling K. Berberian, A first course in real analysis, Springer-Verlag, c1994
- Berenstein, Roger Gay, Carlos A. Complex variables: an introduction, Springer-Verlag, c1991
- J. Erven, D. Schwägerl, Mathematik für Ingenieure, Oldenbourg Verlag, 4. Auflage, 3. Auflage, 2010
- W. Mückenheim, Mathematik für die ersten Semester, Oldenbourg Verlag, 3. Auflage, 2011

ESE-02 INFORMATICS FOR ENGINEERING I

Module code	ESE-02
Module coordination	Wolfgang Schauer
Course number and name	ESE-02 Informatics for Engineering I
Lecturer	Wolfgang Schauer
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

- Know and understand the basic principles of informatics (number systems, boolean logic, codes).
- Know and understand the structure of computer systems.
- Know and understand the fundamentals of programming languages (variables and commands).

Skills

- Ability to handle, convert and calculate numbers in different number systems.
- Ability to analyse networks and truth tables and to derive and simplify their boolean expressions.
- Ability to derive algorithms for unknown problems.
- Ability to transfer logical thinking into applied problem solution.

Personal Competence

Social competence

- Ability to work problem/solution-oriented in small mixed groups, learning and broadening teamwork abilities.
- Ability to communicate with peers about a complex (and yet unknown) topic and find a joint approach to solving it.

Autonomy

- Develop ability to self-study a complex and abstract topic.
- Develop analytical thinking, attention to details and ability to consider different strategies to solve individually problems related to this lecture.
- Develop judgement on the level of own skills.

Applicability in this and other Programs

- Bachelor Energy Systems Engineering
- Bachelor Industrial Engineering
- Bachelor Health Informatics

All similar technical or computer science related programs

Entrance Requirements

No prerequesites besides school level math.

Learning Content

- History of informatics / computer schience
- Number systems
- Conversion of number systems
- Fractions and negative numbers in different number systems
- Floating point numbers
- Information and code types
- Data types
- Analog to digital conversion
- Digital to analog conversion
- Boolean logic
- Disjunctive normal form

- Network analysis and simplification
- Registers and flip-flops
- Von-Neumann pronciples and architecture
- Machine code
- Algorithms
- Coding fundamentals
- Networks
- Hardware

Teaching Methods

Lectures / exercises / tutorials / home work

PowerPoint presentation, whiteboard, document camera (visualiser) and additional lecture materials in iLearn

Recommended Literature

- Glenn Brookshear: Computer Science ? An Overview, 11th ed, Addison-Wesley, 2010
- Helmut Herold: Grundlagen der Informatik, 3. Ausgabe, Pearson, 2017

ESE-03 FUNDAMENTALS OF ELECTRICAL ENGINEERING

Module code	ESE-03
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-03 Fundamentals of Electrical Engineering
Lecturers	Prof. Dr. Stefan Mátéfi-Tempfli Wolfgang Schauer
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

Students are able to explain and reproduce basic theories, principles, and methods related to:

- Fundamental relations between electrical quantities
- Basic components: sources, resistance, capacitor and inductor
- Electrical circuits and fundamental effects that may occur within electrical circuits and networks
- Network theorems and network analysis methods
- Transient analysis of electrical circuits and application of the Laplace transform for transient analysis
- Steady dc and ac analysis, complex representations and phasor diagrams
- Fundamental elements and parameters of electrical power supply

Skills

Students are capable of:

- Applying theoretical concepts to practical applications
- Applying general methods for the analysis of electrical networks
- Calculating parameters of simple electrical networks
- Calculate networks with sinusoidal excitations applying the complex calculation methods
- Using the Laplace transform to compute transients with initial conditions and work with correspondence tables
- Applying simulation tool SPICE for the simulation of simple stationary and unsteady problems
- Dimensioning circuit elements by means of a design
- Analysing and building simple circuits on experimental boards
- Implementing simple measurements, working with instruments: multimeters, signal generators and oscilloscope

Personal Competence

Social competence

Students can analyse and solve problems in small groups, can compare theoretical results with experiments and discuss it within the group. Present the related topics to professionals and discuss and argue for the obtained results.

Autonomy

The students are able to acquire skills outside their lectures form literature as well as and can solve problems by their own. They are able to relate their acquired knowledge to other lectures.

Applicability in this and other Programs

The module provides basic competences for other courses of different study programs that require electrical engineering fundamentals (e.g. for: Electrical and Power Engineering (ESE-09), Measurement and Control Engineering (ESE-17), Plant Engineering (ESE-24 and Energy Technology (ESE-16) etc.

Entrance Requirements

For ESE: Knowledge of elementary mathematics and physics is recommended.

Learning Content

The module provides introduction to the fundamentals of electrical engineering addressing:

- Physical electrical quantities, dc and ac signals
- Circuit components: sources, resistors, capacitors and inductors
- Circuits: series, parallel, star and delta connections
- Ohm's law, electrical dc power and energy
- Kirchhoff's laws
- Network theorems: Thévenin, Norton, Superposition
- Network analysis: mesh current and nodal voltage methods
- Transient analysis using Laplace transform
- AC circuits and components with sinusoidal excitation
- Apparent, reactive and active ac power, power factor
- Phasors and phasor diagrams
- Complex representations and calculation of ac circuits
- Transfer functions, logarithmic scales, Decibels and Bode-plot
- Simple filters

Practical laboratory experimental sessions are enabling the students to consolidate the theoretical knowledge as well as to develop practical skills in addressing and handling electrical circuits and equipment.

Teaching Methods

Seminaristic teaching / exercises / home work

Whiteboard, PowerPoint presentation, document camera (visualiser) and additional lecture materials in iLearn

Experiments in small groups using training material that relays on professional computer-based experimentation system where multimedia combines cognitive and hands-on training units into a comprehensive unified concept enabling students to consolidate theoretical building blocks and practical skills for a maximum learning effectiveness.

Recommended Literature

- Allan R Hambley, Electrical Engineering: Principles and Applications, 7th International Edition, Pearson 2018
- Edward Hughes, John Hiley, Ian McKenzie-Smith, Keith Brown, Hughes Electrical and Electronic Technology, 12/E, Pearson 2016
- Horst Clausert, Gunther Wiesemann, Volker Hinrichsen, Jürgen Stenzel, Grundgebiete der Elektrotechnik 1/2, Oldenbourg Wissenschaftsverlag 2014/2009
- Thomas Harriehausen, Dieter Schwarzenau, Moeller Grundlagen der Elektrotechnik, 23 Auflage, Springer Vieweg 2013
- Lucas-Nülle, Computer-based training material and experimentation systems on Electrical Engineering, UniTrain Course and Systems, https://www.lucas-nuelle.com/

ESE-04 PHYSICS

Module code	ESE-04
Module coordination	Prof. Dr. Rui Li
Course number and name	ESE-04 Physics
Lecturer	Prof. Dr. Rui Li
Semester	1
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 90hours self-study: 60hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

- Understand, that physics' laws are at the fundamental basis for every technology.
- Know the fundamental laws and principles of physics.
- Know the physical approaches of using boundary conditions, conservation laws or equilibrium conditions to describe systems and solve problems.

Skills

- Ability to structure physical problems and translate them into equations and apply the principles of physics to solve the problems.
- Ability to analyse the context of complex technical problems and to apply this to the design and development of technical systems and processes.
- Ability to transfer the knowledge of physics principles into understanding the behaviour of unknown systems.
- Ability to plan and conduct experiments.
- Ability to evaluate and explain the results of experiments.

Personal Competence

Social competence

- Ability to work problem/solution-oriented in small mixed groups, learning and broadening teamwork abilities.
- Ability to communicate with peers about a complex (and yet unknown) topic and find a joint approach to solving it.
- Ability to coordinate small teams for experiment execution and lab report preparation.

Autonomy

- Develop ability to self-study a complex and abstract topic.
- Develop analytical thinking, attention to details and ability to consider different strategies to solve individually problems related to this lecture.
- Develop judgement on the level of own skills.

Applicability in this and other Programs

Applicable in Bachelor of Energy Systems Engineering, Bachelor Industrial Engineering, Bachelor Health Informatics and all similar study programs.

Entrance Requirements

Advanced mathematics

Learning Content

- History and Origin of Physics
- Unit Systems (SI)
- The Newton laws of motion
- Motions in several dimensions
- Equations of motion
- Force and Work
- Work and Energy
- Conservative and non-conservative forces
- Energy conservation

- Mechanics of mass points and systems
- Linear momentum
- Conservation of linear momentum
- Collisions
- Friction
- Circular motion
- Torque
- Moment of inertia
- Angular momentum
- Conservation of angular momentum
- Center of mass concept
- Fundamentals of fluid mechanics
- Fundamentals of thermodynamics
- Phase transitions
- Temperature, pressure, entropy
- The laws of thermodynamics
- Thermodynamic processes

Teaching Methods

Lectures / exercises / tutorials / home work / lab work

PowerPoint presentation, whiteboard, document camera (visualiser) and additional lecture materials in iLearn

Recommended Literature

The course will be mainly based on:

- David Halliday, Robert Resnick, Jearl Walker. *Principles of Physics*. 10th edition. Hoboken, NJ: Wiley. (2014)
- All other books on Physics (namely for engineering) are suited as well.

ESE-05 CHEMISTRY

Module code	ESE-05
Module coordination	Prof. Dr. Roland Augustin
Course number and name	ESE-05 Chemistry
Lecturer	Prof. Dr. Roland Augustin
Semester	1
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Students learn about the basics of chemistry to understand the material composition of matter and to derive basic properties and behaviours.

Professional Competence

Knowledge

- Students know the structure of matter at element and molecular level.
- They are able to understand the language of chemistry (symbols, formula, equations, solution, concentrations).
- Students understand the fundamental properties of elements and molecules and are able to establish simple reaction equations.
- They are able to describe simple chemical reactions (Acid-Base Reactions, Redox reactions, simple organic reactions).
- Based on their knowledge of the state and reaction possibilities of matter, students know the essential properties of water, metals, plastics, natural substances and energy raw materials.
- Students understand the fundamentals of electrochemical cells, redox reactions and their importance to corrosion, batteries and electrochemical industry.

- In the lab work part, students get introduced to gain experience in the conduct of laboratory experiments, the acquisition and treatment of data and report preparation.

Skills

- Ability to understand chemical problems and translate them into equations and apply the principles of chemistry to solve the problems.
- Ability to analyse the context of material based technical problems and to apply this to the design and development of technical systems and processes.
- Ability to transfer the knowledge of chemical principles into understanding the behaviour of unknown systems.

Personal Competence

Methodological competences

After participating in this module, students will be able to understand and analyse material-based and substance-related aspects of products, processes and nature. They understand possible material-dependent challenges that arise in product and process development. In addition, students learn the first fundamental aspects about the climate and environmental relevance of materials.

Social competence

- Ability to work in intercultural mixed teams and communicate their progress and results.
- Ability to communicate with peers about a complex topic and find a joint approach to solving it.

Applicability in this and other Programs

- IE-18 Chemistry, BA Industrial Engineering at ECRI
- D-1105 Chemie, BA Maschinenbau at THD
- E-1101 Chemie, BA Bauingenieurwesen at THD
- Y-1101 Chemie, BA Umweltingenieurwesen at THD

Entrance Requirements

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Learning Content

- Introduction to chemistry

- The periodic table of elements
- Atomic and molecular structure
- Condition of substances, aggregate states, phase transformations, modification
- Chemical bonding
- Chemical reactions, reaction kinetics and thermodynamics
- Principles of organic chemistry
- Composition and properties of industrially important materials (metals, polymers, oil, coal, gas, glas, biomass)

Teaching Methods

Course teaching / exercises /tutorials / experimental demonstrations and practical lab work in small teams

Remarks

Laboratory work for the application and accompanying deepening of the knowledge learned in the lecture

Recommended Literature

- S.S. Zumdahl, S.A. Zumdahl, D. J. DeCoste; "Chemistry"; 10th edition; Cengage Learing; Boston; 2016
- J.T. Moore, "Chemistry for dummies"; 2nd edition, Wiley; Hoboken; 2011
- J.T. Moore, "Chemistry Essentials for dummies"; 2nd edition, Wiley; Hoboken; 2010
- E.R. Riedl, H.-H. Meyer; "Allgemeine und anorganische Chemie"; De Gruyter, Berlin / Boston; 11. Auflage, 2013

ESE-06 FOREIGN LANGUAGE I

Module code	ESE-06
Module coordination	Tanja Mertadana
Course number and name	ESE-06 Foreign Language I
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	4
Workload	Time of attendance: 60hours self-study: 60hours Total: 120hours
Weighting of the grade	4/210
Language of Instruction	English

Module Objective

The modules Foreign Language I and III aim to equip students with specialized language skills necessary for independent performance in a globalized energy systems engineering sector. In doing so, it strives to deepen students? relationship with the English language in business and technical settings so that they can implement the language effectively and efficiently as a practical communication tool. International students are recommended to take German as a Foreign Language up to the level of B2.

To this end, the module targets instruction of the four cardinal language skills (listening, reading, speaking, and writing) across a wide range of core topics related to energy systems engineering. Students also craft the content of their own learning through needs analyses and frequent immersive and self-directed projects.

It is essential to the module to optimize fluency and communication skills, as well as to cultivate a clear understanding of the finer points of textual meaning and meaning produced in dialogue with others. Through a variety of task-based speaking, listening and writing activities, students enhance their oral and aural production and expand their ability to produce clear, concise and coherent pieces of writing ? emails, reports, or expository paragraphs on processes. Particular emphasis will be placed on honing students? public speaking and team skills through work on a team presentation project for each course.

General Business English

On completion of the module, students will have achieved the following learning objectives:

Professional competencies

- Students will have an independent command of specialized business and technical terminology relevant to the field of energy systems engineering. Command here refers to oral and written production as well as aural and reading comprehension.
- They will be in a position to deploy study skills such as close reading and coherent writing at a B2/C1-level and for use in niche tasks for the energy systems engineering sector.
- They will have gained substantial knowledge of B2/C1-level language registers ? both for formal study contexts and for semi-formal to formal professional contexts.
- They will have gained essential experience in presenting on topics related to business and technical English. The goal here is to include niche knowledge in the protocols of a clearly structured, effectively delivered piece of public speaking.

Methodological competencies

- Students will have enhanced their abilities to structure the acquisition of specialized terminology and grammatical items and practiced ways to internalize new language that yield optimal learning benefits.
- They will have extended and refined their practical research skills in English by engaging in at least two research projects ? for example, by being asked to present on a discipline-specific topic in an individual or team presentation.

Social competences

- Students will have gained valuable experience in training other personal effectiveness skills such as teamwork, integrity, and reliability.
- They will have reflected on the learning benefits derived from several immersion projects.

German as a Foreign Language

Please see the respective course description for module objectives.

Applicability in this and other Programs

The module can also be chosen by students of other fields of study.

Entrance Requirements

General Business English: The minimum entry-level requirement is a B2-level of English according to the Common European Framework of Reference for Languages (CEFR).

German as a Foreign Language: Upon arrival, the student´s German language proficiency is tested by means of a placement test. Depending on the result, the students attend a course of the appropriate level. After the successful completion of a course, students attend an advanced German course in the following semester.

Learning Content

General Business English

- business basics
- company structures
- markets and market structures
- business startups
- launching a product
- innovation and technology in business
- online business
- marketing
- communication and business correspondence
- business meetings and presentations
- working across cultures
- current business topics

German as a Foreign Language

Please see the respective course description for specific information on contents.

Teaching Methods

Instruction and learning methods focus on training the four cardinal language skills (speaking, listening, reading, and writing) and on enhancing professional and social competencies. They include group discussions and group projects, individual and team work (e.g. individual and group presentations), real- and role-playing, close reading and listening activities, grammar games, method of loci, running dictations,

translations, peer feedback and review, work with learning stations, and various follow-up viewing and writing activities.

Study assignments will be set on a weekly basis.

Recommended Literature

General Business English

- Brook-Hart, Guy. *Business Benchmark*. 2nd ed.: Upper Intermediate. Cambridge: CUP, 2013.
- Business Spotlight: <www.business-spotlight.de>
- Butzphal, G., Maier-Fairclough, J. *Career Express. Business English B2*. Berlin: Cornelson, 2015.
- Cotton, D., Falvey, D. & Kent, S. *Market Leader Upper Intermediate*. Harlow: Pearson Longman, 2016.
- Doyle, Charles. *A Dictionary of Marketing*. 4th ed. Oxford: OUP, 2016.
- Duckworth, M., Turner, R. *Business Results Upper Intermediate*. Oxford: OUP, 2008.
- Emmerson, P. *Business Vocabulary Builder*. London: Macmillian, 2009.
- Emmerson, P. *Business Grammar Builder. Intermediate to Upper-intermediate*. London: Macmillian, 2010.
- Foley, M., Hall, D. *MyGrammarLab. Intermediate B1/B2*. Harlow: Pearson, 2012.
- Law, Jonathan. *A Dictionary of Business and Management*. 6th ed. Oxford: OUP, 2016.
- Rogers, Louis. *Skills for Business Studies*. Upper Intermediate. Oxford: OUP, 2012.
- Vince, Michael. *Intermediate Language Practice*. 3rd ed. London: Macmillan, 2010.

German as a Foreign Language

Please see the respective course description for literature references.

ESE-07 MATHEMATICS FOR ENGINEERING

Module code	ESE-07
Module coordination	Ibrahim Bader
Course number and name	ESE-07 Mathematics for Engineering
Lecturer	Ibrahim Bader
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Module Objective

This module equips students with the fundamental mathematical skills necessary for engineering applications. It covers essential concepts in calculus, differential equations, and mathematical modeling, providing a strong foundation for solving real-world engineering problems.

Professional Competence

Expertise

Upon successful completion of this module, students get to:

- Recognize and apply the fundamental concepts of theoretical mathematics and calculus.
- Identify and describe elementary functions, partial differentiation, and ordinary differential equations.
- Understand and apply the Fundamental Theorem of Calculus.
- Explain the role of mathematical modeling in engineering and business applications.
- Evaluate and apply mathematical techniques to solve engineering problems effectively.

Methodological Competence

Students will be able to:

- Compute limits of basic functions and analyze continuity.
- Differentiate functions of one or more variables and apply differentiation techniques.
- Solve first-order ordinary differential equations using analytical and numerical methods.
- Perform partial differentiation and manipulate derivatives of multivariable functions.
- Compute and analyze infinite and finite integrals, including multiple integrals.
- Obtain numerical solutions to engineering and real-life problems using differential and integral methods.
- Expand periodic functions using Fourier Series.
- Apply mathematical concepts to engineering case studies and practical scenarios.

Personal Competence

Students will develop:

- Independent problem-solving abilities through structured exercises and applications.
- Logical reasoning and critical thinking skills in mathematical problem-solving.

Social Competence

Students will:

- Collaborate in small, diverse groups to solve mathematical problems, enhancing teamwork and communication skills.
- Engage in multicultural learning environments, strengthening intercultural competence.

Practical Components

tudents apply mathematical methods to solve real-life engineering problems through structured worksheets and exercises. They practice numerical problem-solving and analytical thinking in practical contexts relevant to engineering.

Applicability in this and other Programs

Mathematics is essential for most engineering and scientific courses. This module, together with Analytical Principles of Engineering and Applied Mathematics, establishes a foundation for advanced engineering and scientific studies.

Entrance Requirements

ESE-01 Analytical Principles of Engineering

Learning Content

- Functions and Limits (functions in one variable)
- Differentiation (functions in one variable)
- Applications on derivatives
- Integration
- Power Series
- Basics of differential geometry for plane curves
- Area calculation of plane regions (bounded by a number of curves)
- Differentiation of functions with several variables
- Multiple integrals (domain, region, area and volume integration)
- Fourier-Series
- Introduction to Power Series

Teaching Methods

- Lectures, exercises, tutorials, homework, and group activities.
- Use of whiteboard, visualizer, online learning portal (iLearn), and active learning methods.
- Weekly hands-on exercise sessions incorporating real-life engineering applications.

Remarks

This module includes a significant amount of practical applications to strengthen students understanding of engineering mathematics through hands-on experience.

Recommended Literature

- Dwivedi, A.P, Engineering mathematics, PHI Learning Private Limited, New Delhi, 2015

- James, Glyn, Advanced modern engineering mathematics, Fifth edition, Pearson, 2018
- Harvey P. Greenspan, David J. Benney, Calculus: an introduction to applied mathematics, Breukelen Press, c1997
- Anton Howard, Calculus: with analytical geometry, 5th ed. Wiley, 1995
- Sterling K. Berberian, A first course in real analysis, Springer-Verlag, c1994
- K. Dürrschnabel, Mathematik für Ingenieure, Springer Verlag, 2. Auflage, 2012
- T. Westermann, Mathematik für Ingenieure, Springer Verlag, 6. Auflage, 2011

ESE-08 INFORMATICS FOR ENGINEERING II

Module code	ESE-08
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-08 Informatics for Engineering II
Lecturer	Ibrahim Bader
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

- Know and understand the basic principles, commands and syntax of the Phyton programming language
- Know and understand the structure of computer programs
- Know and understand how to write a program in computer code
- Know and understand different programing paradigms and styles

Skills

- Ability to implement different algorithms and methods in a computer program
- Ability to understand and debug computer programs
- Ability to structure problems and create solutions for given tasks in computer code
- Ability to write computer code using different programming styles, i.e. procedural, object oriented or event driven that are the best suited to the programming task
- Ability to create graphical user interfaces for given tasks

Personal Competence

Social competence

- Ability to work problem/solution-oriented in small mixed groups, learning and broadening teamwork abilities.
- Ability to communicate with peers about a complex (and yet unknown) topic and find a joint approach to solving it.

Autonomy

- Develop ability to use online resources to learn syntax and methods of python programming.
- Develop ability to design criteria and testing strategies to check quality of own work.
- Gain experience in time-boxed problem solution.

Applicability in this and other Programs

Directly applicable in all modules of Energy Systems Engineering that requires skills in programming (e.g. Project Work I, II, III (ESE-19, 21, 33), Smart Systems and Technologies (ESE-31), Grid Management (ESE-34), etc.) also in other study programs i.e. Bachelor of Industrial Engineering.

Entrance Requirements

ESE-02 Informatics for Engineering I

Learning Content

- Programming languages, syntax and semantics
- Program execution, compilers and interpreters
- Program structure and general programming guidelines
- Python, an interpreted, high-level, general-purpose programming language
- Variable data types, casting
- Numbers, strings, booleans
- Operators, expressions
- Lists, tuples, sets and dictionaries
- Loops and conditionals

- Named and anonymous functions
- Programming paradigms: procedural and object oriented programming
- Classes and Objects
- Object properties, methods, object constructor method
- Inheritance, encapsulation
- Modules and external libraries: Math, Numpy, Matplotlib
- User input, output, formating
- File and internet data handling
- Graphical user interfaces and event driven programming

Teaching Methods

Lectures / exercises / tutorials / home work

PowerPoint presentation, whiteboard, exercises on PC, document camera (visualiser) and additional lecture materials in iLearn

Remarks

Python will be the main language in this class employed on the following platforms:

- Anaconda Data Science Platform : Spyder or PyCharm IDEs

- Online: https://repl.it , https://edabit.com

Recommended Literature

- Learn to Program with Python: Take your first steps in programming and learn the powerful Python programming language, Irv Kalb, Apress 2016 https://ebookcentral.proquest.com/lib/th-deggendorf/reader.action?docID=4652556. Download source code from: https://github.com/apress/learn-to-program-w-python
- Python Projects for Beginners: A Ten-Week Bootcamp Approach to Python Programming, Connor P. Milliken, Apress 2020 https://link.springer.com/book/10.1007%2F978-1-4842-5355-7. Download source code from: https://github.com/Apress/python-projects-for-beginners
- Massachusetts Institute of Technology (MIT) OpenCourseWare : Introduction to Computer Science and Programming https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-00-introduction-to-computer-science-and-programming-fall-2008/video-lectures/

- Python tutorials on:
  - https://www.w3schools.com/python/default.asp
  - https://www.python-course.eu/python3_course.php

ESE-09 ELECTRICAL AND POWER ENGINEERING

Module code	ESE-09
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-09 Electrical and Power Engineering
Lecturer	Prof. Dr. Stefan Mátéfi-Tempfli
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

Students are able to explain and reproduce basic theories, principles, and methods related to:

- Principles associated with single and three-phase systems, star and delta connection methods and relationship between phase and line currents and voltages
- Understand the role of electromagnetism in inductors, transformers and electrical machines
- Fundamentals of electrical machines, motor and generator regimes, various types: dc brushed and brushless, ac- asychronous and synchronous, variable reluctance and more complex doubly excited machines, their analysis and operation
- Electronic and power electronic devices, semiconductors: diodes, thyristors, transistors (BJT, FET, IGBT, GTO)
- Passive and reactive power devices
- Basic electronic circuits: amplifiers, op-amps, analog and switch-mode circuits, PWM control.

- Power Rectifiers, Converters and Power Drives
- Electrical energy supply technologies, generation of energy from regenerative sources and processes utilized in distribution networks
- Power electricity supply systems and distribution networks, analysis and operation

Skills

Students are capable of:

- Calculation and measurement of single and multi-phase systems
- Implementing measurements, working with power equipment and instruments
- Undertaking exercises in linear dc and ac-machine operation
- Discussing the appropriate starting methods of induction machines and three-phase motors
- Determining torque/speed load characteristics and efficiency of motors
- Understanding and operating simple wind and other mechanical to electrical power production plants as well as of photovoltaic systems
- Manual and automatic synchronization of generators with the 3-phase electricity grid, controlling of active and apparent power, frequency and voltage, optimum operating points under changing conditions
- Applying simulation tools for the simulation of stationary and unsteady problems
- Dimensioning circuit elements by means of a design
- Analysing and building simple switch-mode converter and driver circuits on experimental boards

Personal Competence

Social competence

Students can analyse and solve problems in small groups, can compare theoretical results with experiments and discuss it within the group. Present the related topics to professionals and discuss and argue for the obtained results.

Autonomy

The students are able to analyse and solve problems individually as well as to develop further competences by self-studying the literature.

Applicability in this and other Programs

The module provides basic competences for other courses of different study programs that require electrical engineering and power engineering fundamentals (e.g. for: Measurement and Control Engineering (ESE-17), Plant Engineering (ESE-24 and Energy Technology (ESE-16) Project Work I, II, III , etc.

Entrance Requirements

Fundamentals of Electrical Engineering (ESE-03)

Learning Content

The module provides advancements in electrical engineering and introduction to electronic, power electronics and power engineering addressing:

- Single and Multi-phase Systems
- Electromagnetism, Magnetic Circuits, Transformers
- Introduction to Machine Theory
- DC-Machines
- AC-Asynchronous Machines
- AC-Synchronous Machines
- Electronic devices and circuits
- Amplifiers and Op-Amps
- Power Electronic devices and Switch Mode circuits
- Basic Switch Mode Converter circuits
- Introduction to Power Drives
- Electrical Energy Systems
- Power Systems

Practical laboratory experimental sessions are enabling the students to consolidate the theoretical knowledge as well as to develop practical skills in addressing and handling electrical equipment and machines as well as electronic and power electronic circuits and instruments.

Teaching Methods

Seminaristic teaching / exercises / home work

Whiteboard, PowerPoint presentation, document camera (visualiser) and additional lecture materials in iLearn

Experiments in small groups using laboratory instruments and prototyping/experimenting boards as well as training material that relays on professional computer-based experimentation system where multimedia combines cognitive and hands-on training units into a comprehensive unified concept enabling students to consolidate theoretical building blocks and practical skills for a maximum learning effectiveness.

Recommended Literature

- Edward Hughes, John Hiley, Ian McKenzie-Smith, Keith Brown, Hughes Electrical and Electronic Technology, 12/E, Pearson 2016
- Allan R Hambley, Electrical Engineering: Principles and Applications, 7th International Edition, Pearson 2018
- Horowitz, Paul, The art of electronics, 3rd Ed., Cambridge Univ. Press 2015
- Ned Mohan, Power electronics : Converters, Applications, and Design, 3rd Ed., Wiley 2003
- Ned Mohan, Electric power systems, Wiley 2012
- Lucas-Nülle, Computer-based training material and experimentation systems on Electrical Power Engineering, Photovoltaic and Wind Power Plant Simulator UniTrain Course and Systems, https://www.lucas-nuelle.com/

ESE-10 LAB WORK IN NATURAL SCIENCES

Module code	ESE-10
Module coordination	Prof. Dr. Roland Augustin Wolfgang Schauer
Course number and name	Lab Work in Chemistry Lab Work in Physics ESE-10 Lab work in Natural Sciences
Lecturers	Prof. Dr. Roland Augustin Wolfgang Schauer
Semester	2
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	8
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English, German

Module Objective

Physics

Professional Competence

Knowledge

- Understand, that physics' laws are at the fundamental basis for every technology.
- Know the fundamental laws and principles of physics.
- Know the physical approaches of using boundary conditions, conservation laws or equilibrium conditions to describe systems and solve problems.

Skills

- Ability to structure physical problems and translate them into equations and apply the principles of physics to solve the problems.
- Ability to analyse the context of complex technical problems and to apply this to the design and development of technical systems and processes.

- Ability to transfer the knowledge of physics principles into understanding the behaviour of unknown systems.
- Ability to plan and conduct experiments.
- Ability to evaluate and explain the results of experiments.

Personal Competence

Social competence

- Ability to work problem/solution-oriented in small mixed groups, learning and broadening teamwork abilities.
- Ability to communicate with peers about a complex (and yet unknown) topic and find a joint approach to solving it.
- Ability to coordinate small teams for experiment execution and lab report preparation.

Autonomy

- Develop ability to self-study a complex and abstract topic.
- Develop analytical thinking, attention to details and ability to consider different strategies to solve individually problems related to this lecture.
- Develop judgement on the level of own skills.

Chemistry

Students learn about the basics of chemistry to understand the material composition of matter and to derive basic properties and behaviours.

Professional Competence

Knowledge

- Students know the structure of matter at element and molecular level.
- They are able to understand the language of chemistry (symbols, formula, equations, solution, concentrations).
- Students understand the fundamental properties of elements and molecules and are able to establish simple reaction equations.
- They are able to describe simple chemical reactions (Acid-Base Reactions, Redox reactions, simple organic reactions).
- Based on their knowledge of the state and reaction possibilities of matter, students know the essential properties of water, metals, plastics, natural substances and energy raw materials.

- Students understand the fundamentals of electrochemical cells, redox reactions and their importance to corrosion, batteries and electrochemical industry.
- In the lab work part, students get introduced to gain experience in the conduct of laboratory experiments, the acquisition and treatment of data and report preparation.

Skills

- Ability to understand chemical problems and translate them into equations and apply the principles of chemistry to solve the problems.
- Ability to analyse the context of material based technical problems and to apply this to the design and development of technical systems and processes.
- Ability to transfer the knowledge of chemical principles into understanding the behaviour of unknown systems.

Personal Competence

Methodoligical competence

After participating in this module, students will be able to understand and analyse material-based and substance-related aspects of products, processes and nature. They understand possible material-dependent challenges that arise in product and process development. In addition, students learn the first fundamental aspects about the climate and environmental relevance of materials.

Social competence

- Ability to work in intercultural mixed teams and communicate their progress and results.
- Ability to communicate with peers about a complex topic and find a joint approach to solving it.

Applicability in this and other Programs

Physics

Applicable in Bachelor of Energy Systems Engineering, Bachelor Industrial Engineering, Bachelor Health Informatics and all similar study programs.

Chemistry

- IE-18 Chemistry, BA Industrial Engineering at ECRI
- D-1105 Chemie, BA Maschinenbau at THD
- E-1101 Chemie, BA Bauingenieurwesen at THD

- Y-1101 Chemie, BA Umweltingenieurwesen at THD

Entrance Requirements

Physics

Advanced mathematics (Analytical Principles of Engineering ESE-01)

Chemistry

- Analytical Principles of Engineering (ESE-01)
- Physics (ESE-04)

Learning Content

Physics

- History and Origin of Physics
- Unit Systems (SI)
- The Newton laws of motion
- Motions in several dimensions
- Equations of motion
- Force and Work
- Work and Energy
- Conservative and non-conservative forces
- Energy conservation
- Mechanics of mass points and systems
- Linear momentum
- Conservation of linear momentum
- Collisions
- Friction
- Circular motion
- Torque
- Moment of inertia
- Angular momentum

- Conservation of angular momentum
- Center of mass concept
- Fundamentals of fluid mechanics
- Fundamentals of thermodynamics
- Phase transitions
- Temperature, pressure, entropy
- The laws of thermodynamics
- Thermodynamic processes

Chemistry

- Introduction to chemistry
- The periodic table of elements
- Atomic and molecular structure
- Condition of substances, aggregate states, phase transformations, modification
- Chemical bonding
- Chemical reactions, reaction kinetics and thermodynamics
- Principles of organic chemistry
- Composition and properties of industrially important materials (metals, polymers, oil, coal, gas, glas, biomass)

Teaching Methods

Physics

Lectures / exercises / tutorials / home work / lab work

PowerPoint presentation, whiteboard, document camera (visualiser) and additional lecture materials in iLearn

Chemistry

Course teaching / exercises /tutorials / experimental demonstrations and practical lab work in small teams

Remarks

Laboratory work for the application and accompanying deepening of the knowledge learned in the lecture

Recommended Literature

Physics

The course will be mainly based on:

- David Halliday, Robert Resnick, Jearl Walker. *Principles of Physics*. 10th edition. Hoboken, NJ: Wiley. (2014)
- All other books on Physics (namely for engineering) are suited as well.

Chemistry

- S.S. Zumdahl, S.A. Zumdahl, D. J. DeCoste; Chemistry; 10th edition; Cengage Learing; Boston; 2016
- J.T. Moore, Chemistry for dummies; 2nd edition, Wiley; Hoboken; 2011
- J.T. Moore, Chemistry Essentials for dummies; 2nd edition, Wiley; Hoboken; 2010
- E.R. Riedl, H.-H. Meyer; Allgemeine und anorganische Chemie; De Gruyter, Berlin / Boston; 11. Auflage, 2013

ESE-11 MATERIALS AND DESIGN

Module code	ESE-11
Module coordination	Prof. Dr. Markus Hainthaler
Course number and name	ESE-11 Materials and Design
Lecturers	Prof. Dr. Thorsten Gerdes Prof. Dr. Markus Hainthaler
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Qualification Goals

Within this course, students acquire the ability to understand the relationship between the correct choice of materials, their behaviour under mechanical stresses (including failure) and their applicability for the design of real machines. Additionally, they are able to sketch their design ideas with the most common types of technical drawings. This creates the basis for any further subject within the study programme where reliable design of plant equipment is crucial.

Professional and methodological Competences

Knowledge

From ESE-04 Physics, the students possess already the basics about forces and moments acting on simple mechanical structures. Within this module, these competences are developed further towards the design of realistic machine components, beginning with the choice of the adequate construction material up to the evaluation of the component´s probability to fail. All these steps of construction are practiced with idealized geometric parts. Altogether, this expertise will be needed in all further engineering lectures of the study programme which include the design and operation of apparatuses and other plant equipment.

Skills

After completing this module, the students will be able to discuss with design specialists about problem-solving in all steps of construction. They understand the advantages and disadvantages of applying the most common construction materials, and the calculation procedure of analysing and evaluating combined stresses on machine parts and their safety against failure. Additionally, they possess a general understanding how to generate and interpret both 2D and 3D technical drawings.

Personal and social Competences

The solution of the tasks given both in the lecture and the exam requires students´ self-responsible and self-directed working style. Herein, the concepts of all module topics have to be applied to new problems, analyzed regarding their relevance, and evaluated in order to yield a reliable result. Each student has practiced step by step how to create 3D objects both as a technical drawing and a machineable plant component.

Applicability in this and other Programs

The learning outcomes of this module can be applied in any lectures and other study programmes that deal with materials selection and the design of plant and construction equipment.

Entrance Requirements

Successful completion of the following modules is recommended:

Analytical Principles of Engineering (ESE-01), Physics (ESE-04)

Learning Content

Material Science

- General material properties: classification, applications and selection criteria, chemical bonding in solids, phase diagrams
- Mechanical properties fundamentals: stress and strain, Hooke´s law, strength, hardness
- Metals: steel, light alloys, copper alloys; processing, properties and applications
- Ceramics: processing, properties and applications of oxides, nitride and carbides
- Glass: structure, processing, properties and applications of silicate glasses
- Polymers: structure, properties and applications
- Composite materials: structure, processing, properties and applications

Technical Drawing

- National and international standards of technical drawings
- Isometric projection: normal objects, box construction, non-isometric and curved shapes
- Geometric construction: angles, parallels, tangents, circles, arcs, bisections, geometric objects, complex objects
- Orthographic projection: generation of views, missing view problems, normal and inclined faces, curved faces

Machine Component Design

- Elastic / plastic deformation
- Static body stresses: description of single stresses, Mohr circle representation, combination of stresses, analytical and graphical evaluation
- Failure Analysis: Safety factors, failure theories, graphical representation
- Threaded fasteners: characterization, stresses and loads, initial tensile force, tightening torque
- Bearings & lubrication: stresses and loads, types of friction, types of lubricants, Stribeck curve

Teaching Methods

The lecture focuses on seminaristic teaching, but also applies detailed practical exercises based on the theoretical background. The key content is denoted in a written script via visualizer, while the supplemental content is conveyed via slide and video presentations. All material is uploaded to an online learning portal (iLearn). The students are strongly invited to discuss real-life problems and applications interactively throughout the lecture. Concerning technical drawing, each student is engaged to join the construction procedure, and the drawings are developed step by step with individual help. Tutorials will be offered on demand.

Remarks

A drawing set consisting of at least a set square, compasses, a thin and a thick pen and an eraser is essential for each student.

Recommended Literature

- W.D. Callister, D.G. Rethwisch "Materials Science and Engineering - An Introduction", Wiley, 9th edition 2013
- F.E. Giesecke, A. Mitchell et al. "Technical drawing with engineering graphics", Pearson, 15th edition 2016

o R.C. Juvinall, K.M. Marshek "Machine Component Design", Wiley, 5th edition 2012

ESE-12 INTERCULTURAL COMPETENCES

Module code	ESE-12
Module coordination	Prof. Dr. Michelle Cummings-Koether
Course number and name	ESE-12 Intercultural competences
Lecturer	Prof. Dr. Michelle Cummings-Koether
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	2
ECTS	2
Workload	Time of attendance: 30hours self-study: 30hours Total: 60hours
Type of Examination	report and presentation
Weighting of the grade	2/210
Language of Instruction	English

Module Objective

Module Objective

Intercultural differences can affect the ability to constructively work together in international environments. Often those differences are not recognized until after misunderstandings have already begun. In the field of engineering, this differences not only affect the ability to work together, but can also affect the quality of the product that is being designed or built. Many conflicts in international teams can be led back to cultural differences, and the ability to recognize the causes of these conflicts, as well as the ability to rationalize different possibilities to solve these conflicts, is an essential part of being culturally competent.

This ability to recognize and respond appropriately to cultural differences can help lead to more successful working relationships. Intercultural competence is the ability to recognized one's own cultural patterns, and the ability to respond to other's cultural patterns in the best way possible for both sides, and to find way to reduce misunderstandings and conflicts for future cultural interactions.

After completing the course, the students should have the following competences and skills:

Professional competence and skills

o Basic knowledge and understanding of key theories, concepts and models in intercultural communication

o Work with other cultures on a common level of understanding, based on an analysis of commonalities and differences

o To be more effective in international environments

o Recognize how stereotypes and prejudice play into interactions between cultures

o The ability to differentiate between the different types of cultures

o Presentation and research skills

Methodological competence

The students are able to understand how cultures develop and change over time. They can look at certain behavior in a certain culture, and are able to recognize what cultural standards and dimensions are driving this behavior, thus being able to adapt their own behavior to be able to react appropriately. They are able to gain basic knowledge of the effectiveness of working with others on various levels and look for cultural patterns that work well with their own patterns through application of theory.

Personal and social competence

o The ability to understand one's own cultural patterns and attitude

o The possibility to increase one's own tolerance for cultural differences

o Increased cultural and emotional intelligence

Applicability in this and other Programs

All courses that have an international or intercultural aspect.

Entrance Requirements

English skills

Learning Content

- Defining what culture is
- Recognizing cultural patterns
- Responses to other cultures
- How culture functions
- Different layers of culture

- Cultural and emotional intelligence

Teaching Methods

Interactive teaching in a seminar environment / group exercises and discussions / case studies

Recommended Literature

Recommended reading (if possible in the most current edition):

- Hofstede, G. (2010). *Cultures and Organizations: Software of the Mind*. New York: Mcgraw-Hill.
- Lewis, R.D. (2005). *When Cultures Collide: Leading Across Cultures*. Boston, MA: Nicholas Brealey International.
- Meyer, E. (2016). *The Culture Map*. New York: Public Affairs
- Sowell, T. (2019). *Discrimination and Disparities*. New York: Basic Books
- Trompenaars, F. & Hampden-Turner, C. (2011). *Riding the Waves of Culture: Understanding Diversity in Global Business*. Boston, MA: Nicholas Brealey International.

ESE-13 COMPULSORY ELECTIVE SUBJECT OF A GENERAL ACADEMIC NATURE (AWP) I

Module code	ESE-13
Module coordination	Tanja Mertadana
Course number and name	ESE-13 Compulsory elective subject of a general academic nature (AWP) I
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	2
ECTS	2
Workload	Time of attendance: 30hours self-study: 30hours Total: 60hours
Weighting of the grade	2/210
Language of Instruction	German

Module Objective

The AWP subjects (electives) provide the students with the opportunity to gain knowledge and skills in other fields than their chosen field of study. Students can choose both instructor-led inhouse courses and courses of the Virtual University of Bavaria (vhb).

The contents of the courses cover the following areas:

- Languages
- Didactical-educational area
- Social sciences
- Psychological-sociological area
- Technical-scientific area
- Philosophical and socio-ethical area
- Business area

The students can choose their courses from the AWP-module according to their own preferences.

Applicability in this and other Programs

The module can also be chosen by students of other fields of study.

Entrance Requirements

For advanced language courses, students have to prove the required language skills (for example through successful completion of a lower level).

AWP subjects may not have thematic overlaps with the actual study course.

Learning Content

Please see the respective course descriptions for specific information on contents.

Teaching Methods

Seminar / exercises / class presentations / classroom pair/group work

Remarks

Please see the respective course descriptions for course-specific remarks.

Recommended Literature

Please see the respective course descriptions for literature references.

ESE-14 FOREIGN LANGUAGE II

Module code	ESE-14
Module coordination	Tanja Mertadana
Course number and name	ESE-14 Foreign Language II
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	2
ECTS	2
Workload	Time of attendance: 30hours self-study: 30hours Total: 60hours
Weighting of the grade	2/210
Language of Instruction	English

Module Objective

The modules Foreign Language II and IV aim to equip students with specialized language skills necessary for independent performance in a globalized energy systems engineering sector. As a specialty, the students can choose either an English course or vote between other languages such as Italian, Spanish, French or German as a Foreign Language.

Business English: Writing and communication skills
On completion of the module students will have achieved the following learning objectives:

Professional competencies

- Students will have an independent command of specialized business terminology relevant to the field of energy systems engineering. Command here refers to oral and written production as well as aural and reading comprehension.
- They will be in a position to deploy study skills such as close reading and coherent writing at a B2/C1-level and for use in niche tasks for the energy systems engineering sector.
- They will have gained substantial knowledge of B2/C1-level language registers ? both for formal study contexts and for semi-formal to formal professional contexts.

- They will have gained essential experience in presenting on topics related to business English. The goal here is to include niche knowledge in the protocols of a clearly structured, effectively delivered piece of public speaking.

Methodological competencies

- Students will have enhanced their abilities to structure the acquisition of specialized terminology and grammatical items and practiced ways to internalize new language that yield optimal learning benefits.
- They will have extended and refined their practical research skills in English by engaging in at least two research projects ? for example, by being asked to present on a discipline-specific topic in an individual or team presentation.

Social competencies

- Students will have gained valuable experience in training other personal effectiveness skills such as teamwork, integrity, and reliability.
- They will have reflected on the learning benefits derived from several immersion projects.

Other languages

Please see the respective course description for module objectives.

German as a Foreign Language

Please see the respective course description for module objectives.

Applicability in this and other Programs

The module can also be chosen by students of other fields of study.

Entrance Requirements

Business English

Writing and communication skills: The minimum entry-level requirement is a B2/C1-level of English according to the Common European Framework of Reference for Languages (CEFR).

Other languages

Please see the respective course description for entrance requirements.

German as a Foreign Language

Upon arrival, the student´s German language proficiency is tested by means of a placement test. Depending on the result, the students attend a course of the appropriate level. After the successful completion of a course, students attend an advanced German course in the following semester.

Learning Content

Business English: Writing and communication skills

Writing and communication skills in business, including a review and consolidation of the business topics dealt with in Foreign Language I (General Business English).

- review and consolidation of FL I topics
- job satisfaction
- success in business
- business correspondence
- meetings, negotiations and presentations
- international marketing
- working across cultures
- current business topics

Other languages

Please see the respective course description for specific information on contents.

German as a Foreign Language

Please see the respective course description for specific information on contents.

Teaching Methods

Instruction and learning methods focus on training the four cardinal language skills (speaking, listening, reading, and writing) and on enhancing professional and social competencies. They include group discussions and group projects, individual and team work (e.g. individual and group presentations), real- and role-playing, close reading and listening activities, grammar games, method of loci, running dictations, translations, peer feedback and review, work with learning stations, and various follow-up viewing and writing activities.

Study assignments will be set on a weekly basis.

Recommended Literature

Business English: Writing and communication skills

- Black, John, Hashimzade, Nigar & Myles, Gareth. *A Dictionary of Economics*. 5th ed. Oxford: OUP, 2017.
- Brook-Hart, Guy. *Business Benchmark*. 2nd ed.: Upper Intermediate. Cambridge: CUP, 2013.
- Business Spotlight: <www.business-spotlight.de>
- Butzphal, G., Maier-Fairclough, J. *Career Express. Business English B2*. Berlin: Cornelson, 2015.
- Cotton, D., Falvey, D. & Kent, S. *Market Leader Upper Intermediate*. Harlow: Pearson Longman, 2016.
- Doyle, Charles. *A Dictionary of Marketing*. 4th ed. Oxford: OUP, 2016.
- Duckworth, M., Turner, R. *Business Results Upper Intermediate*. Oxford: OUP, 2008.
- Law, Jonathan. *A Dictionary of Business and Management*. 6th ed. Oxford: OUP, 2016.
- McCarthy, Michael & O'Dell, Felicity. *Academic Vocabulary in Use*. Cambridge: CUP, 2016.
- Murphy, Raymond. *English Grammar in Use*. Klett Verlag, 2012.
- Rogers, Louis. *Skills for Business Studies*. Upper Intermediate. Oxford: OUP, 2012.

Other languages

Please see the respective course description for literature references.

German as a Foreign Language

Please see the respective course description for literature references.

ESE-15 APPLIED MATHEMATICS

Module code	ESE-15
Module coordination	Prof. Dr. Robert Feicht
Course number and name	ESE-15 Applied Mathematics
Lecturer	Prof. Dr. Robert Feicht
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional and methodological Competence
Based on the learning outcomes of Analytical Principles of Engineering (ESE-01) and Mathematics for Engineering (ESE-07), in this module students will develop an intuition for numbers, data and dimensions.

Knowledge

- Students know and understand different statistical methods based on their capability, assumptions, and limitations and select suitable methods appropriate to specific (research) problems.
- Students are familiar with the methodological foundations of empirical surveys and can apply them, for example, to empirical project work.

Skills

- From unstructured data students are able to gain relevant business and economic information and insights with the help of appropriate structuring, consolidation, graphical processing, and calculation of parameters.
- The corresponding analyses are made both manually and with the help of appropriate software packages.
- Students can critically interpret own and existing statistics from internal or external sources.

Personal Competence

Social competence

- Small work groups are defined to solve (research) problems and case studies. Close cooperation deepens student's social competences and fosters a team-oriented working style.
- Students can explain and defend their results in front of the class. They are able to explain their assessment of alternative courses of action and impugn the plausibility of using models. This interactive character of the lectures and tutorials strengthens the student's discussion and presentation skills in the academic context.

Autonomy

- Students can self-responsibly deal with unstructured data and select appropriate statistical models.
- Students are able to carry out their own empirical project work and derive recommended actions for the client.
- Students can handle complex work and study contexts independently and design them in an application-oriented way.
- Students are able to relate their acquired knowledge to other lectures and topics.

Applicability in this and other Programs

The learning outcomes of this module can be applied in any lectures and other study programs that require a basic understanding of statistical methods and handling of data.

Entrance Requirements

Analytical Principles of Engineering (ESE-01) and Mathematics for Engineering (ESE-07) are recommended.

Learning Content

1. Exploring and collecting data

- Displaying and describing categorical and quantitative data
- Correlation and linear regression

2. Modeling with probability

- Random variables and probability models

- The normal and other continuous distributions

Surveys and sampling

- Sampling distributions and confidence intervals for proportions

3. Inference for Decision Making

- Testing hypotheses about proportions
- Confidence intervals and hypothesis tests for means

Teaching Methods

Seminaristic teaching combining topic-oriented lectures, exercises, group work, group presentations, and classroom discussions.
Students are encouraged to actively participate in course by choosing appropriate didactical methods. They are strongly invited to discuss real-life problems and applications interactively throughout the lecture.
The seminar is accompanied by tutorials where calculation examples from the course are repeated for better understanding and examples similar to those used during course sessions are calculated.

Remarks

Teaching is supported by iLearn platform: Relevant course materials are made available online.

Recommended Literature

Basic literature

- Sharpe N.R., De Veaux R.D., Velleman P.F.; "Business Statistics"; 3rd global edition; Harlow: Pearson Education; 2015.
- Levine D.M., Stephan D.F., Szabat K.A.; "Statistics for Managers Using Micorosft Excel"; 8th global edition; Harlow: Pearson Education; 2017.

Supplementary literature

- Groebner D.F., Shannon P.W., Fry P.C.; "Business Statistics"; 10th global edition; Harlow: Pearson Education; 2018.
- Barrow M.; "Statistics for Economics, Accounting and Business Studies"; 7th edition; Harlow: Pearson Education; 2017.

ESE-16 ENERGY TECHNOLOGY

Module code	ESE-16
Module coordination	Prof. Dr. Rui Li
Course number and name	ESE-16 Energy Technology
Lecturer	Prof. Dr. Rui Li
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The students should understand and apply the basic principles of thermodynamics and applications for conventional energy technology.

Professional Competence

The students know the transport phenomenon in the engineering systems, and they could be able to apply thermodynamics laws to make analysis for different power cycles. By presenting a wealth of real-world engineering examples in this lecture, students are given a feel for how thermodynamics is applied in engineering practice. The students are able to develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.

Knowledge

Students are able to explain and reproduce the following basic theories, principles and practical applications:

- Physical concepts related to thermodynamics
- First law of thermodynamics for the energy conservation
- Properties of pure substances namely water and air, e.g. what is phase change
- Energy balance analysis of closed and open systems e.g. turbine, compressor
- Second law thermodynamics and increase of entropy principle

- How a steam or gas power station works
- How an automobile engine works
- Entropy and exergy analysis for power systems

Skills

- Communication skill directly to the minds of the engineers in a simple yet precise manner
- Ability to solve the thermal related problem with properties of substances and laws of thermodynamics
- Ability to have creative thinking and development of a deeper understanding and intuitive feel for thermodynamics

Personal Competence

Methodological competence

The students present and classify open system and close system thus apply different approaches to solve the problem. They are familiar with different working fluids thus apply corresponding approaches to do the correct calculations. They are capable of analysing conventional steam or gas power plants, and car engines.

Social / personal competence

The students are able to

- express their arguments in a comprehensible way within a group in the field of energy technology.
- reflect their knowledge, evaluate their own results and sustainable ideas

Applicability in this and other Programs

- IE-16: Energy Technology, BA Industrial Engineering at ECRI
- W-16 Fluid- und Energietechnik, BA Wirtschaftsingenieurwesen at THD
- D-4108 Technische Thermodynamik, BA Maschinenbau at THD
- 100-790 Thermodynamics, BA General Engineering at THD

And any other study programme that deals with thermodynamics.

Entrance Requirements

Analytical principles of engineering (ESE-01)

Mathematics for engineers (ESE-07)

Physics (ESE-04)

Learning Content

- Energy, energy transfer and energy analysis
- Properties of pure substances: enthalpy, latent heat, specific heat, steam table, equation of state, ideal gas
- Closed system and open system (control volume)
- Second law of thermodynamics, Carnot cycle, entropy, isentropic process
- Rankine cycle, Brayton cycle, Otto cycles, Diesel cycle
- Exergy, exergy analysis
- Components: boiler, chiller, steam turbine, gas turbine, cooling tower, etc.
- Advanced power generations: combined steam-gas power plants, cogeneration, super critical power plants, etc.

Teaching Methods

Seminaristic teaching / exercises / tutorials / home work

The presentation slides are available in the online platform ilearn, and all important contents will be repeatedly emphasized by script via a visualizer. Additional tutorials are offered bio-weekly with concrete problem solution process.

Recommended Literature

- Çengel Y. A., Boles M.A.: Thermodynamics: An Engineering Approach, 8th Edition, McGraw-Hill Education, New York, 2014
- Demirel Y.: Energy: Production, Conversion, Storage, Conservation, and Coupling, 2nd Edition, Springer-Verlag, London, 2016
- Langeheinecke K., Jany P., Thieleke G, Langeheinecke K., Kaufmann A..: Thermodynamik für Ingenieure, 9. überarb. u. erweiterte Auflage, Springer Vieweg, 2013

ESE-17 MEASUREMENT AND CONTROL ENGINEERING

Module code	ESE-17
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-17 Measurement and Control Engineering
Lecturers	Prof. Dr. Stefan Mátéfi-Tempfli
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

Students are able to explain and reproduce basic theories, principles, and methods related to:

- Fundamentals of measuring physical quantities
- Measuring methods, devices and instruments
- Metrology
- Measurement of electrical and non-electrical quantities
- Analysis and processing of measurement results
- Basic control systems as well as control engineering relationships
- Mathematical modelling of control systems
- Control systems analysis and design using various different methods

- Dynamic system behaviour in time and frequency domain, and can explain properties of first and second order systems
- Dynamics of simple control loops and interpret dynamic properties in terms of frequency response and root locus
- Nyquist stability criterion and the stability margins derived from it
- Role of the phase margin in analysis and synthesis of control loops

Skills

Students are capable of:

- Measurement and analysis of various physical signals and quantities
- Employing basic measurement instruments
- Evaluating problems of metrology and to apply methods for describing and processing of measurements
- Employing software tools for measurement, data analysis and processing
- Characterisation of controlled systems based on their static and dynamic responses
- Analysing using time and frequency response techniques
- Analysing absolute and relative stability of control systems
- Design and synthesising closed-loop controllers
- Using software tools (Matlab, Octave, etc.) for carrying out control system analysis

Personal Competence

Social competence

Students can work in small groups to jointly solve technical problems, and experimentally validate their controller designs.

Autonomy

- The students can reflect their knowledge and discuss and evaluate their own results
- Applying of theoretical concepts to practical applications

Applicability in this and other Programs

The module provides the background competences for all modules and study programs that require the fundamentals in the measurement and control fields.

Entrance Requirements

Fundamentals of Electrical Engineering (ESE-03), Physics (ESE-04) and Materials (ESE-11) are recommended.

Learning Content

The module provides introduction to fundamentals of measurement and control engineering focusing on:

- Measurement parameters, unit systems, standards
- Signals, characterisation, conversion
- Measuring methods and devices, basic instruments
- Evaluation of measurement results, errors and uncertainties
- Measurement of electrical quantities
- Measurement of non-electrical physical quantities
- Analog and digital procedures
- Reliability measurements
- Introduction to control systems
- Mathematical modelling of control systems
- Modelling of mechanical, electrical, fluid and thermal systems
- Transient and steady-state response analyses
- Control systems analysis and design, root-Locus method
- Frequency-response methods
- PID controllers and modified PID controllers
- Control systems analysis and design in state space

Teaching Methods

Lectures / exercises /tutorials / home work

PowerPoint presentation, whiteboard, document camera (visualiser) and additional lecture materials in iLearn

Recommended Literature

- Parthier R., Messtechnik: Grundlagen und Anwendungen der elektrischen Messtechnik, Ausgabe 8, Springer 2016
- A. Ferrero, D. Petri, P. Carbone, M. Catelani, Modern Measurements: Fundamentals and Applications, Wiley 2015
- Bartiromo R., De Vincenzi M., Electrical Measurements in the Laboratory Practice, Springer 2016
- Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Pear-son 2010
- Richard C. Dorf, Robert H. Bishop, Modern Control Systems, 13th Edition, Pearson 2017
- William S. Levine, The Control Handbook, 2nd Edition (3 volume set: Control System Fundamentals; Control System Applications; Control System Advanced Methods), CRC Press 2010

ESE-18 FUNDAMENTALS OF ENERGY ECONOMY

Module code	ESE-18
Module coordination	Prof. Dr. Sascha Kreiskott
Course number and name	ESE-18 Fundamentals of Energy Economy
Lecturer	Prof. Dr. Sascha Kreiskott
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

- Understand international Energy Regulation principles and scope.
- Understand fundamentals and scope of German Energy regulation.
- Develop judgement on business models with respect to regulation.
- Understand the layers of value creation in the energy business.
- Understand regulated processes in energy economy.
- Understand the role of the state in energy economy.
- Understand and apply the triangle of energy policy.

Applicability in this and other Programs

This module is obligatory for Energy Systems Engineering.

Entrance Requirements

None

Learning Content

- Market roles from the gas well to the lightbulb

- The energy policy triangle
- Monopolies
- The role of the state(s)
- Regulation
- Energy production
- Energy trading
- Energy procurement
- Energy transmission
- Energy distribution
- Energy sales
- Energy metering
- Regulated processes
- Global development
- Future of energy economics

Teaching Methods

- Seminaristic teaching
- Group work
- Student's presentations
- Applied problem solving

Remarks

None

Recommended Literature

- Konstantin, Panos: Praxisbuch Energiewirtschaft. Energieumwandlung, -transport und -beschaffung, Übertragungsnetzausbau und Kernenergieausstieg. 4., aktualisierte Auflage. Berlin: Springer Vieweg (VDI-Buch), 2017
- Löschel, Andreas; Rübbelke, Dirk; Ströbele, Wolfgang; Pfaffenberger, Wolfgang; Heuterkes, Michael: Energiewirtschaft. Einführung in Theorie und Politik. 4th

revised and updated new edition. Berlin: De Gruyter Oldenbourg (De Gruyter Studium), 2020

- Nersesian, Roy L.: Energy Economics. Markets, History and Policy. s.l.: Taylor and Francis, 2016
- Praxisbuch Energiewirtschaft: Energieumwandlung, -transport und -beschaffung, Übertragungsnetzausbau und Kernenergieausstieg.
- Zweifel, Peter; Praktiknjo, Aaron; Erdmann, Georg: Energy Economics. Theory and Applications. Berlin, Heidelberg, s.l.: Springer Berlin Heidelberg (Springer Texts in Business and Economics), 2017

ESE-19 PROJECT WORK I INCL. SCIENTIFIC WRITING

Module code	ESE-19
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-19 Project Work I incl. Scientific Writing
Lecturers	Prof. Dr. Tobias Bader Bernadette Busler Prof. Dr. Matthias Hümmer Prof. Dr. Sascha Kreiskott Prof. Dr. Stefan Mátéfi-Tempfli Wolfgang Schauer
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	6
ECTS	6
Workload	Time of attendance: 90hours self-study: 90hours Total: 180hours
Weighting of the grade	6/210
Language of Instruction	English

Module Objective

Module Objective

The Project Work I, II and III modules commit the practice oriented teaching concept of the ESE study programme by enabling the students to consolidate the theoretical knowledge acquired in different courses as well as to further develop practical skills in the field of energy systems and engineering areas.

By doing project work, the students should pass throughout the process of application of the learned knowledge: from theoretical to practice.

Professional Competence

With focusing on energy systems, the students are expected to have

Knowledge

- Apply theoretical knowledge into practice

- Know and understand the principles, processes and tools of project management.
- Students need to work themselves independently into a new work field / work area
- Assess interdisciplinary scientific research topics and applications

Skills

- Ability to apply systematic approaches to practical work.
- Ability to independently manage a project or part of a project.
- Ability to present and communicate results of the work in an oral presentation and a report.
- Practical skills in dependence of the project.
- Document scientific work and results, present and discuss them.

Personal Competence

Social competence

The students are able to

- Ability to work task-oriented in small mixed groups, leveraging different skills in the team.
- Ability to prioritize tasks.
- Ability to escalate problematic issues.
- Reflect their knowledge, exchange their own applications and sustainable ideas.
- Communicate and collaborate successfully and respectfully with others in a team

Autonomy

- Show ability to structure, plan and execute tasks around a new project.
- Show the willing to compromise during teamwork
- Show skills in issue management.
- Ability to re-plan if issues cannot be solved.

Applicability in this and other Programs

Specific for ESE study programme

Entrance Requirements

Successful passing of fundamental courses is recommended

Learning Content

- Introduction to methods in scientific work.
- Code of ethics of engineers, plagiarism.
- Working in teams in collaboration with others in a multicultural international environment.
- Team sizes varies (project dependent) in between 2 - 8 students.
- A given task need to be structured and executed.
- Task consist of (and might combine)
  - Technical design and planning
  - Specification design
  - Building of items/electronics
  - Software programming
  - Hardware programming
  - Numerical simulation
  - Technical implementation
- Processing and presenting scientific data and results
- Writing technical reports and scientific papers
- Oral presentation of the work and discussion of the results

Teaching Methods

Tutorials or pre-training could be provided
Independent and team work
Supervision by professors and lab engineers/technicians
Counseling if needed

Recommended Literature

- Kerzner Harold, Project Management: A Systems Approach to Planning, Scheduling and Controlling; 11th Ed., Wiley 2013
- Kate L. Turabian, A Manual for Writers of Research Papers, Theses, and Dissertations, 8th Ed., Chicago Press 2013

- Depending on the individual project

ESE-20 FOREIGN LANGUAGE III

Module code	ESE-20
Module coordination	Tanja Mertadana
Course number and name	ESE-20 Foreign Language III
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	4
Workload	Time of attendance: 60hours self-study: 60hours Total: 120hours
Weighting of the grade	4/210
Language of Instruction	English

Module Objective

The modules Foreign Language I and III aim to equip students with specialized language skills necessary for independent performance in a globalized energy systems engineering sector. In doing so, it strives to deepen students? relationship with the English language in business and technical settings so that they can implement the language effectively and efficiently as a practical communication tool. International students are recommended to take German as a Foreign Language up to the level of B2.

To this end, the module targets instruction of the four cardinal language skills (listening, reading, speaking, and writing) across a wide range of core topics related to energy systems engineering. Students also craft the content of their own learning through needs analyses and frequent immersive and self-directed projects.

It is essential to the module to optimize fluency and communication skills, as well as to cultivate a clear understanding of the finer points of textual meaning and meaning produced in dialogue with others. Through a variety of task-based speaking, listening and writing activities, students enhance their oral and aural production and expand their ability to produce clear, concise and coherent pieces of writing ? emails, reports, or expository paragraphs on processes. Particular emphasis will be placed on honing students? public speaking and team skills through work on a team presentation project for each course.

Technical English (C1)

On completion of the module, students will have achieved the following learning objectives:

Professional competences

- Students will have an independent command of specialized business and technical terminology relevant to the field of energy systems engineering. Command here refers to oral and written production as well as aural and reading comprehension.
- They will be in a position to deploy study skills such as close reading and coherent writing at a C1-level and for use in niche tasks for the energy systems engineering sector.
- They will have gained substantial knowledge of C1-level language registers ? both for formal study contexts and for semi-formal to formal professional contexts.
- They will have gained essential experience in presenting on topics related to business and technical English. The goal here is to include niche knowledge in the protocols of a clearly structured, effectively delivered piece of public speaking.

Methodological competences

- Students will have enhanced their abilities to structure the acquisition of specialized terminology and grammatical items and practiced ways to internalize new language that yield optimal learning benefits.
- They will have extended and refined their practical research skills in English by engaging in at least two research projects ? for example, by being asked to present on a discipline-specific topic in an individual or team presentation.

Social competences

- Students will have gained valuable experience in training other personal effectiveness skills such as teamwork, integrity, and reliability.
- They will have reflected on the learning benefits derived from several immersion projects.

German as a Foreign Language

Please see the respective course description for module objective.

Applicability in this and other Programs

The module can also be chosen by students of other fields of study.

Entrance Requirements

Technical English (C1)

The minimum entry-level requirement is B2/C1-level of English according to the Common European Framework of Reference for Languages (CEFR).

German as a Foreign Language

Upon arrival, the student´s German language proficiency is tested by means of a placement test. Depending on the result, the students attend a course of the appropriate level. After the successful completion of a course, students attend an advanced German course in the following semester.

Learning Content

Technical English (C1)

Course content is divided across a set of mandatory topics that the lecturer chooses and non-mandatory topics that students elect to work on.

Mandatory topics include, but are not restricted to the following:

- Mathematical operations and numbers
- Measurements and units
- Geometric forms
- Fundamentals of physics (e.g. forces)
- Materials and their properties
- Case study on an area related to technology/design/engineering
- Communication skills (e.g. presentations)
- Grammar items (e.g. passive vs active, tenses, conditionals)

Examples of non-mandatory topics include the following:

- Renewable energy
- E-mobility
- Basic electrical engineering
- Computing
- Geo-information systems
- Work safety

German as a Foreign Language

Please see the respective course description for specific information on contents.

Teaching Methods

Instruction and learning methods focus on training the four cardinal language skills (speaking, listening, reading, and writing) and on enhancing professional and social competencies. They include group discussions and group projects, individual and team work (e.g. individual and group presentations), real- and role-playing, close reading and listening activities, grammar games, method of loci, running dictations, translations, peer feedback and review, work with learning stations, and various follow-up viewing and writing activities.

Study assignments will be set on a weekly basis.

Recommended Literature

Technical English (C1)

- Astley, Peter, and Lewis Lansford. *Engineering 1: Student's Book*. Oxford: Oxford UP, 2013. Print.
- Bauer, Hans-Jürgen. *English for Technical Purposes.* Berlin: Cornelson, 2000. Print.
- Blockley, David. *Engineering: A Very Short Introduction.* Oxford: OUP, 2012. Print.
- Büchel, Wolfram, et. al. *Englisch-Grundkurs für technische Berufe*. Stuttgart: Klett, 2001. Print.
- engine: Englisch für Ingenieure. Darmstadt. <www.engine-magazin.de>
- Foley, Mark, and Diane Hall. *MyGrammarLab*. Harlow: Pearson, 2012. Print.
- Glendinning, Eric H., and Alison Pohl. *Technology 2*. Oxford: Oxford UP, 2008. Print.
- Glendinning, Eric H. and Norman. *Oxford English for Electrical and Mechanical Engineering. Oxford: OUP, 2001. Print.*
- Hollett, Vicki and John Sydes. *Tech Talk: Intermediate.* Oxford: OUP, 2010. Print.
- Ibbotson, Mark. *Cambridge English for Engineering.* Cambridge: Cambridge UP, 2008. Print.
- Lansford, Lewis, and Peter Astley. *Engineering 1*. Oxford: Oxford UP, 2013. Print.
- Möllerke, Georg. *Modern English for Mechanical Engineers.* Munich: Carl Hanser Verlag, 2010. Print.

o Puderbach, Ulrike, and Michael Giesa. *Technical English - Mechanical Engineering. Haan-Gruiten: Verl. Europa-Lehrmittel Nourney, Vollmer, 2012. Print.*

German as a Foreign Language

Please see the respective course description for literature references.

ESE-21 PROJECT WORK II INCL. SIMULATION AND DESIGN

Module code	ESE-21
Module coordination	Prof. Dr. Rui Li
Course number and name	ESE-21 Project Work II incl. Simulation and Design
Lecturers	Andreas Blüml Bernadette Busler Prof. Dr. Matthias Hümmer Markus Killinger Prof. Dr. Sascha Kreiskott Prof. Dr. Stefan Mátéfi-Tempfli Dr. Saeed Salarkheili Wolfgang Schauer
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	6
ECTS	6
Workload	Time of attendance: 90hours self-study: 90hours Total: 180hours
Weighting of the grade	6/210
Language of Instruction	English

Module Objective

Module Objective

The Project Work I, II and III modules commit the practice oriented teaching concept of the ESE study programme by enabling the students to consolidate the theoretical knowledge acquired in different courses as well as to further develop practical skills in the field of energy systems and engineering areas.

By doing project work, the students should pass throughout the process of application of the learned knowledge: from theoretical to practice.

Professional Competence

With focusing on energy systems, the students are expected to have

Knowledge

- Apply the theoretical knowledge into practice
- Know and understand the principles, processes and tools of project management.
- Students need to work themselves independently into a new work field / work area

Skills

- Ability to apply systematic approaches to practical work.
- Ability to independently manage a project or part of a project.
- Ability to present and communicate results of the work in an oral presentation and a report.
- Practical skills in dependence of the project.

Personal Competence

Social competence

The students are able to

- Ability to work task-oriented in small mixed groups, leveraging different skills in the team.
- Ability to prioritize tasks.
- Ability to escalate problematic issues.
- reflect their knowledge, exchange their own applications and sustainable ideas

Autonomy

- Show ability to structure, plan and execute tasks around a new project.
- Show the willing to compromise during teamwork
- Show skills in issue management.
- Ability to re-plan if issues cannot be solved.

Applicability in this and other Programs

Specific for ESE program, partial IE study program.

Entrance Requirements

Successful passing of fundamental courses e.g. physics, math, informatics

Learning Content

- Students work in teams on real engineering projects.
- Team sizes varies (project dependent) in between 2 - 8 students.
- A given task need to be structured and executed.
- Task consist of (and might combine)
  - Technical planning
  - Technical design
  - Computer-Aid design
  - Specification design
  - Building of items/electronics
  - Software programming
  - Hardware programming
  - Numerical simulation
  - Technical implementation

Teaching Methods

Tutorials or pre-training could be provided
Independent and team work
Supervision by professors and lab engineers/technicians
Counseling if needed

Recommended Literature

Depending on the individual project

ESE-22 RENEWABLE ENERGIES

Module code	ESE-22
Module coordination	Prof. Dr. Raimund Brotsack
Course number and name	ESE-22 Renewable Energies
Lecturers	Prof. Dr. Tobias Bader Prof. Dr. Raimund Brotsack
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

based on the analytical, mathematical and scientific foundations of engineering (physics and chemistry), students learn about the sources and selected technologies for the use of renewable energies. Students know the sources of regenerative energies (sun, gravitation, geothermal energy) and their engineering applications for the conversion of energy systems.The module develops competences and skills in the evaluation of potentials and options for technical applications of renewable energies.

Professional Competence

Knowledge

Understanding the fundamentals of energy, forms of energy and performance, climate change - greenhouse effect, processes in the atmosphere as well as the basics of bio-energy (plants, photosynthesis, chemical building blocks), the finite nature of fossil resources and the fundamentals for the evaluation of renewable energy systems - sustainability, selected technologies of renewable energy systems and energy storage research.

Skills

Students are able to use the acquired knowledge to describe, analyse, plan and apply the technologies in the field of the conversion of energy systems. Studends understand the challenges in the field of mostly fluctuating renewable energies as well

as the needs for innovating the energy grids as well as the needs in energy stoarage. Calculation examples enhance these skills.

Personal Competence

Methodological competence

The students improve the knowledge in the field of renewable forms based on real case studies. The students should be enabled to apply the acquired knowledge and to critically evaluate and inter-present subject-specific information on the basis of chemical and physical basics. Students develop a analytical system oriented way of thinking.

Social competence

- Students develop analytical thinking and learn to discuss technical aspects in an analytical objective manner.

Applicability in this and other Programs

IE-22 Renewable Energies, Bachelor Industrial Engineering at ECRI

Y-09 Regenerative Energien 1, Bachelor Umweltingenieurwesen at THD

W-17, Regenerative Energien und Stofftechnik, Bachelor Wirtschaftsingenieurwesen at THD

D-30 / D-7106 Regenerative Energie- und Stofftechnik, Bachelor Maschinenbau at THD

Entrance Requirements

Recommended requirements

- Analytical Principles of Engineering (ESE-01)
- Fundamentals of Electrical Engineering (ESE-03)
- Physics (ESE-04)
- Chemistry (ESE-05)
- Mathematics for Engineering (ESE-07)
- Energy Technology (ESE-16)

Learning Content

- Basics about energy / forms of energy / power

- Sources of renewable energies: solar energy - light, geothermal energy, gravitation - tides
- finiteness of fossil resources
- energy conservation and recovery
- energy storage and regulation
- water power, hydroelectric power stations, and storage power stations; tidal power stations; solar power: thermal solar power stations, photovoltaic energy conversion; wind power: operation of wind farms, solar chimney power stations; geo-thermal energy; bioenergy
- sector coupling between renewable energy resource and the electric grid
- ”Energiewende” in Germany
- energy supply in the near future and future perspectives

Teaching Methods

seminaristic teaching / exercises / tutorials / home work

Remarks

- Excursions to companies and/or research institutions serve the purpose of in-depth
- Transfer of practical knowledge or current research topics

Recommended Literature

- Godfrey Boyle; ?Renewable Energy?, 3rd. Edition, Oxford University Press; 13. September 2012 ISBN-10: 0199545332; ISBN-13: 978-0199545339
- Andy Mccrea; ?Renewable Energy?; neue Auflage; The Crowood Press Ltd; 18. Februar 2013 ISBN-10: 1847974791; ISBN-13: 978-1847974792
- Quaschnig V.: ?Regenerative Energie-systeme?, 9. Auflage; Hanser Verlag München; 8. 2015
- Wesselak, V.; Schabbach, T., et al.; ?Regenerative Energietechnik?; Springer Verlag Berlin Heidelberg, 2te Auflage 2013
- Kaltschmitt, M., Streicher, W., Wiese, A. (eds.) Renewable Energy: Technology, Economics and Environment, Springer. Heidelberg, 2007
- Harvery, D., Energy and the New Reality 2: Carbon-Free Energy Supply, Eathscan, Lon-don/Washington, 2010

- Boyle, G. (ed.), Renewable Energy: Pow-er for a Sustainable Future, 2nd Edition, Open University Press, Oxford, 2004
- Struchtrup, H., Thermodynamics and Energy Conversion, Springer. Heidelberg, 2014
- Demirel, Y., (2nd ed.), Energy: Produc-tion, Conversion, Storage, Conservation, and Coupling, 2016

ESE-23 SUSTAINABILITY

Module code	ESE-23
Module coordination	Prof. Dr. Robert Feicht
Course number and name	ESE-23 Sustainability
Lecturer	Prof. Dr. Robert Feicht
Semester	4
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Using selected examples out of the field of Sustainable Develpment Goals and based on the fundamentals of natural science and renewable energies, students learn about various aspects of sustainable product and process evaluation.

Professional Competence

Knowledge

Students acquire in-depth knowledge of the material cycles in nature with the aim of deriving strategies for sustainable development. In addition, students learn about the effects of the emission of climate-relevant greeenhouse gases from transport, trade and industry as well as climate-induced changes in nature and society. They will understand the basic strategies in the field of material and energy resource saving and efficient behaviour. The module is rounded off by an introduction to certification systems for the uniform evaluation of sustainable professional actions.

Skills

The acquired knowledge forms the basis for an understanding of the challenges associated with the transformation towards a sustainable industrial society. Practical examples enhance the knowledge. Students are able to analyse and evaluate technologies and processes regarding the SDG´s especially in the field of affordable an clean energy, responsible consumption and production and climate action.

Personal Competence

Methodological competences

After participating in this module, the students will be able to critically analyze subject-specific information on energy and material efficiency while evaluating climate relevance and to observe the principles of sustainable development when developing new technologies, production processes and procedures.

Social competence

- Ability to work problem/solution-oriented in small mixed groups, learning and broadening teamwork abilities.
- Ability to communicate with peers about a complex (and yet unknown) topic and find a joint approach to solving it.

Applicability in this and other Programs

(Modul "Sustainability" planed in other faculties at THD)

Entrance Requirements

- Chemistry (ESE-05)

Learning Content

Environment an Climate

- Definition of sustainability
- History of sustainability (Club of Rome, Bruntlandt, Agenda 21, Millennium Development Goals, Climate Change, …)
- Chemisty of the atmosphere
- climate changing gases and greenhouse effect
- Environmental protection and nature conservation

Certification systems

- The systematic approach of the Sustainable Development Goals (SDGs)
- The United Nations Global Compact, the ISO 26000 and the OECD Guidelines for Multinational Enterprises as international frameworks for the assessment of sustainable development
- The GRI Sustainability Reporting Standards – Its guidelines and practical experience
- The VDI 4605 Evaluation of sustainability – a guidance for engineers

- Standards and legal requirements
  - Environmental Management Systems (Environmental Product Declaration, Cradle to Cradle, DGNB, BREEAM, LEED, EMAS)
  - energy saving regulation, Product laws relevant to energy consumption, Greenhouse Gas Emissions Trading Act, building products regulation, Closed Substance Cycle and Waste Management Act

Excursion, workshop, teamwork

The students experience, reflect and evaluate personally natural circulatory systems as a basis for transferring these experiences with regard to sustainability education in the further course of studies to resource-oriented technical circulatory systems and to evaluate the desired and undesirable effects of influencing these systems in a new, appropriate manner, case-based project work in intercultural and international teams.

Teaching Methods

seminaristic teaching / exercises / tutorials / home work / excursion (tactile, psychological and practical experience in the framework of the "Education for Sustainable Development" methodology, followed by reflection)

Remarks

Excursion to the Youth Education Institute and the Environmental Education Station Windberg

Recommended Literature

- Sustainable development goals (http://www.un.org/sustainabledevelopment/climate-change-2/)
- IPCC ? perspecives on climate change and sustainability: (https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter20.pdf)
- Michael Blowfield; ?Business and Sustainability (Englisch)? publischer: Oxford University Press; Auflage: New, 8. Februar 2013 ; ISBN-10: 0199642982; ISBN-13: 978-0199642984
- R. Friedel, E. A. Sindler (Hrsg.); ?Zertifizierung als Erfolgsfaktor ? Nachhaltiges Wirtschaften mit Vertrauen und Transparenz?; Springer-Verlag, 2016 / ISBN: 3658097019, 9783658097011
- VDI 4605 Evaluation of sustainability. Düsseldorf 2017.
- Global Reporting Initiative, G4 Sustainability Reporting Guidelines. Implementation Manual. Amsterdam 2013.

- UN Global Compact, Guide to Corporate Sustainability. Shaping a Sustainable Future. New York 2014
- DIN EN ISO 14001
- ENEV
- EVPG
- KrW-/AbfG
- EU *Emissions Trading* Scheme (EU ETS) - Greenhous gas emission trading act

ESE-24 PLANT ENGINEERING

Module code	ESE-24
Module coordination	Prof. Dr. Markus Hainthaler
Course number and name	ESE-24 Plant Engineering
Lecturer	Prof. Dr. Markus Hainthaler
Semester	4
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Qualification Goals

Within this course, students acquire the ability to understand the technological design and operation of plants from the equipment installed, over the plant´s specific energy demands and energy transfer, up to their optimization. Additionally, they are able to sketch and discuss their design ideas with other specialists by help of the most common types of flowsheets. This creates the basis for the reliable design and operation of any plant the students are concerned in their future engineer´s life.

Professional and methodological Competences

Knowledge

From previous semesters, the students have already been taught the fundamentals of natural sciences, engineering and economics in individual lectures. Within this module, all these separate competences are combined in order to design, operate and optimize whole plants and production systems. Its content commences with the mathematical description of fluid flows and heat transfer mechanisms between the single units of the plant, continues with modes of operation and detailed visualization of the production process, and finishes with the most important aspects of selecting the appropriate plant equipment. All these topics are practiced with real-life problems in a broad variety of production systems and applications.

Skills

After completing this module, the students will be able to understand, analyse and evaluate plants and production systems regarding their actual set-up, their actual productivity, and their possible future optimization in these concerns. They can identify weaknesses of construction, layout and assembly in order to advise specialists to improve the function and efficiency of the plant. Additionally, they are able to communicate and visualize the production systems by creating flow-sheets in different depth of detailedness.

Personal and social Competences

The solution of the tasks given both in the lecture and the exam requires students´ self-responsible and self-directed working style. Herein, the concepts of all module topics have to be applied to new problems, analyzed regarding their relevance, and evaluated in order to yield a reliable result.

Applicability in this and other Programs

The learning outcomes of this module can be applied in any lectures and other study programmes that deal with the visualization, design, operation, maintenance and optimization of plants and production systems.

Entrance Requirements

Successful completion of the following modules is recommended:

Analytical Principles of Engineering (ESE-01),

Fundamentals of Electrical Engineering (ESE-03),

Physics (ESE-04), Chemistry (ESE-05),

Mathematics for Engineering (ESE-07),

Materials and Design (ESE-11),

Energy Technology (ESE-16)

Learning Content

Fluid Mechanics

- Fluid characterization: classes of fluids, rheology, pressure
- Fluid statics: submerged surfaces, buoyancy
- Fluid kinematics (introduction): Lagrangian vs. Eulerian model, material derivative, flow visualization, unsteady flow
- Conservation of material / energy: continuity equation, Bernoulli equation

- Internal / external flow: velocity profiles, boundary layers

Heat Transfer

- Heat transfer mechanisms: conduction, convection, radiation
- Thermal resistance networks
- Heat exchangers: characterization, analytical description

Production System Engineering

- Flow-sheeting: block diagram, process flow diagram (PFD), piping and instrumentation diagram (PID), process control engineering (PCE)
- Friction losses: pressure drop, cavitation, NPSH, total head
- Duty point curves: system curve, pump curve, efficiency optimization
- Plant equipment: types of pumps / valves, pipe selection
- Modes of operation

Intended Lab Sessions

- Determination of the rheological behaviour of different fluids in a rotational viscosimeter
- Determination of the thermal conductivity of different metals
- Verification of the Stephan-Boltzmann Law
- Determination of the convective heat transfer coefficient
- Determination of the flow properties for laminar / turbulent flow
- Determination of the pipe friction factor for laminar / turbulent flow
- Determination of energy losses of piping instrumentation
- Behaviour / properties of a centrifugal pump

Teaching Methods

The lecture focuses on seminaristic teaching, but also applies detailed practical exercises based on the theoretical background. The key content is denoted in a written script via visualizer, while the supplemental content is conveyed via slide and video presentations. All material is uploaded to an online learning portal (iLearn). The students are strongly invited to discuss real-life problems and applications interactively throughout the lecture. Lab sessions on state-of the-art experimental set-ups and lab equipment support the students in getting hands-on

experience and thus transfer their theoretical knowledge into practice. Tutorials will be offered on demand.

Remarks

Although the lecture is taught in English, the focus lies on the application of German norms and standards in plant engineering (some selected German literature inevitable). In order to substantiate the lessons learnt, it is planned to offer an excursion to an industrial production site.

Recommended Literature

- Y.A. Cengel, J.M. Cimbala "Fluid Mechanics - Fundamentals and Applications", McGraw Hill, 4th edition 2018
- Y.A. Cengel, A.J. Ghajar "Heat and Mass Transfer - Fundamentals and Applications", McGraw Hill, 5th edition 2015
- R. Sinnott, G. Towler "Chemical Engineering Design", Butterworth-Heinemann, 5th edition 2009
- R. Chhabra, V. Shankar "Coulson and Richardson´s Chemical Engineering Vol. 1A: Fluid Flow - Fundamentals and Applications", Butterworth-Heinemann, 7th edition 2018
- K.A. Solen, J.N. Harb "Introduction to Chemical Engineering", Wiley, 5th edition 2011
- C.J. Geankoplis, A.A. Hersel, D.H. Lepek "Transport Processes and Separation Process Principles", Prentice Hall, 5th edition 2018
- E. Ignatowitz "Chemietechnik", Europa-Lehrmittel, 12th edition 2015
- W. Bohl, W. Elmendorf "Technische Strömungslehre", 15th edition 2014
- H.D. Baehr, K. Stephan "Wärme- und Stoffübertragung", Springer, 9th edition 2016
- G. Vetter "Rotierende Verdrängerpumpen für die Prozesstechnik", Vulkan, 1st edition 2006
- W. Eifler, E. Schlücker, U. Spicher, G. Will "Küttner Kolbenmascinen", Vieweg, 7th edition 2009
- various German and international norms and standards (announced in the lecture)

ESE-25 COMPULSORY ELECTIVE SUBJECT OF A GENERAL ACADEMIC NATURE (AWP) II

Module code	ESE-25
Module coordination	Tanja Mertadana
Course number and name	ESE-25 Compulsory elective subject of a general academic nature (AWP) II
Semester	4
Duration of the module	1 semester
Module frequency	Annually
Course type	elective course
Level	Undergraduate
Semester periods per week (SWS)	2
ECTS	2
Workload	Time of attendance: 30hours self-study: 30hours Total: 60hours
Weighting of the grade	2/210
Language of Instruction	English

Module Objective

The AWP subjects (electives) provide the students with the opportunity to gain knowledge and skills in other fields than their chosen field of study. Students can choose both instructor-led inhouse courses and courses of the Virtual University of Bavaria (vhb).

The contents of the courses cover the following areas:

- Languages
- Didactical-educational area
- Social sciences
- Psychological-sociological area
- Technical-scientific area
- Philosophical and socio-ethical area
- Business area

The students can choose their courses from the AWP-module according to their own preferences.

Applicability in this and other Programs

The module can also be chosen by students of other fields of study.

Entrance Requirements

For advanced language courses, students have to prove the required language skills (for example through successful completion of a lower level).

AWP-subjects may not have thematic overlaps with the actual study course.

Learning Content

Please see the respective course descriptions for specific information on contents.

Teaching Methods

Seminar / exercises / class presentations / classroom pair/group work

Remarks

Please see the respective course descriptions for course-specific remarks.

Recommended Literature

Please see the respective course descriptions for literature references.

ESE-26 COMPULSORY ELECTIVE I*

Module code	ESE-26
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-26 Compulsory Elective I*
Semester	4
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The Compulsory Elective I, II and III modules provide the students with the opportunity to address specialized topics, other than the mandatory courses of the main field of study, topics that are broadening by that their field of knowledge and skills in these areas.

Several courses will be offered for each Compulsory Elective module upon availability and attendance interest of students from the following pool:

- Advanced Fluid and Energy Technology
- Computer Simulation in Energy and Resource Economics
- Energy and Ressource Efficiency
- Energy Economics Policy
- Entrepreneurship
- Finance and Accounting
- Health Safety Environment
- International Energy Regulations
- Modelling Theory
- MRO-Strategies and Process Reliability

- Operational Processes
- Principles of Energy Systems Management
- Process Engineering
- Process Optimization
- Safety and Security in Energy Systems
- Strategic Planning and Project Management
- Technology and Intellectual Property Rights Management

The students have to chose, according to their own preferences one course for each of the Compulsory Elective modules from the list of courses offered.

Applicability in this and other Programs

The module is primarily intended for the Bachelor of Energy Systems Engineering but it can also be chosen by students of other fields of study.

Entrance Requirements

Please see the respective course descriptions for specific information on prerequisites.

Learning Content

Please see the respective course descriptions for specific information on content.

Teaching Methods

Please see the respective course descriptions for specific information on didactic methods employed.

Remarks

Please see the respective course descriptions for course-specific remarks.

Recommended Literature

Please see the respective course descriptions for literature references.

ESE-27 FOREIGN LANGUAGE IV

Module code	ESE-27
Module coordination	Tanja Mertadana
Course number and name	ESE-27 Foreign Language IV
Semester	4
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	2
ECTS	2
Workload	Time of attendance: 30hours self-study: 30hours Total: 60hours
Weighting of the grade	2/210
Language of Instruction	English

Module Objective

The modules Foreign Language II and IV aim to equip students with specialized language skills necessary for independent performance in a globalized energy systems engineering sector. As a specialty, the students can choose either an English course or vote between other languages such as Italian, Spanish, French or German as a Foreign Language.

Presentation skills for technical purposes (C1)
On completion of the module students will have achieved the following learning objectives:

Professional competencies

- Students will have an independent command of specialized technical terminology relevant to the field of energy systems engineering. Command here refers to oral and written production as well as aural and reading comprehension.
- They will be in a position to deploy study skills such as close reading and coherent writing at a C1-level and for use in niche tasks for the energy systems engineering sector.
- They will have gained substantial knowledge of C1-level language registers ? both for formal study contexts and for semi-formal to formal professional contexts.

- They will have gained essential experience in presenting on topics related to technical English. The goal here is to include niche knowledge in the protocols of a clearly structured, effectively delivered piece of public speaking.

Methodological competencies

- Students will have enhanced their abilities to structure the acquisition of specialized terminology and grammatical items and practiced ways to internalize new language that yield optimal learning benefits.
- They will have extended and refined their practical research skills in English by engaging in at least two research projects ? for example, by being asked to present on a discipline-specific topic in an individual or team presentation.

Social competencies

- Students will have gained valuable experience in training other personal effectiveness skills such as teamwork, integrity, and reliability.
- They will have reflected on the learning benefits derived from several immersion projects.

Other languages
Please see the respective course description for module objective.

German as a Foreign Language

Please see the respective course description for module objective.

Applicability in this and other Programs

The module can also be chosen by students of other fields of study.

Entrance Requirements

Presentation skills for technical purposes (C1):

The minimum entry-level requirement is C1-level of English according to the Common European Framework of Reference for Languages (CEFR).

Other languages:

Please see the respective course description for entrance requirement.

German as a Foreign Language:

Upon arrival, the student´s German language proficiency is tested by means of a placement test. Depending on the result, the students attend a course of the appropriate level. After the successful completion of a course, students attend an advanced German course in the following semester.

Learning Content

Presentation skills for technical purposes (C1)

Communication skills for technical contexts, including a review and consolidation of the topics dealt with in Foreign Language III (Technical English (C1)), with a special focus on presentations.

- technical presentations, discussions and negotiations
- commercial correspondence on technical topics
- renewable energies and sustainability
- product and project management
- complaint management, service and repair
- the future of cars
- case study on an area related to technology/design/engineering
- review of some grammar items

Other languages

Please see the respective course description for specific information on contents.

German as a Foreign Language

Please see the respective course description for specific information on contents.

Teaching Methods

Instruction and learning methods focus on training the four cardinal language skills (speaking, listening, reading, and writing) and on enhancing professional and social competencies. They include group discussions and group projects, individual and team work (e.g. individual and group presentations), real- and role-playing, close reading and listening activities, grammar games, method of loci, running dictations, translations, peer feedback and review, work with learning stations, and various follow-up viewing and writing activities.

Study assignments will be set on a weekly basis.

Recommended Literature

Presentation skills for technical purposes (C1)

- Bonamy, David. *Technical English 4*. Harlow, England: Pearson Education, 2011. Print.
- Dunn, Marian, David Howey, and Amanda Ilic. *English for Mechanical Engineering in Higher Education Studies Coursebook. Reading: Garnet Education, 2010. Print.*
- engine: Englisch für Ingenieure. Darmstadt. <www.engine-magazin.de>
- Ibbotson, Mark. *Professional English in Use Engineering Technical English for Professionals. Cambridge: Cambridge UP, 2009. Print.*
- Inch. *Inch, das neue Sprachmagazin für technisches English.* <inchbyinch.de>
- Möllerke, Georg. *Modern English for Mechanical Engineers.* Munich: Carl Hanser Verlag, 2010. Print.

Other languages

Please see the respective course description for literature references.

German as a Foreign Language

Please see the respective course description for literature references.

ESE-28 INTERNSHIP INCLUDING PLV SEMINARS

Module code	ESE-28
Module coordination	Prof. Dr. Sascha Kreiskott
Course number and name	ESE-28 Internship including PLV seminars
Semester	5
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	30
ECTS	30
Workload	Time of attendance: 0hours self-study: 900hours Total: 900hours
Weighting of the grade	30/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

- Understand the processes and procedures of a company.
- Understand the requirements in the professional live.
- Understand basic techniques around application preparation, presentation and communication.

Skills

- Ability to apply gained knowledge in a professional/commercial setting.
- Ability to access new work areas.
- Ability to evaluate real-life problems and to design and apply solution approaches.
- Ability to evaluate and explain the achievements and learnings.

Personal Competence

Social competence

- Ability to integrate into teams with more experienced professionals.

Autonomy

- Succeed professionally in a new environment.
- Learn how to autonomously achieve results.
- Learn how to gain a position in industry.

Applicability in this and other Programs

Applicable in all technical programs with practical semester.

Entrance Requirements

For internship: 90 ECTS and PLV1 finalized.

For PLV2: Internship finalized.

Learning Content

PLV 1 seminars: Seven workshops, thereof four in the personal competence area and three in the professional competence area (to be selected from the overall course offering of the International Office and Career Services).

Workshops include:

- Application skills
- Interview training
- Communication training
- Presentation trainings
- MS-Office trainings
- Intercultural training
- Job skills
- Pyramidal communication

PLV 2 seminar: One week of training in advanced presentation techniques and communication. Each student has to give a 20 minute presentation on the content of his internship.

Internship: 18 week full time internship in a field which is related to industrial engineering. The internship can be planned with any German company or a research institute. Student's who want to do the internship in an international context need to get approval by the Practical Responsible Professor. The Practical Responsible Professor decides on whether a job is accepted for the internship.

Teaching Methods

Seminaristic workshops.

Practical work.

Recommended Literature

Depends on subject of internship.

ESE-29 POWER GRID TECHNOLOGIES

Module code	ESE-29
Module coordination	Wolfgang Schauer
Course number and name	ESE-29 Power Grid Technologies
Lecturer	Dr. Saeed Salarkheili
Semester	6
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The students have basic general knowledge and basic expertise in the field of power grid technologies. Besides electrical power grids, the module focuses on other forms of power grids. The students are able to practically apply the knowledge and to solve simple till moderate problems.

Professional Competence

Knowledge

Students are able to explain and reproduce basic theories, principles, and methods related to:

- Fundamentals of power systems
- Electrical power distribution and transmission
- District Heating
- Gas Networks
- Smart grids

Skills

Students are capable of:

- Applying theoretical concepts to practical applications
- Applying general methods for the analysis of power grids
- Calculating parameters of simple power grids
- Understanding the structure, functionality and circuit diagrams of essential power engineering equipment
- Analysing and design of power networks

Personal Competence

Social competence

Students can analyse and solve problems in small groups, can compare theoretical results with experiments and discuss it within the group. Present the related topics to professionals and discuss and argue for the obtained results.

Autonomy

The students are able to acquire skills outside their lectures form literature as well as and can solve problems by their own. They are able to relate their acquired knowledge to other lectures.

Applicability in this and other Programs

The module provides basic competences for other courses of different study programs that require power grid technology fundamentals

Entrance Requirements

Fundamentals of Electrical Engineering (ESE-03)

Electrical and Power Engineering (ESE-09)

Learning Content

The module provides introduction to the fundamentals of power grid technologies:

- Electric Power System Fundamentals
- Power Distribution and Transmission, System Performance and Operation
- Power Transformers and Substations
- Power switching components
- Heating distribution
- Gas distribution

- Integration of distributed renewable energy systems
- Monitoring and control of power grids, SCADA
- Smart Grids

Practical laboratory experimental sessions are enabling the students to consolidate the theoretical knowledge as well as to develop practical skills in addressing and handling power grid technologies.

Teaching Methods

Seminaristic teaching / exercises / home work

Whiteboard, PowerPoint presentation, document camera (visualiser) and additional lecture materials in iLearn

Experiments in small groups using training material that relays on professional computer-based experimentation system where multimedia combines cognitive and hands-on training units into a comprehensive unified concept enabling students to consolidate theoretical building blocks and practical skills for a maximum learning effectiveness.

Recommended Literature

- R. Flosdorff, G. Hilgarth: Elektrische Energieverteilung, 9. Auflage. Springer/Vieweg, Wiesbaden 2005
- Morteza Zare Oskouei, Behnam Mohammadi-Ivatloo: Integration of Renewable Energy Sources Into the Power Grid Through PowerFactory. Springer International Publishing, 2020
- Meysam Qadrdan,
  Muditha Abeysekera, Jianzhong Wu, Nick Jenkins, Bethan Winter: The Future of Gas Networks. Springer Nature Switzerland AG, 2020
- Yatish T. Shah: Modular Systems for Energy Usage Management. Taylor & Francis Group, 2020
- Bernd M. Buchholz, Smart Grids : Fundamentals and Technologies in Electric Power Systems of the future, 2nd. Ed., Springer 2020

ESE-30 ENERGY STORAGE

Module code	ESE-30
Module coordination	Wolfgang Schauer
Course number and name	ESE-30 Energy Storage
Lecturer	Dr. Saeed Salarkheili
Semester	6
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The students have basic general knowledge and basic expertise in the field of energy storage. Besides the storage of electrical energy, the module focuses on the storage of other forms of energy. The students are able to practically apply the knowledge and to solve simple till moderate problems.

After completing the module, students have achived the following learning outcomes:

Professional Competence

Knowledge

Students are able to explain and reproduce basic theories, principles, and methods related to:

- Fundamentals and applications of energy storage in electricity networks
- Principles of energy storage (electrical, chemical, mechanical)
- Selection of storage technologies
- Stabilizing of electrical networks using storage systems
- Planing and implementing of storage systems

Skills

Students are capable of:

- Applying theoretical concepts to practical applications
- Applying scientific principles underpinning the operation of energy storage systems
- Analysing existing energy networks for upgrading energy storage systems
- Dimensioning energy storage systems as a means of resolving the intermittency of renewable energy sources such and solar and wind
- Using novel and applied storage principles to design energy storage systems
- Calculating parameters of energy storage systems

Personal Competence

Social competence

Students can analyse and solve problems in small groups, can compare theoretical results with experiments and discuss it within the group. Present the related topics to professionals and discuss and argue for the obtained results.

Autonomy

The students are able to acquire skills outside their lectures form literature as well as and can solve problems by their own. They are able to relate their acquired knowledge to other lectures.

Applicability in this and other Programs

The module provides basic competences for other courses of different study programs that require energy storage fundamentals

Entrance Requirements

- Fundamentals of Electrical Engineering (ESE-03)
- Chemistry (ESE-05)
- Electrical and Power Engineering (ESE-09)

Learning Content

The module provides introduction to energy storage addressing:

- Principles of energy storage (electrical, chemical, mechanical)
- Electrical Energy Storage: Capacitors and Supercapacitors (SC), Superconducting Magnetic Energy Storage (SMES)

- Chemical Energy Storage
- Thermal Energy Storage: Sensible Heat Storage, Latent Heat Storage
- Mechanical Energy Storage: Pumped Hydro Storage (PHS), Flywheel Energy Storage (FES), Compressed Air Energy Storage, Solid Mass Gravitational Energy Storage (SMGES)
- Electrochemical Energy Storage: Fundamentals of electrochemistry and batteries, Secondary Batteries, Flow Batteries and Redox Flow Batteries, Hybrid Flow Batteries (HFB)
- Thermochemical Energy Storage
- Thermomechanical Energy Storage

Practical laboratory experimental sessions are enabling the students to consolidate the theoretical knowledge as well as to develop practical skills in addressing and handling engergy storage systems.

Teaching Methods

Seminaristic teaching / exercises / home work

Whiteboard, PowerPoint presentation, document camera (visualiser) and additional lecture materials in iLearn

Experiments in small groups using training material that relays on professional computer-based experimentation system where multimedia combines cognitive and hands-on training units into a comprehensive unified concept enabling students to consolidate theoretical building blocks and practical skills for a maximum learning effectiveness.

Recommended Literature

- Michael Sterner, Ingo Stadler: Energiespeicher ? Bedarf, Technologien, Integration. Springer Berlin Heidelberg, 2017
- Michael Sterner, Ingo Stadler: Handbook of Energy Storage. Springer Verlag, 2019
- Odne Stokke Burheim: Engineering energy storage. Elsevier, Academic Press, 2017
- Graham Palmer, Joshua Floyd: Energy Storage and Civilization, A Systems Approach. Springer Verlag, 2020

ESE-31 SMART SYSTEMS AND TECHNOLOGIES

Module code	ESE-31
Module coordination	Wolfgang Schauer
Course number and name	ESE-31 Smart Systems and Technologies
Lecturers	Dr. Saeed Salarkheili Wolfgang Schauer
Semester	6
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The students have basic general knowledge and basic expertise in the field of automation systems and smart system. The students are able to practically apply the knowledge and to solve simple till moderate problems.

After completing the module, students have achived the following learning outcomes:

Professional Competence

Knowledge

Students are able to explain and reproduce basic theories, principles, and methods related to:

- Characteristic components of an automation system and have good understanding of their interaction
- Characteristic components for measuring, distributing and switching energy
- Characteristic components for smart grids and their interaction
- Systematical analysis of automation tasks in energy industry and smart buildings and are able to use them
- Logical design of industrial and smart building automation

- Networks protocols and IP networks
- Network structures and network components
- Principles of field bus systems and how to use them
- Smart Factory technologies and Industry 4.0
- Big Data aspects of industrial and factory business systems

Skills

Students are capable of:

- Applying theoretical concepts to practical applications
- Analysing complex automation tasks and complex networks
- Dimensioning industrial and building networks
- Dimensioning instrumentation and components for smart grids
- Implementing communication using different field buses and network protocols
- Comparing methods for process modelling and select an appropriate method for actual problems
- Developing programs for programmable logic controllers
- Reflecting their knowledge in practical applications and document the results of their work

Personal Competence

Social competence

Students can analyse and solve problems in small groups, can compare theoretical results with experiments and discuss it within the group. Present the related topics to professionals and discuss and argue for the obtained results.

Autonomy

The students are able to acquire skills outside their lectures form literature as well as and can solve problems by their own. They are able to relate their acquired knowledge to other lectures.

Applicability in this and other Programs

The module provides basic competences for other courses of different study programs that require smart systems and technologies

Entrance Requirements

- Informatics for Engineering I (ESE-02)
- Informatics for Engineering II (ESE-08)

Learning Content

The Smart Systems and Technologies module is focusing to the following aspects:

- Introduction to automation technology and smart grid technology
- Automation of energy processes and buildings
- Basic Programming Principles of PLCs
- Analog and Digital Input/Output Configuration
- Measuring, storing and distributing of energy
- Industrial automation networks
- Field bus systems
- IP-based networks
- Network structures and components
- Concepts of Industry 4.0
- Smart Factory and Smart Building technologies
- Big Data, Cyber-Physical Systems
- Internet of Things

Practical computer-based and experimental sessions are further enabling the students to consolidate the theoretical knowledge as well as to develop practical skills in implementing and testing network and automation applications.

Thematic workshop on automation topics, onsite or at an industrial partner are further developing collaborative problem-solving skills and cooperation dexterity with qualified personnel at technical level.

Teaching Methods

Seminaristic teaching / exercises / home work

Whiteboard, PowerPoint presentation, document camera (visualiser) and additional lecture materials in iLearn.

Experiments in small groups using training material that relays on professional computer-based experimentation system where multimedia combines cognitive and hands-on training units into a comprehensive unified concept enabling students to

consolidate theoretical building blocks and practical skills for a maximum learning effectiveness.

Workshop on automation and networking where students work individually and in groups on practical examples and on assignments implementing various automation and networking tasks.

Recommended Literature

- Stamatios Manesis: Introduction to industrial automation, CRC Press, Taylor & Francis 2018
- Bernd Michael Buchholz, Zbigniew Styczynski: Grundlagen und Technologien der elektrischen Netze der Zukunft, VDE Verlag, 2018
- Hans-Jürgen Appelrath, Petra Beenken, Ludger Bischofs, Mathias Uslar: IT-Architekturentwicklung im Smart Grid, Springer-Verlag, 2012
- Quoc-Tuan Vien: Network Design, Modelling and Performance Evaluation, Institution of Engineering & Technology, 2018
- Boca Raton: Industrial communication technology handbook, CRC Press Taylor & Francis 2017
- Alasdair Gilchrist: Industry 4.0: the industrial internet of things, Apress 2016
- Arun Solanki, Anand Nayyar: Green building management and smart automation, Hershey, 2020
- Computer-based training material and experimentation systems on Photovoltaik, UniTrain Course and Systems, Lucas-Nülle - https://www.lucas-nuelle.com/

ESE-32 COMPULSORY ELECTIVE II*

Module code	ESE-32
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	Basics in CAD/CAM ESE-32 Compulsory Elective II*
Lecturer	Stefan Holfelder
Semester	4, 6
Duration of the module	2 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The Compulsory Elective I, II and III modules provide the students with the opportunity to address specialized topics, other than the mandatory courses of the main field of study, topics that are broadening by that their field of knowledge and skills in these areas.

Several courses will be offered for each Compulsory Elective module upon availability and attendance interest of students from the following pool:

- Advanced Fluid and Energy Technology
- Computer Simulation in Energy and Resource Economics
- Energy and Ressource Efficiency
- Energy Economics Policy
- Entrepreneurship
- Finance and Accounting
- Health Safety Environment
- International Energy Regulations
- Modelling Theory

- MRO-Strategies and Process Reliability
- Operational Processes
- Principles of Energy Systems Management
- Process Engineering
- Process Optimization
- Safety and Security in Energy Systems
- Strategic Planning and Project Management
- Technology and Intellectual Property Rights Management

The students have to chose, according to their own preferences one course for each of the Compulsory Elective modules from the list of courses offered.

Applicability in this and other Programs

The module is primarily intended for the Bachelor of Energy Systems Engineering but it can also be chosen by students of other fields of study.

Entrance Requirements

Please see the respective course descriptions for specific information on prerequisites.

Learning Content

Please see the respective course descriptions for specific information on content.

Teaching Methods

Please see the respective course descriptions for specific information on didactic methods employed.

Remarks

Please see the respective course descriptions for course-specific remarks.

Recommended Literature

Please see the respective course descriptions for literature references.

ESE-33 PROJECT WORK III INCL. LAB WORK IN ENERGY SYSTEMS

Module code	ESE-33
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-33 Project Work III incl. Lab Work in Energy Systems
Lecturers	Bernadette Busler Prof. Dr. Matthias Hümmer Markus Killinger Prof. Dr. Sascha Kreiskott Prof. Dr. Stefan Mátéfi-Tempfli Dr. Saeed Salarkheili Wolfgang Schauer
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	8
ECTS	10
Workload	Time of attendance: 120hours self-study: 180hours Total: 300hours
Weighting of the grade	10/210
Language of Instruction	English

Module Objective

Module Objective

The Project Work I, II and III modules commit the practice oriented teaching concept of the ESE study programme by enabling the students to consolidate the theoretical knowledge acquired in different courses as well as to further develop practical skills in the field of energy systems and engineering areas.

By doing project work, the students should pass throughout the process of application of the learned knowledge: from theoretical to practice.

Professional Competence

With focusing on energy systems, the students are expected to have

Knowledge

- Apply the theoretical knowledge into practice
- Know and understand the principles, processes and tools of project management.
- Students need to work themselves independently into a new work field / work area

Skills

- Ability to apply systematic approaches to practical work.
- Ability to independently manage a project or part of a project.
- Ability to present and communicate results of the work in an oral presentation and a report.
- Practical skills in dependence of the project.

Personal Competence

Social competence

The students are able to

- Ability to work task-oriented in small mixed groups, leveraging different skills in the team.
- Ability to prioritize tasks.
- Ability to escalate problematic issues.
- reflect their knowledge, exchange their own applications and sustainable ideas

Autonomy

- Show ability to structure, plan and execute tasks around a new project.
- Show the willing to compromise during teamwork
- Show skills in issue management.
- Ability to re-plan if issues cannot be solved.

Applicability in this and other Programs

Specific for ESE study program

Entrance Requirements

Successful passing of fundamental courses

Learning Content

- Students work in teams on real engineering projects.
- Team sizes varies (project dependent) in between 2 - 8 students.
- A given task need to be structured and executed.
- Task consist of (and might combine)
  - Technical planning
  - Technical design
  - Computer-Aid design
  - Specification design
  - Building of items/electronics
  - Software programming
  - Hardware programming
  - Numerical simulation
  - Technical implementation
- Practical laboratory experimental sessions in the field of energy systems that are enabling the students to develop practical skills in addressing and handling related systems and equipment as well as to consolidate theoretical building blocks and practical skills for a maximum learning effectiveness.

Teaching Methods

Tutorials or pre-training could be provided
Independent and team work
Supervision by professors and lab engineers/technicians
Counseling if needed

Recommended Literature

Depending on the individual project

ESE-34 GRID MANAGEMENT

Module code	ESE-34
Module coordination	Prashant Pant
Course number and name	ESE-34 Grid Management
Semester	7
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Primary goal of the module is to familiarize the students with the latest grid management technologies, covering from the basics of power flow in the distribution grids and their analysis through the current challenges in the power distribution to the application of advanced mathematical methods for optimization and smart grid management and control. A special focus lies on the integration of renewable energy sources, storage, and the charging of electric vehicles.

Secondary objective is to prepare the student to take a responsible role as future engineer in the application-oriented activities of the energy grid management, develop team orientation and creativity.

In this module, the students will gain the following competencies:

Professional Competence

Knowledge

After this module, students

- Know major aspects of grid managment. This includes the major types of electricity grids and their operational methods
- Understand the key problems and solutions for grid managment
- Are able to explain the challenges ahead for grid management, especially with the increase of distributed generation

Skills

After this module, students are capable of

- Applying mathematical methods for analyzing electricity grids
- Developing ideas for grid management solutions
- Reflecting on changes in the electricity grid and the need for innovative solutions in grid management
- Analysing challenges of electricity systems with the integration of renewable energies, storage, and electric vehicles

Personal Competence

Social competence

- Learn or work with others, get verbal and written information and exchange ideas.

Autonomy

- Reflect on, evaluate, pursue and take responsibility for your own and externally set learning and work goals

Applicability in this and other Programs

Bachelor of Energy Systems Engineering

Entrance Requirements

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Learning Content

- Definition Grid Management
- Overview of grids
  - Transmission grids
  - Distribution grids
- Basics of power flow
- Current challenges in electricity grids
- The need for smart grids
- Extension / repetition of optimization theory
- Electricity markets

- Optimal Power Flow
- Unit Commitment
- Storage Operation
- Control theory introduction
- Primary, Secondary, and Tertiary reserve mechanism
- Distribution grids
- Renewable energy and electric vehicle integration
- Sector coupling
- Microgrids
- Local Market Places
- SCADA Systems

Teaching Methods

- Seminaristic teaching.
- Group work and role game.
- Student's presentations.
- Applied problem solving.

Recommended Literature

- Kundur: Power System Stability and Control, McGraw-Hill 1994
- Boca Raton, Power system stability and control, CRC Press 2007
- Stephen Boyd and Lieven Vandenberghe, Convex Optimization, Cambridge University Press 2004
- Hussein Mouftah, Melike Erol-Kantarci, Smart Grid: Networking, Data Management, and Business Models, CRC Press 2019

ESE-35 SITE PLANNING AND GIS

Module code	ESE-35
Module coordination	Anna Marquardt
Course number and name	ESE-35 Site Planning and GIS
Semester	7
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 60hours virtual learning: 30hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	German

Module Objective

By doing site planning and GIS, the students should pass throughout the process of application of the learned knowledge: from theoretical to practice.

Professional Competence

Knowledge

The students are able to explain and reproduce basic theories, principles and methods:

- methods of site assessment
- location models
- indicator evaluation/selection
- process automation
- geoprocessing tools

Skills

Students are able to...

- apply theoretical concepts to practical applications

- application of scientific principles of site planning
- analysis and evaluation of existing data sets
- selection and configuration of suitable geoprocessing tools and parameters into a model

Personal Competence

Social Competence

Students can analyse and solve problems in small groups, compare theoretical results with practical examples and discuss them in the group. They can present the related topics to experts and discuss and argue the results achieved.

Autonomy

Students are also able to acquire skills outside of lectures and can solve problems independently. They are able to look at problems in a networked way and to apply their acquired knowledge to other issues.

Applicability in this and other Programs

The learning outcomes of this module can be applied in any lectures and other study programs that require a basic understanding of modelbuilding and handling of data.

Entrance Requirements

- ESE-B-18 Fundamentals of Energy Economy
- ESE-B-22 Renewable Energies

Learning Content

Working on smaller subtasks of site planning during the semester in isolated exercises (e.g. site analysis for the planning of energy plants or charging points, ...).

Included in these excercises:

- working and preparing the data: acquisition, evaluation, selection
- modelbuilder: indicators of site planning & geoprocessing tools

Combing the individual excercices into an overall site planning for a given theme.

Teaching Methods

Seminaristic teaching combining topic-oriented lectures, exercises, group work, discussions and presentations of work in progress.
Students are encouraged to actively participate in course by choosing appropriate

didactical methods.
Teaching is supported by iLearn platform: relevant course materials are made available online.

Remarks

The students make a significant contribution to the lessons through presentations. The procedure and results of the thematic subtasks are presented.

Recommended Literature

Current literature and data sources based on the subtasks (books, media, internet resources) will be announced in the lecture.

ESE-36 COMPULSORY ELECTIVE III*

Module code	ESE-36
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-36 Compulsory Elective III*
Semester	7
Duration of the module	1 semester
Module frequency	Annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The Compulsory Elective I, II and III modules provide the students with the opportunity to address specialized topics, other than the mandatory courses of the main field of study, topics that are broadening by that their field of knowledge and skills in these areas.

Several courses will be offered for each Compulsory Elective module upon availability and attendance interest of students from the following pool:

- Advanced Fluid and Energy Technology
- Computer Simulation in Energy and Resource Economics
- Energy and Ressource Efficiency
- Energy Economics Policy
- Entrepreneurship
- Finance and Accounting
- Health Safety Environment
- International Energy Regulations
- Modelling Theory
- MRO-Strategies and Process Reliability

- Operational Processes
- Principles of Energy Systems Management
- Process Engineering
- Process Optimization
- Safety and Security in Energy Systems
- Strategic Planning and Project Management
- Technology and Intellectual Property Rights Management

The students have to chose, according to their own preferences one course for each of the Compulsory Elective modules from the list of courses offered.

Applicability in this and other Programs

The module is primarily intended for the Bachelor of Energy Systems Engineering but it can also be chosen by students of other fields of study.

Entrance Requirements

Please see the respective course descriptions for specific information on prerequisites.

Learning Content

Please see the respective course descriptions for specific information on content.

Teaching Methods

Please see the respective course descriptions for specific information on didactic methods employed.

Remarks

Please see the respective course descriptions for course-specific remarks.

Recommended Literature

Please see the respective course descriptions for literature references.

ESE-37 BACHELOR THESIS

Module code	ESE-37
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	ESE-7104 Bachelor thesis incl. final presentation ESE-7105 Bachelor Seminar
Semester	7
Duration of the module	1 semester
Module frequency	Annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	14
ECTS	15
Workload	Time of attendance: 60hours self-study: 30hours virtual learning: 360hours Total: 450hours
Weighting of the grade	15/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

- The students are in possession of necessary knowledge of theories and methods for addressing complex engineering problems in the field of energy systems
- The students can explain in depth the relevant approaches and terminologies in one or more areas of their subject
- The students can position a research task in their subject area in its context, describe and critically assess it
- Students are able to explain and apply basic principles and methods for planning and structuring project work as well as adequate communication technics employed in professional collaborations and for dissemination of results

Skills

- Students are able to independently address complex scientific problems
- The students are able to select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question

- Applying the methods, they have acquired during their studies the students can analyze problems, make decisions on technical issues, and develop solutions.
- The students can take up a critical position on the findings of their own research work from a specialized perspective.
- The students are able to work alone and in teams, structure and plan their work, communicate appropriately with partners, present the addressed problem and discuss the obtained results

Personal Competence

Social competence

- Students can outline a scientific problem for an expert audience accurately, understandably and in a structured way both in written and oral communication
- Deal with issues competently in an expert discussion and answer them in a manner that is appropriate for the audience

Autonomy

- The students are able to apply the techniques of scientific work comprehensively on their own to connect knowledge and material necessary for working on an engineering or research problem
- The students are capable of structuring on their own an extensive work in task and process them within a specified time frame
- The students are capable of individually presenting their work and results in a scientific style employing appropriate communication techniques

Applicability in this and other Programs

Bachelor of Energy System Engineering

Entrance Requirements

According to the study and examination regulations of the Bachelor of Energy Systems Engineering study programme, Section 12 - Bachelor's dissertation (2):

Students who have attained 150 ECTS credit points can enrol for the bachelor module and thesis.

Learning Content

The module provides a seminaristic training in communication techniques and the possibility for the students to demonstrate their ability to independently apply the knowledge and skills acquired during the academic studies to address a larger engineering problem. Concrete topics and problems will be independently addressed

and developed based on scientific research methods and documented within a written final Bachelor thesis.

The seminar is focusing on:

- Writing in academic style with clarity and accuracy
- Referencing with accuracy and plagiarism
- Giving effective presentations
- Time management and harmony of the presentation
- Dimensions and levels of communication
- Nonverbal communication and emotions
- Body language and facial expressions
- Impact of your nonverbal communication on others
- Culture and its impact on communication

At the end of the bachelor project the students should make oral presentations applying the communication competencies gained in the applied communication techniques part of the module. The presentation should address their bachelor project work and its outcomes.

The Bachelor thesis can be written in English or German language.

Teaching Methods

Self-reliant working / seminaristic teaching / individual and team working

Recommended Literature

Thesis:

- Eco U., Schick W., Wie man eine wissenschaftliche Abschlussarbeit schreibt, 13. Auflage, UTB 2010
- Ebel Hans Friedrich, Bliefert Claus, Bachelor-, Master- und Doktorarbeit, 4. Auflage, Wiley-VCH Verlag 2009
- Charles Lipson, How to Write a BA Thesis: A Practical Guide from Your First Ideas to Your Finished Paper, Chicago Press 2005
- As well as depending on the selected topic and area of expertise

Applied communication techniques:

- Diana Hopkins, Tom Reid, The Academic skills handbook: your guide to success in writing, thinking and communicating at university, Sage 2018
- Frank Garten, The international manager: a guide for communicating, cooperating, and negotiating with worldwide colleagues, CRC Press 2015

ESE-ELECTIVE ADVANCED FLUID AND ENERGY TECHNOLOGY

Module code	ESE-Elective
Module coordination	Prof. Dr. Rui Li
	Energy
Course number and name	Advanced Fluid and Energy Technology
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	Annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	German

Module Objective

Module Objective

The students should understand and apply the principles of advanced fluid dynamics, heat transfer, together with thermodynamics ? and their integrated applications for energy technology.

Professional Competence

The students know and understand the transport phenomenon in the engineering systems, and they could be able to apply advanced fluid dynamics, heat transfer to make analysis for flow systems. By presenting a wealth of real-world engineering examples in this lecture, students are taught a feel for how these physical principles is applied in engineering practice. The students are able to develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.

Knowledge

Students are able to explain and reproduce the following basic theories, principles and practical applications:

- Have the concept of dimensional homogeneity and the Buckingham theorem of dimensional analysis

- Derive the continuity equationnd and the applications
- Discuss several approximations of the Navier-Stokes equation and provides example solutions
- Extends fluid flow analysis to compressible flow using Mach number
- Analytically solve a mostly relatively simple heat conductions problem
- Understand general spects of forced convection with the local friction coefficient and Nusselt number
- Derive the governing equations of natural convection, evaluate Nusselt number
- Have fundamental concepts of computational fluid dynamics, as tools to complex problem

Skill

- Communication skill directly to the minds of the engineers in a simple yet precise manner
- Ability to towards a clear understanding and firm grasp of the principles of fluid dynamics and heat transfer
- Ability to have creative thinking and development of a deeper understanding and intuitive feel for fluid dynamics and heat transfer

Personal Competence

The students present and classify the phenomena and energy systems thus apply different approaches to solve the problem. They are familiar with different analysis methods thus apply corresponding approaches to do the correct calculations. They are capable of analysing e.g. internal or external flow, the heat exchangers.

Social competence

Students are able to

- express their arguments in a comprehensible way within a group in the field of energy technology.
- reflect their knowledge, exchange their own results and sustainable ideas

Autonomy

Students can

- understand and tell the significance of different advanced energy systems
- Furthermore, they are able to evaluate these topics.

Applicability in this and other Programs

The module provides advanced competences for other courses of different study programs that require fluid dynamics and related computer simulation e.g. Project Work II, III, etc.

Entrance Requirements

Knowledge of elementary mathematics and physics, in particular thermodynamics is recommended.

Learning Content

- Dimensional analysis and modeling, dynamics similarity and the method of repeating variables
- Differential analysis of fluid flow, the continuity equation, the Cauchy equation and a short overview to biofluids
- Approximate solutions of navier-stokes equations
- Compressible flow, expansion waves, normal and oblique shock waves and chocked flow
- Numerical methods in heat conduction, heat conductions problem involving simple geometries and simple boundary using e.g. the finite difference method, the finite element method
- Internal and external forced convection by external means e.g. pump or fan
- Natural convection with vertical, horizontal and inclined plates, cylinders and spheres.
- Computational fluid dynamics and numerical heat transfer, commercial or open source codes

Teaching Methods

Seminaristic teaching / exercises / home work Whiteboard, simulations tutorial, document camera (visualizer) and additional lecture materials in iLearn.

Remarks

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Recommended Literature

- Cengel Y., Heat and Mass Transfer: Fundamentals and Applications5th Edition, McGraw-Hill Education, New York, 2014

- Cengel Y., Fluid Mechanics: Fundamentals and Applications, 4th edition, McGraw-Hill Education, New York, 2014
- Böirth L., Bschorer S., Technische Strömungslehre, 9. Aufl., Vieweg & Teubner, Wiesbaden, 2012
- Marek R., Nitsche K. Praxis der Wärmeüber-tragung, Hanser, München, 2012
- Çengel Y.,Thermodynamics: An Engineering Approach, 8th Edition, McGraw-Hill Education, New York, 2014

ESE-ELECTIVE COMPUTER SIMULATION IN ENERGY AND RESOURCE ECONOMICS

Module code	ESE-Elective
Module coordination	Prof. Dr. Rui Li
Course number and name	Computer Simulation in Energy and Resource Economics
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Module Objective

Professional Competence

Knowledge

- Students are able to explain models and simulations as part of many disciplines of in the energy field and resource field.
- They are able to reproduce the interdisciplinary aspects of typical modeling and simulation techniques e.g. matlab, ansys and Netlogo.
- They are proficient in simulation studies from problem formulation to modeling, simulation, verification and validation.
- They are proficient to perform parameter survey on a basis of a simulation model.

Skills

- perform comprehensive and interdisciplinary simulation studies to assess the simulation results and to critically evaluate the quality of the simulation results.

Personal Competence

Social competence

The students are able to

- express their modeling thinking (make things simple) in a comprehensible way within a group in the field of energy systems
- reflect their knowledge, exchange their own applications and sustainable ideas

Autonomy

Students can

- Interpret and learn the new unknown various model and simulation tools in a reasonable way.
- Develop the couplings between energy and resources further with the consideration of economics

Applicability in this and other Programs

ESE-26 Compulsory Elective I*

Entrance Requirements

Knowledge of elementary mathematics, economics, physics and informatics

Learning Content

- Introduction to modeling and simulation
- Matlab programming including Simulink
- Modeling of thermodynamical processes using ansys
- Modelling of resource economics using NetLogo
- Coupling between codes using interfaces

Teaching Methods

in the IT lab: seminaristic teaching / exercises / home work, document camera (visualizer) and additional lecture materials in iLearn.

Remarks

no

Recommended Literature

- lecture scripts
- user guides and help documentations of the various codes

ESE-ELECTIVE ENERGY AND RESSOURCE EFFICIENCY

Module code	ESE-Elective
Module coordination	Prof. Dr. Rui Li
Course number and name	Energy and Ressource Efficiency
Lecturer	Prof. Dr. Roland Augustin
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The students should understand and apply the basic principles of the energy conversions, the technical aspects of energy and resource management. They will learn that the energy manager nowadays has many opportunities to reduce utility costs by using energy procurement strategies.

Professional Competence

- The students can understand the least expensive and most efficient in this endeavor is energy conservation, rather than more energy production.
- The core concept: improving energy efficiency increases the productivity of basic energy resources by providing the needs of society with less energy.
- Implement some efficiency analysis in some certain energy devices.
- Energy conversion and distribution during the power generations.
- Interactions between: energy procurement, raw material procurement, energy consumption and production planning.
- Technical aspects of energy and resource management: lifecycle costs, investment costs, manufacturing costs.
- Energy management strategies in different countries.

Personal Competence

Methodological competence

The students are able to present and classify different calculation methods for different apparatus and machinery drives in the industry. They know the methods to improve the efficiency across all sectors of the economy. They are familiar with energy and resource management systems and standards.

Personal and social competences

- Access and evaluate the ways of energy conservation in its various forms that are the cornerstones of a successful national energy strategy.
- Communication skills to argue that the best way to protect the environment and reduce global warming is a higher energy efficiency with a reasonable energy management.

Applicability in this and other Programs

BA Industrial Engineering at ECRI

BA Wirtschaftsingenieurwesen at THD

Mechanical Engineering

And any other study programme that deals with energy technology, energy management standards.

Entrance Requirements

- Energy Technology (ESE-16)
- Renewable Energies (ESE-22)
- Sustainability (ESE-23)
- Plant Engineering (ESE-24)

Learning Content

- Core concepts and basic points on resource and energy efficiency and management
- Basic calculations of energy efficiency for different power cycles
- Conventional fossil resources distributions, transport and utilization
- Efficiency and irreversible losses of apparatus and machinery drives: pumps, fans, blowers, compressors, filters, dryers, stirrers, heat exchangers, conveyors, indoor air quality

- Process analysis and optimization: energy benchmarks, pinch analysis, heat integration, evaluation of alternative technology
- Introductions of energy and resource management systems: e.g. DIN EN 16001, VDI Guidelines 4661, technical benefits of energy management systems
- Project definition and implementation, operational responsibilities, employees: training and motivation

Teaching Methods

seminaristic teaching / exercises / tutorials / home work

Recommended Literature

- Harvery, D., Energy and the New Reality 2: Carbon-Free Energy Supply, Eathscan, 2010
- Yogi Goswami D.: Handbook of Energy Efficiency and Renew-able Energies, CRC Press, 2016
- Struchtrup, H., Thermodynamics and Energy Conversion, Springer, Heidelberg,2014
- Demirel, Y., Energy: Production, Conversion, Storage, Conservation, and Coupling, 2016

ESE-ELECTIVE ENERGY ECONOMICS POLICY

Module code	ESE-Elective
Module coordination	Prof. Dr. Matthias Huber
Course number and name	Energy Economics Policy
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Primary goal of the module is to develop the students' understanding of energy economics and how it permeates political and economic realities throughout the world. In this, the module covers the foundations for this understanding, i.e. concepts of microeconomics, policy, as well as specific regions that exemplify this preeminent role.

Secondary objective of this module is to make students aware of their influence as shapers of the energy technologies in crucial political and economic issues, develop team orientation and a responsible mindset.

Students should also improve their presentation skills and enhanve their scientific writing methods which serves also as a preperation for the Bachelor's thesis.

In this module, the students will gain the following competencies:

Professional Competence

Knowledge

After this module, students

- Know how the basic concepts of microeconomics apply to the energy sector
- Understand the importance of major energy markets for different parts of the world as well as international cooperation between countries
- Are able to reproduce examples for important energy policies

- Are able to explain the connection of overall goals in energy economics to policies in environment, climate, and R&D
- Know the significance of energy economics for overall economic growth

Skills

After this module, students are capable of

- Analyzing basic microeconomic questions for energy markets
- Applying their knowledge on energy markets to developing a simple strategy for an example of electrification in the developing world
- Reflecting on the interaction of economic policy and political action around the world
- Conducting research, giving a presentation, and writing a scientific report

Personal Competence

Social competence

- Learn or work with others, get verbal and written information and exchange ideas.
- Participate in a group. Accept and express general suggestions and criticism. Act and react appropriately to the situation in oral and written communication.
- Participate in a group and offer selective support. Help shape the learning or working environment, design processes and present results in a target-oriented manner.
- Help shape the work in a group and its learning or working environment and offer continuous support. Justify processes and results. Communicate comprehensively about facts.
- Plan and design work processes cooperatively, also in heterogeneous groups, guide others and support them with sound learning advice. Also present complex, interdisciplinary issues in a structured, targeted and addressee-related manner, taking into account the interests and needs of addressees in a forward-looking manner

Applicability in this and other Programs

Bachelor of Energy Systems Engineering

Entrance Requirements

- Basic mathematical concepts
- Fundementals of Energy Economy

Learning Content

- Introduction: Energy Economics Policies
- Overview of energy markets
- Important methods from microeconomics
- International politics introduction
- Oil markets and policies
  - Focus topic: OPEC and Oligopolies
- Gas markets and policies
  - Focus topic: Russia and Europe, Middle East gas markets
- Electricity markets and policies
  - Focus topic: Electricity market design
- Policy measures for electrification in development countries
  - Case studies and comparison of policies
- Environmental and Climate Policies
- R&D Policies, Learning curves
- Energy and Economic Growth

Teaching Methods

Seminaristic teaching.
Group work.
Student's presentations.
Applied problem solving.

Recommended Literature

- Steven Stoft: Power system economics designing markets for electricity
- Energy Economics: Concepts, Issues, Markets and Governance, by Subhes C. Bhattacharyya.
- Global Energy Politics, Thijs Van de Graaf

ESE-ELECTIVE ENTREPRENEURSHIP

Module code	ESE-Elective
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	Entrepreneurship
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	Undergraduate level
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Module objectives

The students should learn an efficient and goal-oriented entrepreneurship management. Efficient and goal-oriented entrepreneurship management makes it necessary to implement structured business processes and use up-to-date, demand-oriented start-up methodologies.
Entrepreneurial Management understands how to identify, analyze and seize opportunities, turn big/smart data into business opportunities and take full advantage of the digital transformation, manage stakeholders and communication, surf on diversity and do business in emerging markets, manage growth and understand the fundamentals of business rules.
The students learn a systematic process of envisioning a desired future, and translating this vision into broadly defined goals or objectives and a sequence of steps to achieve them.

Applicability in this and other Programs

Bachelor Energy Systems Engineering

Entrance Requirements

no

Learning Content

The module considers business start-ups as a process from the identification and evaluation of opportunities, the procurement of relevant human and monetary resources, the establishment of an organization, to the management of a start-up. In addition to theories and concepts, relevant practical methods to build a start-up team and procedures are taught to support this process.

Teaching Methods

Seminaristic teaching / exercises / team work / home work

Remarks

no

Recommended Literature

- Blank, S., *The startup owner's manual: The step-by-step guide for building a great company*. BookBaby, 2012
- Brown, T., *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. Harper Collins, 2009
- Clark, T., Osterwalder, A., & Pigneur, Y.,. *Business model you: a one-page method for reinventing your career*. John Wiley & Sons, 2012
- Doz, Y. L., & Kosonen, M., *Fast strategy: How strategic agility will help you stay ahead of the game*. Pearson Education, 2008
- Drucker, P., *Innovation and entrepreneurship*. Routledge, 2014
- Maurya, A., *Running lean: iterate from plan A to a plan that works*. O?Reilly Media, Inc., 2012
- Osterwalder, A., & Pigneur, Y., *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons, 2010
- Porter, M. E., & Advantage, C., *Creating and Sustaining Superior Performance*. New York, NY: Free press, 1985
- Ries, E., *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create RadicallySuccessful Businesses*. Crown Publishing Group, 2011
- Wirtz, B. W. *Business Model Management: Design - Instrumente - Erfolgsfaktoren von Geschäftsmodellen*. Gabler Verlag, 2013
- Zollenkop, M., *Geschäftsmodellinnovation: Initiierung eines systematischen Innovationsmanagements für Geschäftsmodelle auf Basis lebenszyklusorientierter Frühaufklärung*. Springer-Verlag, 2009

ESE-ELECTIVE FINANCE AND ACCOUNTING

Module code	ESE-Elective
Module coordination	Prof. Dr. Robert Feicht
Course number and name	Finance and Accounting
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional and methodological Competence
Students develop a thorough understanding of basic accounting principles, can classify the functions of investment and financing into the operational sequences and apply their instruments.

Knowledge

- Students know and understand the essential features of financial and management accounting as well as the legal foundations and components of bookkeeping and accounting.
- Students have a deep understanding of financial reports as a basic skill for business studies.
- Students are familiar with central methodological foundations and instruments of investment and financing, can explain them and apply them to typical operational problems.

Skills

- Students are able to evaluate the impact of business transactions on financial accounting. In particular, students have a deep understanding of the effectiveness/neutrality of business transactions on financial statements, and execute accounting transactions independently.

- Students are able to prepare and analyze financial statements and management reports.
- In their professional practice, students can identify problem situations that require investment and financing solutions. They are able to independently find adequate solutions for these situations, to evaluate them and to question them critically.

Personal Competence

Social competence

- Students develop communication skills that are supported by tasks and case studies. They are familiar with the essential terminology of financial accounting and communicate about basic problems with other participants using the appropriate technical terms.
- Students are encouraged to discuss critical/controversial topics in an objective atmosphere.
- Students can present their analyses in a goal-oriented and application-oriented manner matching the target audience.
- Students are able to work problem/solution-oriented in small mixed groups, learning and broadening teamwork abilities.

Autonomy

- Students will be able to solve complex problems independently with application-related, fundamental knowledge of bookkeeping and accounting.
- Students know and understand the limitations, assumptions and problems of methods and instruments of investment and financing in a specific context. Students can independently choose and employ suitable valuation approaches for the respective task.
- Students are able to relate their acquired knowledge to other lectures and topics.

Applicability in this and other Programs

The learning outcomes of this module can be applied in any lectures and other study programs that require a basic understanding of accounting concepts and the functions of investment and financing.

Entrance Requirements

Analytical Principles of Engineering (ESE-01), Mathematics for Engineering (ESE-07), and Applied Mathematics (ESE-15) are recommended.

Learning Content

1. Accounting: information for decision making
2. Basic financial statements
3. The accounting cycle
4. Understanding financial statements and cash flow
5. Time value of money
6. Valuing stocks and bonds
7. Capital Budgeting

Teaching Methods

Seminaristic teaching combining topic-oriented lectures, exercises, group work, group presentations, and classroom discussions.
Students are encouraged to actively participate in course by choosing appropriate didactical methods. They are strongly invited to discuss real-life problems and applications interactively throughout the lecture.
The seminar is accompanied by tutorials where calculation examples from the course are repeated for better understanding and examples similar to those used during course sessions are calculated.

Remarks

Teaching is supported by iLearn platform: Relevant course materials are made available online.

Recommended Literature

Basic literature

- Williams J.R., Haka S.F., Bettner M.S., Carcello J.V.; "Financial & Managerial Accounting: The Basis for Business Decisions"; 17th internat. edition; New York: McGraw-Hill Education; 2015.
- Ross S.A., Westerfield R.W., Jordan B.D.; "Essentials of Corporate Finance"; 9th internat. edition; New York: McGraw-Hill Education; 2017.

Supplementary literature

- McLaney E., Atrill P.; "Accounting and Finance: An Introduction"; 9th edition; Harlow: Pearson Education; 2018.
- Gitman L.J., Zutter C.J.; "Principles of Managerial Finance"; 14th global edition; Harlow: Pearson Education; 2015.

ESE-ELECTIVE HEALTH SAFETY ENVIRONMENT

Module code	ESE-Elective
Module coordination	Prof. Dr. Rui Li
	Energy
Course number and name	Health Safety Environment
Lecturers	Prof. Dr. Roland Augustin Matilda Subek Simon
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Module Objective

The students should understand and comply with the mandated safety and environment subjects, and apply the enforced site safety rules for the technicians.

Professional Competence

The students know and understand the various hazards in the processing and manufacturing industry as the enormous amount of knowledge and economics involved in an entire plant?s safety, health, and environmental (SHE) infrastructure and administration. Students can reveal and implement the SHE rules to protest people, equipment, and potential profits form e.g. fires, explosion, and expensive litigation. The students are able to develop an intuitive understanding of safety culture.

Knowledge

Students are able to explain and reproduce the following basic theories, principles and practical applications:

- Understand the basic concepts of safety, with the focus on health and environment.

- Know where and how to find latest relevant knowledge, standards, regulations as well as research results.
- Use simple models to describe the different accident or incident scenarios
- Know the meanings of graphical symbols on hazard and warning signs.
- Understand and how to set priority of SHE concepts when dealing with the industrial process.

Skills

- Communication skill directly to safety engineers in a simple yet precise manner
- Ability to describe measures used to protect workers
- Ability to have creative thinking and development of the safety rules

Personal Competence

The students present and classify national and international standards and their enforcement and the student realizes there are severe penalties if a site fails to protect its workforce and surrounding community.

Social competence

The students are able to

- Express their arguments in a comprehensible way within a group in the field of safty technology.
- Reflect their knowledge, exchange their own applications and sustainable ideas

Autonomy

Students can

- Cover most government-mandated training and foundational aspects of apprentice technician safety training.
- Furthermore, they are able to evaluate and update these standards and rules.

Applicability in this and other Programs

ESE-21 Project Work II incl. Simulation and Design

Compulsory Electives: Safety and Security in Energy Systems

Entrance Requirements

Knowledge of elementary mathematics, physics and chemistry.

Learning Content

- Importance of process safety specifically for industries such as refining, petrochemicals, electric power generation, etc.
- Hazard Classification
- Routes of Entry & Environmental Effects
- Gases, Vapors, Particulates, & Toxic Metals
- Hazards of Liquids
- Fire and Explosion
- Respiratory Protection
- Electrical, Noise, Heat, Radiation, Ergonomic and Biological Hazards
- Personal Protective Equipment

Teaching Methods

Seminaristic teaching / exercises / home work, document camera (visualizer) and additional lecture materials in iLearn.

Remarks

none

Recommended Literature

- Speegle M., Safety Health and Environmental Concepts for the Process Industry, 2nd Edition, Delmar- Cengage Learning, New York, 2013
- Thomas, Charles E., Process Technology: Safety, Health, and Environment, 3rd Edition, Delmar- Cengage Learning, New York, 2012
- Deutsche Gesetzliche Unfallversicherung e.V. Machine Tool, Fire and Explosion Prevention and Protection , 2012

ESE-ELECTIVE INTERNATIONAL ENERGY REGULATIONS

Module code	ESE-Elective
Module coordination	Prof. Dr. Matthias Huber
Course number and name	International Energy Regulations
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Primary goal of the module is to expand the students judgment on the realities of international energy regulations. To this end, the module introduces students to existing energy laws and agreements on the one hand and the process of international negotiations on the other hand. A focus is on the interconnection of these negotiations and regulations and their consequences in and outside the energy sector.

Secondary objective of this module is to advance the students ability for goal-directed reasoning and negotiation, develop team orientation and empathy.

Students should also improve their presentation skills and enhanve their scientific writing methods which serves also as a preperation for the Bachelor's thesis.

In this module, the students will gain the following competencies:

Professional Competence

Knowledge

After this module, students

- Know different measures for energy regulation and examples for each measure around the world
- Understand how energy trading and laws regulate international markets

- Know important international agreements on global environment and their connection to energy regulation
- Understand the basics of international negotiations and their impact for the interaction of countries around their energy policies
- Are able to explain the role of trading schemes for international energy regulation
- Know how the energy sector and its regulation connects to other sectors

Skills

After this module, students are capable of

- Comparing different measures for international energy regulation
- Developing a negotiation strategy for a simulated international conference on energy regulation
- Reflecting on the effectiveness of major international energy laws and agreements
- Conducting research, giving a presentation, and writing a scientific report

Personal Competence

Social competence

- Plan and design work processes cooperatively, also in heterogeneous groups, guide others and support them with sound learning advice. Also present complex, interdisciplinary issues in a structured, targeted and addressee-related manner, taking into account the interests and needs of addressees in a forward-looking manner

Applicability in this and other Programs

Bachelor of Energy Systems Engineering

Entrance Requirements

- Basic mathematical concepts
- Fundementals of Energy Economy

Learning Content

- Regulation: An Introduction
- Examples of international regulations
- Typical regulation

- Efficiency standards
- Renewable quotas
- Taxes and subsidies
- Emission trading schemes
- New topics, e.g. cybersecurity in critical infrastructures

- Economics of regulation
- International Energy Trading and Laws
  - Energy import / export regulations
  - Comparison of major energy laws
- International Environmental regulations
  - Kyoto
  - Paris Agreement
- Energy negotiations
  - Theory of negotiations
  - Game theory with application to climate regulations
  - Negotiations: basics and **interactive game**
- Trading Schemes
  - European Trading Schemes
  - CO^2 trading schemes around the globe
- Energy and interaction to other sectors, e.g. Water, Food

Teaching Methods

Seminaristic teaching.
Group work and role game.
Student's presentations.
Applied problem solving.

Recommended Literature

- Ignacio J. Pérez Arriaga, Regulation of the Power Sector,
- André B. Dorsman, Regulations in the Energy Industry

ESE-ELECTIVE MODELLING THEORY

Module code	ESE-Elective
Module coordination	Prof. Dr. Robert Feicht
Course number and name	Modelling Theory
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional and methodological Competence
Based on the learning outcomes of Applied Mathematics (ESE-15), after successfully completing this module, students will be able to classify and formally describe the various strategic interactions (games) in practice.

Knowledge

- Students know and understand methods and strategies of non-cooperative and cooperative game theory.
- Students know and understand the possibilities and limits of modeling interdependent decision situations.

Skills

- Students are able to conceptualize "rational behavior" and to identify adequate solutions for decision situations.
- Students recognize the influence of intuition and societal expectations on decision-making.

Personal Competence

Social competence

- The assumptions regarding rationality and self-interest in economic theory are critically questioned.

- Students are able to highlight different perspectives of a problem and work out solutions in teams.
- The interactive character of the lectures and tutorials strengthens the student's discussion and presentation skills in the academic context.

Autonomy

- The students can independently identify, model and analyze strategic aspects of economic, political and social interactions.
- Students are able to relate their acquired knowledge to other lectures and topics.

Applicability in this and other Programs

The learning outcomes of this module can be applied in any lectures and other study programs that require a basic understanding of modelling and game theory. They form the basis of further application-oriented theorizing in areas such as institutional economics, industrial economics, behavioral economics, and information economics.

Entrance Requirements

Analytical Principles of Engineering (ESE-01), Mathematics for Engineering (ESE-07), and Applied Mathematics (ESE-15) are recommended.

Learning Content

1. Theoretical framework
   - Representation of a game in extensive form
   - Representation of a game in strategic form
   - Mixed extension of a game
2. Strategic-form analysis
   - Dominance and iterative dominance
   - Nash equilibrium, existence
3. Refinements of Nash equilibrium
   - Subgame-perfect equilibrium
   - Weak perfect Bayesian equilibrium
   - Sequential equilibrium

Teaching Methods

Seminaristic teaching combining topic-oriented lectures, exercises, group work, group presentations, and classroom discussions.
Students are encouraged to actively participate in course by choosing appropriate didactical methods. They are strongly invited to discuss real-life problems and applications interactively throughout the lecture.
The seminar is accompanied by tutorials where calculation examples from the course are repeated for better understanding and examples similar to those used during course sessions are calculated.

Remarks

Teaching is supported by iLearn platform: Relevant course materials are made available online.

Recommended Literature

Basic literature

- Gibbons R.; "A Primer in Game Theory"; 1st edition; Harlow: Prentice Hall, Pearson Education; 1992.
- Vega-Redondo F.; "Economics and the Theory of Games"; 1st edition; New York: Cambridge University Press; 2003.

Supplementary literature

- Fudenberg D., Tirole J.; "Game Theory"; 1st edition; Cambridge: MIT Press; 1991.
- Myerson R.B.; "Game Theory. Analysis of Conflict"; 1st edition; Harvard University Press; 1991.
- Mas-Colell A., Whinston M.D., Green J.R.; "Microeconomic Theory"; 1st edition; Oxford University Press; 1995.
- Dixit A.K., Skeath S., Reiley D.H.; "Games of Strategy"; 4th edition; New York: Norton; 2013.

ESE-ELECTIVE MRO-STRATEGIES AND PROCESS RELIABILITY

Module code	ESE-Elective
Module coordination	Prof. Dr. Stefan Mátéfi-Tempfli
Course number and name	MRO-Strategies and Process Reliability
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	Undergraduate level
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The students should learn an efficient and goal-oriented maintenance management. Efficient and goal-oriented maintenance management makes it necessary to implement structured business processes and use up-to-date, demand-oriented data bases (stock data and status data). Failure to carry out maintenance work will initially have little impact on safety - an increase in the number of failures occurs with a time delay. But like all systems used over long periods of time, however, a track maintenance facility does not forgive maintenance failures: the service life of the system is shortened rapidly - the life cycle costs increase disproportionately.
The process reliability identifies problems, which have significant cost reduction opportunities for improvements. The normal process reliability technique is a look down method. It uses both probability plots and management reports.
The students learn a systematic process of envisioning a desired future, and translating this vision into broadly defined goals or objectives and a sequence of steps to achieve them. In contrast to long-term planning, strategic planning begins with the desired-end and works backward to the current status. In addition, in contrast to tactical planning, strategic planning looks at the wider picture and is flexible in choice of its means.

Applicability in this and other Programs

Bachelor Energy Systems Engineering

Entrance Requirements

no

Learning Content

This course projects how Maintenance, Repair and Operation (MRO) strategies and process reliability can be optimized to the specific needs of end-users. The student can significantly reduce the design and production times for customized parts. This leads to key advantages for MRO strategies from the end-user per-spective, as well as environmental and cost benefits. By enabling end-users to quickly adapt and manufacture spare parts themselves, the dependence on ser-vice providers, and parts and product manufacturers is disrupted. Therefore, end-users can better capitalize on their operational knowledge and experience.

Teaching Methods

Seminaristic teaching / exercises / team work / home work

Remarks

no

Recommended Literature

- Burduk, A., & Mazurkiewicz, D. (2017). Intelligent Systems in Production Engineering and Maintenance ? ISPEM 2017: Proceedings of the First International Conference on Intelligent Systems in Production Engineering and Maintenance ISPEM 2017. Springer.
- Mobley, R. K. (2002). An Introduction to Predictive Maintenance. Elsevier.
- Nakagawa, T. (2005). Maintenance Theory of Reliability. Springer Science & Business Media.
- Pearce, S. L., & MacInnes, R. L. (2003). Strategic MRO: A Roadmap for Transforming Assets into Competitive Advantage. CRC Press.
- Sanz-Bobi, M. A. (2014). Use, Operation and Maintenance of Renewable Energy Systems: Experiences and Future Approaches. Springer.
- Stapelberg, R. F. (2009). Handbook of Reliability, Availability, Maintainability and Safety in Engineering Design. Springer Science & Business Media.
- Wittmann, R. G., Jünger, M., Reuter, M. P., & Alexy, N. (2016). Business Design Innovation: How to set entrepreneurial spirit free and drive your business toward success (1. Auflage 2016). ZIEL.

ESE-ELECTIVE OPERATIONAL PROCESSES

Module code	ESE-Elective
Module coordination	Prof. Dr. Rui Li
Course number and name	Operational Processes
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

With focusing on organization, the students will be equipped with a thorough understanding by organization theory and together with management information systems.

Professional Competence

- Understand the principles of organizational arrangements
- Explain and demonstrate the organization structure, design, competitive strategies
- Assess the outside environments and how organizations can respond to them
- How to handle the operational information processing: fundamental management information systems concepts
- Applications of information systems in business practice
- Apply theoretical concepts to practical applications (case study)
- Understand the direct and indirect connection between information systems and business performance

Personal Competence

Methodological competence

The students will be able to use the organizational theory by knowing concepts, structures and strategies. Students are allowed to have in-depth look at how today's business firms use information technologies and systems to achieve corporate objectives.

Personal and social competences

- Students are able to develop analytical thinking, attention to details
- Students are able to consider and analyze different strategies to solve problems from the organization point of view
- Students are able to solve and discuss business problems in the field of information systems by applying systematic approaches and by identify alternative solutions in teams

Applicability in this and other Programs

IE-Elective: Operational Processes, BA Industrial Engineering at ECRI

W-26 Betriebliche Informationssysteme, BA Wirtschaftsingenieurwesen at THD

And any other study programme that deals with organization theory and information management systems.

Entrance Requirements

no prerequisites

Learning Content

- Nature of organizations and organization theory
- How strategies affect organization design
- Basic concepts of organization structure
- Major environmental forces on the organization
- Information systems in global business
- Information systems, organizations, and strategy
- IT infrastructure and emerging technologies
- Securing information systems

Teaching Methods

seminaristic teaching / exercises / tutorials (case study) / home work

Recommended Literature

- Daft, R.L , Armstrong. A. . Organisation Theory and Design, Nelson Education, 2014
- Laudon K. C., Laudon J.P.,: Management Information Systems: Managing the Digital Firm, 13th Edition, Pearson, 2014.
- Schulz, O. Der SAP-Grundkurs für Einsteiger und Anwender, 2. Auflage, Galileo Press, 2013
- Eversheim, W., Organisation in der Produktionstechnik, Arbeitsvorbereitung, VDIVerlag, Düsseldorf
- Laux, H., Liermann, F.: Grundlagen der Organisation. Springer, 6. Aufl. Berlin 2005

ESE-ELECTIVE PRINCIPLES OF ENERGY SYSTEMS MANAGEMENT

Module code	ESE-Elective
Module coordination	Prof. Dr. Matthias Huber
Course number and name	Principles of Energy Systems Management
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Primary goal of the module is to accustom the students to working with energy management systems. This includes connecting the understanding of different application fields (e.g. buildings, industries, buildings, districts and cities) and the different energy sectors and their coupling. Furthermore, the mathematical methods behind their design and operation with the technological requirements and constraints should be understood. Methods include thermodynamics, machine learning and data analytics, optimization theory.

Secondary objective of this module is to promote students' ability to work in data-driven environments and communicate with experts in data technology, computer science, as well as experts for technological equipment, develop team orientation and focus.

In this module, the students will gain the following competencies:

Professional Competence

Knowledge

After this module, students

- Know major aspects of energy management systems. This includes the application in various sectors, e.g. different kind of industries, buildings, and districts/cities
- Understand the key requirements for an effective energy managements system

- Are able to reproduce major aspects of energy managements systems for important industries, buildings, and cities
- Are able to explain the way modern energy managements systems are implemented and operated

Skills

After this module, students are capable of

- Applying mathematical methods in the design and operation of energy management systems
- Comparing energy needs and efficiency measures across industries and in the built environment and across different energy sectors (sector coupling)
- Developing concepts for energy management systems

Personal Competence

Social competence

- Learn or work with others, get verbal and written information and exchange ideas.

Autonomy

- Reflect on, evaluate, pursue and take responsibility for your own and externally set learning and work goals

Applicability in this and other Programs

Bachelor of Energy Systems Engineering

Entrance Requirements

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Learning Content

- Basics of energy applications and consumptions
- Definition of Energy Management
- Goals of energy management systems
- Multimodality and different energy forms, sector coupling
- Energy tariffs
- Demand response

- Energy technologies and their combination in a system (e.g. PV, Wind, Storage, etc)
- Energy Efficiency Measures
- Monitoring, Energy Accounting, Reporting
- Automation systems
- Application areas
  - Industrial / Production sites
  - Commercials
  - Agriculture
  - Buildings and Neighborhoods
  - Regions and cities
- Introduction to mathematical optimization
- Data Science and machine learning
- Local market places
- Applications, e.g.
  - heating control in building,
  - reducing peak demand in industry
  - investment in efficiency
  - adding solar in agriculture
  - further defined interactively in course

Teaching Methods

- Seminaristic teaching.
- Group work and role game.
- Student's presentations.
- Applied problem solving.

Recommended Literature

- Intelligent Building Control Systems - A Survey of Modern Building Control and Sensing Strategies
- Smart Energy Management for Households: A practical guide for designers, HEMS developers, energy providers, and the building industry
- Managing Energy From the Top Down: Connecting Industrial Energy Efficiency to Business Performance
- GUIDE TO ENERGY MANAGEMENT

ESE-ELECTIVE PROCESS ENGINEERING

Module code	ESE-Elective
Module coordination	Prof. Dr. Markus Hainthaler
Course number and name	Process Engineering
Semester	6, 7
Duration of the module	2 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/10
Language of Instruction	English

Module Objective

Qualification Goals

Within this course, students acquire the ability to understand the working principle of the most common production processes. Additionally, they are able to critically analyze various approaches how to produce a product by mechanical, thermal, chemical or biotechnological means, and judge their individual efficiency. This creates the basis for the reliable design and operation of any production system the students are concerned in their future engineer´s life.

Professional and methodological Competences

Knowledge

After being taught the broad fundamentals of Energy Systems Engineering, this elective module in the higher semesters deepens the education for those students seeking for specialization in the design, operation and optimization of production processes. This module will cover the most important unit operations and plant equipment in mechanical, thermal, chemical and biological process engineering. All these topics are practiced with real-life problems in a broad variety of production systems and applications.

Skills

After completing this module, the students will be able to assist specialists in creating the appropriate educt-to-product process for a given production problem. As they understand both the different unit operations and the respective industrial

equipment, they can evaluate the advantages and disadvantages of alternative methods for reaching the same goal with maximum efficiency. Furthermore, they can analyse an existing process regarding its productivity, both communicate and visualize the function of apparatuses and transfer results towards new applications.

Personal and social Competences

The solution of the tasks given both in the lecture and the exam requires students´ self-responsible and self-directed working style. Herein, the concepts of all module topics have to be applied to new problems, analyzed regarding their relevance, and evaluated in order to yield a reliable result.

Applicability in this and other Programs

This module is an elective lecture in the higher semesters, so there will be no direct applicability within the same study programme. However, the learning outcomes can be applied in any other study programmes that deal with the design, operation, maintenance and optimization of plants and production systems.

Entrance Requirements

Successful completion of the following modules is recommended:

Analytical Principles of Engineering (ESE-01), Mathematics for Engineering (ESE-07), Physics (ESE-04), Chemistry (ESE-05), Materials and Design (ESE-11), Plant Engineering (ESE-24), Energy Technology (ESE-16), Renewable Energies (ESE-22)

Learning Content

Mechanical Process Engineering

- Particle characterization: intrinsic / extrinsic properties, sphericity
- Particle size distributions: cumulative fraction curve, size frequency curve
- Mechanical separation: fraction balance curves, grade efficiency, sharpness of separation, industrial-scale equipment
- Mechanical comminution: transition of particle size distributions, fracture mechanics, energy utilization, industrial-scale equipment
- Mechanical mixing: degree of mixing, industrial-scale equipment
- Scale-up: dimensionless characterization, power curve

Thermal Process Engineering

- Evaporation / condensation: T-H diagram, p-H diagram, stages of boiling, industrial-scale equipment

- Distillation: zeotropic / azeotropic mixtures, partial pressures, partial evaporation and condensation, rectification, McCabe-Thiele method, industrial-scale equipment

Chemical Process Engineering

- Rate of reaction, fundamental mole balances
- Ideal reactor types: batch reactor, plug flow reactor, continuous stirred tank reactor, packed bed reactor, design equations, conversion kinetics, sizing
- Rate laws: power law, elementary / reversible / endothermal / exothermal reactions, reaction rate constant, Arrhenius law
- Catalytic reactions: types of catalysts, rate-limiting steps, diffusion, deactivation
- Multiple reactions: series / parallel reactions, selectivity

Biological Process Engineering

- Biological diversity: cell types, reproduction, nutrients, metabolic pathways, energy conversion
- Enzymes: characterization, co-factors, immobilization, enzyme kinetics (Michaelis-Menten, allosteric, inhibited, competitive, uncompetitive)
- Growth kinetics: yield, batch growth, aerobic / anaerobic growth, chemostat / turbidostat

Teaching Methods

The lecture focuses on seminaristic teaching, but also applies detailed practical exercises based on the theoretical background. The key content is denoted in a written script via visualizer, while the supplemental content is conveyed via slide and video presentations. All material is uploaded to an online learning portal (iLearn). The students are strongly invited to discuss real-life problems and applications interactively throughout the lecture. Tutorials will be offered on demand.

Remarks

Although the lecture is taught in English, some selected German literature is used to supplement the teaching content. In order to substantiate the lessons learnt, it is planned to offer an excursion to an industrial production site.

Recommended Literature

- R. Sinnott, G. Towler "Chemical Engineering Design", Butterworth-Heinemann, 5th edition 2009

- R. Chhabra, V. Shankar "Coulson and Richardson´s Chemical Engineering Vol. 1A: Fluid Flow - Fundamentals and Applications", Butterworth-Heinemann, 7th edition 2018
- J.M. Coulson, J.F. Richardson "Coulson and Richardson´s Chemical Engineering Vol. 2: Particle Technology and Separation Processes", Butterworth-Heinemann, 5th edition 2002
- M. Stieß "Mechanische Verfahrenstechnik 1", Springer, 3rd edition 2009
- M. Stieß "Mechanische Verfahrenstechnik 2", Springer, 1st edition 1997
- H.S. Fogler "Essentials of Chemical Reaction Engineering", Prentice Hall, 2nd edition 2018
- M.L. Shuler, F. Kargi, M. de Lisa "Bioprocess Engineering - Basic Concepts", Prentice Hall, 3rd edition 2017
- A.B. de Haan "Process Technology - An Introduction", De Gruyter, 1st edition 2015
- C.J. Geankoplis, A.A. Hersel, D.H. Lepek "Transport Processes and Separation Process Principles", Prentice Hall, 5th edition 2018

ESE-ELECTIVE PROCESS OPTIMIZATION

Module code	ESE-Elective
Module coordination	Prof. Dr. Markus Hainthaler
Course number and name	Process Optimization
Lecturers	Prof. Dr. Tobias Bader Prof. Dr. Markus Hainthaler
Semester	6, 7
Duration of the module	2 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Qualification Goals

Within this course, students acquire the ability to understand the most common quality assurance and optimization methods throughout the whole life cycle of a plant, be it the responsible employment of investments, plant equipment or energy use. Additionally, they are able to critically analyze the status quo of a plant and develop individual approaches to improve it. This creates the basis for the reliable and sustainable design and operation of any production system the students are concerned in their future engineer´s life.

Professional and methodological Competences

Knowledge

From the diversity of engineering courses in the previous semesters, the students are already capable of analyzing and designing a wide variety of sub-units of any production facility. Within this module, these competences are developed further towards the holistic optimization of these production processes, herein targeting at both quality improvement and energy minimization. A multitude of improvement tools is presented which can be applied in all stages of designing, operating and debottlenecking a plant.

Skills

After completing this module, the students will be able to discuss with specialists both from the engineering and economy department about optimization in all areas of a plant´s performance. They understand the advantages and disadvantages of different optimization tools, their applicability limits and the required effort to realize them.

Personal and social Competences

The solution of the tasks given both in the lecture and the exam requires students´ self-responsible and self-directed working style. Herein, the concepts of all module topics have to be applied to new problems, analyzed regarding their relevance, and evaluated in order to yield a reliable result.

Applicability in this and other Programs

This module is an elective lecture designed for higher semester students, so there will be no direct applicability within the same study programme. However, the learning outcomes can be applied in any other study programmes that deal with the design, operation, maintenance and optimization of plants and production systems.

Entrance Requirements

Successful completion of the following modules is recommended:

Energy Technology (ESE-16), Renewable Energies (ESE-22), Sustainability (ESE-23), Plant Engineering (ESE-24)

Learning Content

Quality Engineering

- Process-oriented quality management
- ISO 9000 ff.
- Set-up and introduction of a quality management system
- Methods and tools of quality planning
- Total Quality Management
- Six Sigma Process
- Define, Measure, Analyze, Improve, and Control (DMAIC-framework)
- Statistical methods within the DMAIC-framework

Production Optimization

- Reliability, Fault Tree Analysis

- Process Integration: Process Design, Global Optimality, Heat Exchanger Networks (Pinch Method)
- Sustainable Engineering: Aqueous Contamination, Atmospheric Emissions, Life Cycle Analysis (LCA)

Teaching Methods

The lecture focuses on seminaristic teaching, but also applies detailed practical exercises based on the theoretical background. The key content is conveyed in combination of a written script and slide and video presentations. All material is uploaded to an online learning portal (iLearn). The students are strongly invited to discuss real-life problems and applications interactively throughout the lecture. Tutorials will be offered on demand.

Recommended Literature

Quality Engineering

- T. Pyzdek "Quality Engineering Handbook", CRC Press
- G. Linß "Qualitätsmanagement für Ingenieure", Hanser, München-Wien
- Pfeifer "Praxisbuch Qualitätsmanagement", Hanser, München-Wien

Production Optimization

- B. Bertsche "Reliability in Automotive and Mechanical Engineering", 1st edition
- R. Smith "Chemical Process Design and Integration", 2nd edition

ESE-ELECTIVE SAFETY AND SECURITY IN ENERGY SYSTEMS

Module code	ESE-Elective
Module coordination	Prof. Dr. Rui Li
Course number and name	Safety and Security in Energy Systems
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Module Objective

The students should understand the safety and security in energy systems to eliminate hazards via engineering controls, and process safety managements.

Professional Competence

The students know and understand the working principles of the safety and security design and implements for different scale energy systems from the big electric power plant to small battery, from conventional to renewable energy suppliers. Students understand the basic safety and security applications using physical and logical way of thinking. The students are able to develop an intuitive understanding of safety and security while considering the energy system efficiency.

Knowledge

Students are able to explain and reproduce the following basic theories, principles and practical applications:

- Understand importance of employee safety to the energy sector.
- Use simple models to describe the different accident or incident scenarios.
- Explain how to tagout an energy source.

- Describe administrative and engineering controls e.g. interlocks and automatic shutdown devices.
- Describe deluge and explosion suppression systems.
- Understand the employee training issues contained in the Process Safety Management standard.

Skills

- Communication skill directly to energy engineers about the safety and security
- Ability to explain working methods thus measures for safety
- Ability to have creative development of the safety and security

Personal Competence

Social competence

The students are able to

- express their safety concerns and arguments in a comprehensible way within a group in the field of energy systems
- reflect their knowledge, exchange their own applications and sustainable ideas

Autonomy

Students can

- Interprete the unknown various documents or standards of energy system safety in a reasonable way.
- Update these safety standards and rules as the energy systems itself develops.

Applicability in this and other Programs

ESE-21 Project Work II incl. Simulation and Design

Compulsory Electives: Health Safety Environment

Entrance Requirements

Knowledge of elementary mathematics, physics and measurement/control theory

Learning Content

- Safety Permit Systems
- Process System Hazards

- Passive Safety system
- Hazards of Process Sampling
- Engineering Control of Hazards
- Administrative Control of Hazards
- Process Safety Management
- Hazardous Waste Operations
- Hurricanes and Plant Security

Teaching Methods

Seminaristic teaching / exercises / home work, document camera (visualizer) and additional lecture materials in iLearn.

Remarks

None

Recommended Literature

- James A. Klein, Bruce K.: Process Safety: Key Concepts and Practical Approaches. CRC Press Taylor & Francis Group, 2017.
- Thomas, Charles E., Process Technology: Safety, Health, and Environment, 3rd Edition, Delmar- Cengage Learning, New York, 2012
- Kahl A., Bier M.: Arbeitssicherheit: Fachliche Grundlagen, Erich Schmidt Verlag, 2019

ESE-ELECTIVE STRATEGIC PLANNING AND PROJECT MANAGEMENT

Module code	ESE-Elective
Module coordination	Prof. Dr. Tobias Bader
Course number and name	Strategic Planning and Project Management
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Students will learn about the processes involved in planning and implementation of project in project management. Beginning with the process of building and leading project team, to project management theory and steps, to finally looking at the implementation of successful project management, this course aims to provide a complete picture of project management in practice. Additionally, different types of project management will be compared, so that the students will be able to apply the most effective method, based on the type of project and/or team that they are dealing with. A special focus will be placed on the elements of planning, leadership and implementation.

Professional Competence

Knowledge

After successfully finishing the module, students should:

o Understand project management theory and its application

o Understand all the steps involved in project management, with a focus on planning

o Understand the different roles involved with project management

o Understand how project management teams work together or are put together in different environments

o Understand how to choose the correct type of project management method for different types of projects

o Understand what successful leadership in and of project management looks like

o Understand the challenges and typical project fails in planning and implementation of project management

Skills

Upon completion of the module the students will be able to:

o Transfer theoretical knowledge of project management real world projects

o Be able to determine which project planning management method is most effective in different situations

o Be able to determine which project management implementation method is most effective in different situations

o Be able to recognize the most effective leadership technique for various project teams

o Be able to recognize the signs when a project is not working or failing

o Be able to work on different projects in various environments

Personal Competence

Social competence

Students will work together on an in-class projects in small groups, in order to learn how to work efficiently with each other on solve problems and on implementing their knowledge together. This aims at enhancing their team-working skills as well as their problem-solving capabilities. Further, these groups are lined-up in a way to be mixed multi-cultural in order to foster and fine-tune students? intercultural interaction capabilities.

Methodological competence

The students will learn how to transfer theoretical knowledge into a project, and hence, will be able to apply their learned skills. This leads to greater retention of the learned theory, and enables transference skills. Further, the students will be provided with an overview of different sets of skills and theory, and will be able to choose the most efficient approach to applying these. Students will develop an analytical system-oriented way of thinking and should able to structure the most effective approach to project management from different aspects, beginning with planning, selection, to implementation.

Applicability in this and other Programs

All study courses "Strategic Planning and Project Management" will be teached

Entrance Requirements

English skills

Learning Content

The course will be taught with a focus specifically planning, leadership and implementation:

- Project management theories
- Project management planning
- Project roles and stakeholders
- Project management theories
- Project management steps
- Project management leadership
- Project management teams
- Project management implementation
- Project management fails

Teaching Methods

Interactive lecture, case studies, in class project, group work, discussions and presentations of work in progress.

Recommended Literature

Recommended reading (if possible in the most current edition):

- Berkun, S., *Making Things Happen: Mastering Project Management (Theory in Practice).* Sebastopol, CA: O'Reilly Media, 2008
- Edge, J., *Agile: An Essential Guide to Agile Project Management, The Kanban Process and Lean Thinking + A Comprehensive Guide to Scrum*. Luxemburg: CreateSpace Independent Publishing Platform, 2018
- Kunow, A., *Project Management & Business Coaching: Agile project management - target-oriented and efficient with active body language & comprehensive communication*. Buchum, Germany: KISP Bücher, 2019

o Martinelli, R.J., Milosevic, D.Z., *Project Management ToolBox - Tools and Techniques for the Practicing Project Manager*. Hoboken: Wiley, 2016

o Project Management Institute (Hrsg.) *A guide to the project management body of knowledge. PMBOK(R) Guide*. Newtown Square, PA: Project Management Institute, 2013

o Sutherland, J., *Scrum: the art of doing twice the work in half the time*. London: Random House Business Books, 2015

o Wysocki, R., *Effective project management: traditional, agile, extreme*. Indianapolis, IN: Wiley, 2014

ESE-ELECTIVE TECHNOLOGY AND INTELLECTUAL PROPERTY RIGHTS MANAGEMENT

Module code	ESE-Elective
Module coordination	Prof. Dr. Tobias Bader
Course number and name	Technology and Intellectual Property Rights Management
Semester	4, 6, 7
Duration of the module	3 semester
Module frequency	annually
Course type	compulsory course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60hours self-study: 90hours Total: 150hours
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

Professional Competence

Knowledge

- Understanding what intellectual property rights are
- Understanding the significance of intellectual property and technological Innovation in society
- Knowledge of basic principles and methods for intellectual property management
- Knowledge of basic principles n technology transfer

Skills

- Students are able to apply theories and methods to :
- Identify intellectual assets
- Identify main types of intellectual property
- Prepare and evaluate an IP exploitation strategy
- Managing Intellectual property rights

- Technology transfer from University to Industry

Personal Competence

Social competence

- Students are able to work goal-oriented in small mixed groups, learning and broadening teamwork abilities.

Autonomy

- Develop analytical thinking, attention to details and ability to consider different strategies to solve individually problems related to this lecture.

Applicability in this and other Programs

Bachelor of Energy Systems Engineering

Entrance Requirements

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Learning Content

- Introduction to Intellectual Property Rights
- Intellectual property rights management national and international environment
- World wide IPR management system, World Intellectual Property Organization (WIPO)
- International Treaties and Conventions on Intellectual Property
- The Impact of Technological Innovation on Society
- Protecting technical innovation: patents and trade secrets
- Intellectual property management in technology transfer

Teaching Methods

Seminaristic teaching / exercises / team work / home work

Recommended Literature

- Melissa A. Schilling, Strategic management of technological innovation, 6th Ed., McGraw-Hill Education 2020
- Keith Goffin Palgrave, Innovation management : effective strategy and implementation, 3rd Ed., Macmillan Education 2017

- Intellectual Property Handbook: Policy, Law and Use, WIPO 2004 : https://www.wipo.int/about-ip/en/iprm/
- WIPO Technology Trends 2019 : https://www.wipo.int/publications/en/details.jsp?id=4386