Module Guide

Industrial Engineering

Faculty European Campus Rottal-Inn

Examination regulations 01.10.2019

Date: Thursday 14.11.2019 15:02
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IE-01 ANALYTICAL PRINCIPLES OF ENGINEERING

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Module Objective

Professional Competence

Knowledge

After successfully finishing the module, students will get to:

- understand basic mathematical concepts and know how to apply standard mathematical methods.
- visualize mathematical objects and interpret mathematical symbols and formulas.
- acquire feeling for handling numbers and functions.
- solve problems on their own and verify the solutions.
- apply numerical and graphical solution methods to various tasks.
- enhance problem solving skills.
- simple application of standard procedures.

Skills

Upon completion of the module the students will be able to:
o evaluate and perform vectors operations.
o perform matrix operations.
o solve systems of linear equations using various methods.
o manipulate complex numbers.
o determine convergence or divergence of a given series or sequence.
o obtain numerical solutions to some problems in important engineering subject areas.
o visualize mathematical objects and to interpret mathematical symbols and formulas.
o apply numerical and graphical solution methods to various tasks.

Social competence

o Students are demonstrating working in small groups to solve problems that 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.

Applicability in this Program

IE-07 Mathematics for Engineering
IE-09 Technical Mechanics II
IE-14 Applied Mathematics
IE-16 Energy Technology
IE-18 Chemistry
IE-23 Plant Engineering
IE-Elective Process Engineering

Applicability in this and other Programs

Mathematics is basic for most of engineering and scientific courses. This module lays the foundation on which most of the engineering and other scientific modules of the study program will be built.

Entrance Requirements

Knowledge of high school mathematics
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 / exercises / tutorials / home work / group activities

Whiteboard, visualizer online learning portal (iLearn), weekly exercise session using active learning.

Recommended Literature

- Sterling K. Berberian, A first course in real analysis, Springer-Verlag, c1994
- 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
IE-02 INFORMATICS FOR ENGINEERING I

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**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 Industrial Engineering

Bachelor Health Informatics

All similar technical or computer science related programs

**Entrance Requirements**

No prerequisites besides school level math.

**Learning Content**

- History of informatics / computer science
- 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 principles 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
IE-03 TECHNICAL MECHANICS I

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Module Objective

Professional Competence

Knowledge

- Understanding the theories and methods of engineering mechanics, statics of structures and beams.
- Understanding mechanical properties of materials, their strengths and elastic properties.
- Knowledge of basic principles and methods for analysing mechanical systems and application of that integrated knowledge to practical problems of mechanical engineering.

Skills

- Students are able to apply theories and methods to calculate:
- Systems of concentrated and distributed forces, moments and couples for mechanical structures.
- Mechanical systems in static equilibrium and limits of equilibrium conditions.
- External and internal effects on loaded beams.
Deformations (1D) based on simple stresses and material data.

**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 Program**

IE-09 Technical Mechanics II

**Applicability in this and other Programs**

The module provides basic knowledge for other courses of different study programs that require engineering mechanics fundamentals.

**Entrance Requirements**

Knowledge of elementary mathematics and physics is recommended.

**Learning Content**

Engineering mechanics, statics of structures and beams, mechanical properties of materials, their strengths and elastic deformations with particular focus on:

- Definitions, Newton's laws, fundamental terms and units, scalars and vectors, force, moment of a force.

- Vectors, properties, trigonometric functions, unit vectors, addition, subtraction, dot and cross products.

- System of forces, principle of transmissibility, rectangular components, moment of a force, Varignon's theorem, couples, resultant of system of forces.

- Equilibrium conditions, free body diagrams, support reactions.

- Distributed forces, center of gravity, center of mass, centroids, composite techniques, beams subjected to distributed forces.

- Internal effects, sign conventions, normal, shear and bending moment, internal effect diagrams.
Stress calculations, material strength, yield and admissible stress, normal and shear stress, bending stress, area moment of inertia, elastic section modulus.

Deformation, Hookes law, deflection of beams, curvature, slope and elastic curve equations.

Friction, static friction, impending motion and kinetic friction, belt friction.

**Teaching Methods**

Lectures / exercises / tutorials / home work

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

**Recommended Literature**

- Aufgabe zu Technische Mechanik 1-3: Statik, Elastostatik, Kinetik 8th ed. by W. Hauger, V. Mannl, W. A. Wall, E. Werner, 2014
IE-04 ACCOUNTING

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Module Objective

Professional and methodological competence
Students develop a thorough understanding of basic accounting principles and practice related to accounting concepts, systems and procedures.

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 fully understand the operational functions of financial accounting and the informational expectations on financial accounting. For this they are able to take the perspectives of all main stakeholders of a business.
- Students have a deep understanding of financial reports as a basic skill for business studies.
- Students know and understand the differences and linkages between the three main financial reporting statements.

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.

Within the scope of double-entry bookkeeping students execute accounting transactions independently.

Students are able to prepare and read financial statements and management reports. They analyze these statements within the context of decision making.

By performing financial statement analyses students are able to assess the financial situation (profitability and financial risk) of a company applying the understanding gained before.

**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 are able to relate their acquired knowledge to other lectures and topics.

**Applicability in this Program**

IE-10 Business Law

IE-20 Financing

**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 bookkeeping, accounting and the assessment of the financial situation of a company.
**Entrance Requirements**
None.

**Learning Content**
1. Accounting: information for decision making
2. Basic financial statements
3. The accounting cycle
   - Capturing economic events
   - Accruals and deferrals
   - Reporting financial results
4. Financial statement analysis

**Teaching Methods**
Seminaristic teaching combining lecture, 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.

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

**Recommended Literature**

**Basic literature**

**Supplementary literature**
IE-05 PRINCIPLES IN BUSINESS

Module code | IE-05
---|---
Module coordination | Prof. Dr. Robert Feicht
Course number and name | Principles in Business
Lecturer | Prof. Dr. Robert Feicht
Semester | 1
Duration of the module | 1 semester
Module frequency | annually
Course type | required course
Niveau | undergraduate
Semester periods per week (SWS) | 6
ECTS | 6
Workload | Time of attendance: 90 hours
| self-study: 135 hours
| Total: 225 hours
Type of Examination | written ex. 90 min.
Duration of Examination | 90 min.
Language of Instruction | English

Module Objective

**Professional and methodological competence**
Students will develop a thorough understanding of business and economic processes and interdependencies.

**Knowledge**

- With a view to the practice, students understand and structure planning processes, decision-making processes and control processes in companies.
- Students know and understand the development of central management approaches. They know the basic instruments in the management process.
- Students have a basic understanding of microeconomic and macroeconomic analysis.

**Skills**

- Students are able to describe the operational functions systematically and explain interdependencies in a differentiated way.
- Students are able to recognize the interdependencies of markets and companies and derive economic policy recommendations from them.
With a view to current discussions, students can use economic models and apply them to corresponding questions. They can create basic economic analyses of a company's market environment and show their consequences for a single firm.

**Personal competence**

**Social competence**

- Students develop communication skills that are supported by tasks and case studies. They 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 understand the interplay between economic regulations, institutional framework and strategic profile of a company and derive their own opinions.
- Students can handle tough work and study contexts independently and design them in an application-oriented way.
- Students are able to handle complex economic issues graphically, arithmetically and verbally.
- Students are able to relate their acquired knowledge to other lectures and topics.

**Applicability in this Program**

IE-10 Business Law

IE-20 Financing

IE-21 Logistics and Operations Research

IE-31 Management

IE-Elective Business Planning and Start-Up Management

IE-Elective Energy Markets

IE-Elective Energy and Resource Efficiency

IE-Elective Globalisation

IE-Elective Modelling Theory

IE-Elective Operational Processes
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 business and economic processes and interdependencies.

Entrance Requirements

None.

Learning Content

Business administration
1. The environment of business
   - Being ethical and socially responsible
   - Global business
2. Business ownership and entrepreneurship
   - Different forms of business ownership
   - Small business, entrepreneurship, and franchises
3. Management and organization
   - Management process
   - Creating a flexible organization
4. Human resources
   - Attracting and retaining the best employees
   - Motivating and satisfying employees and teams

Economics
1. Introduction
   - Ten principles of economics
   - Interdependence and the gains from trade
2. Markets and welfare
   - Supply, demand, and government policies
   - Elasticity
   - Consumers, producers, and the efficiency
   - Costs of taxation
3. The economics of the public sector
   - Externalities
4. Firm behavior and the organization of industry
5. The data of macroeconomics
   - Measuring a nation's income

Teaching Methods

Seminaristic teaching combining lecture, 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.

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

Recommended Literature

Basic literature

Supplementary literature
IE-06 FOREIGN LANGUAGE I

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**Module Objective**

The modules Foreign Language I and III aim to equip students with specialized language skills necessary for independent performance in a globalized industrial engineering sector. In doing so, it strives to deepen students’ relationship with the English language in business and technical settings so that they can effectively and efficiently implement the language as a practical communication tool.

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

Central to the module is optimizing fluency and communication skills; so too is cultivating 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 business and technical processes. Particular emphasis will be placed on honing students’ public speaking and team skills through work on a team presentation project for each course.

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 industrial 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 industrial 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 package 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 team work, integrity, and reliability.

- They will have reflected on the learning benefits derived from several immersion projects.

Applicability in this and other Programs

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

Entrance Requirements

The minimum entry-level requirement is a B2-level of English according to the Common European Framework of Reference for Languages (CEFR) or A-level language skills according to the standards of the German education system. Alternatively, experience living abroad or successful participation in a study exchange may be sufficient.

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

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 Spotlight: <www.business-spotlight.de>


Cotton, D., Falvey, D. & Kent, S. Market Leader Upper Intermediate. Harlow:


IE-07 MATHEMATICS FOR ENGINEERING

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<tr>
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<td>Ibrahim Bader</td>
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<td>Lecturer</td>
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Module Objective

Professional Competence

Knowledge

After successfully finishing the module, students will get:

- awareness of the basic concepts of theoretical mathematics and calculus.
- ability to apply mathematical skills for solving real life engineering problems.
- broad knowledge and basic understanding of the topics related to Elementary functions, Partial differentiation and Ordinary differential equations.
- understand and apply the Fundamental Theorem of Calculus.
- be aware about using mathematical modelling in applied field of engineering and business.
- enhance problem solving and team work skills.

Skills

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

- evaluate limits of basic functions.
- understand the concept of continuous functions.
- differentiate functions of one or more variables.
- solve first order ordinary differential equations.
- manipulate partial derivatives.
- manipulate infinite and finite Integrals.
- obtain numerical solutions to some engineering and real life problems using differential and integral methods.
- expand periodic functions using Fourier-Series.

**Personal competence**

**Social competence**

- Students are demonstrating working in small groups to solve problems that aims at enhancing their team-working and logical problem solving skills. 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.

**Applicability in this Program**

IE-14 Applied Mathematics

IE-16 Energy Technology

IE-23 Plant Engineering

IE-Elective Process Engineering

**Applicability in this and other Programs**

Mathematics is essential for most of engineering and scientific courses. This module, together with Applied Mathematics (IE-14), lay the foundation on which most of the engineering and other scientific modules for the rest of the study program will be built.

**Entrance Requirements**

IE-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

Teaching Methods
Lectures / exercises / tutorials / home work / group activities
Whiteboard, visualizer online learning portal (iLearn), weekly exercise session using active learning methods.

Recommended Literature
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
T. Westermann, Mathematik für Ingenieure, Springer Verlag, 6. Auflage, 2011
IE-08 INFORMATICS FOR ENGINEERING II

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</table>

| Type of Examination | report/presentation |
| Language of Instruction | English |

Module Objective

Professional Competence

Knowledge

- Know and understand the basic principles, commands and syntax of Visual Basic.
- Know and understand the structure of computer programs.
- Know and understand how to write a program in computer code.

Skills

- Ability to understand and debug computer programs.
- Ability to structure problems and create solutions for given tasks in computer code.
- 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.
o Ability to communicate with peers about a complex (and yet unknown) topic and find a joint approach to solving it.

Autonomy

o Develop ability to use online resources to learn syntax and methods of visual basic.

o Develop ability to design criteria and testing strategies to check quality of own work.

o Gain experience in time-boxed problem solution.

**Applicability in this Program**

IE-27 Applied Measurement and Control Engineering

IE-Elective Data Acquisition and Processing

**Applicability in this and other Programs**

All similar study programs.

**Entrance Requirements**

IE-02 Informatics for Engineering I (or similar course)

**Learning Content**

o Visual Basic projects

o Program structure

o Variable types

o Computer languages

o Syntax

o Software development process

o Mathematical library

o Case selection and decision

o Loops

o Arrays

o Subroutines
Functions

Computer graphics

Colour

Teaching Methods

Lectures / exercises / tutorials / home work

PowerPoint presentation, whiteboard, excel and visual basic exercises, document camera (visualiser) and additional lecture materials in iLearn

Remarks

Visual Basic (Microsoft Visual Studio 2017) will be the main language used in this class.

Recommended Literature

https://docs.microsoft.com/de-de/dotnet/visual-basic/getting-started/
Module Objective

Professional and methodological competences:

Knowledge

From IE-03 Technical Mechanics I, the students are already capable of analysing the distribution of forces and moments acting on simplified 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 given examples 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 approximation of the actual 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 Program**

IE-23 Plant Engineering

IE-Elective Process Engineering

**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:

IE-01 Analytical Principles of Engineering, IE-03 Technical Mechanics I

**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, Strubeck curve

**Teaching Methods**

The lecture focuses on seminaristic teaching, but also applies sufficient 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 and home work 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**

IE-10 BUSINESS LAW

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<td>Prof. Dr. Robert Feicht</td>
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<td>Business Law</td>
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<td>Lecturer</td>
<td>Tobias Appel</td>
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Module Objective

Professional and methodological competence
After completing the module, students are able to familiarize themselves with relevant topics of private law and taxation and relate these to adjacent fields like accounting or financing.

Knowledge
- Students know and understand the basics of contract law including the links to the areas of corporate governance, economics, ethics, and financing.
- Students know and understand the basics of commercial and corporate law and learn to anticipate relevant legal risks within the economic life.
- Students are aware of the links between the individual fields of law and their influence on other areas of law, such as tax law and social security law.

Skills
- Students master the handling of the legal text.
- Students are able to identify the fundamental specifications of individual as well as company taxation for various forms of business ownership.
- Students are proficient in dealing with income taxation and sales tax.
Students are able to apply the acquired knowledge at the company level and apply it strategically, to assess problems and to provide suitable solutions.

**Personal competence**

**Social competence**

- By incorporating group discussions on current developments and events both in business life and on the political level, students experience the complexity of business law and taxation aspects.
- Students develop communication skills that are supported by tasks and case studies.
- 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**

- Addressing legal and tax aspects strengthens the self-confidence of the students in dealing with similar problems. In case of multiple solution options, they are able to identify a constructive solution.
- 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 Program**

IE-20 Financing

IE-21 Logistics and Operations Research

IE-31 Management

**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 business law and taxation.

**Entrance Requirements**

Principles in Business (IE-05) and Accounting (IE-04) are recommended.

**Learning Content**
Business law
1. Overview of law basics
2. Legal entities and their capacity to contract
3. Legal transactions and contract law; Breach of contracts
4. Legal representation and agency
5. Objectives of form for contracts
6. Standard business terms
7. Basics of international contract law
8. Torts and product liability
9. Commercial and corporate law

Taxation
1. History and origins of the tax system
2. Introduction to income tax
   - Basic terms and definitions of the income tax
   - Methods to the ascertainment of profits
   - Consideration of loss by the income tax
3. Introduction to corporate taxation
   - Determination of the taxable corporate income
   - Allowable and not allowable expense
   - Hidden profit distribution and deposits
   - Trade tax
4. Basic taxation-related circumstances of value added tax

Teaching Methods
Seminaristic teaching combining lecture, 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.

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

Recommended Literature

Business law

Taxation
Jochum H., Thiele P.J.; "Introduction to German Tax Law"; 2nd edition; Stuttgart:
Boorberg; 2018.
**IE-11 PHYSICS**

<table>
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<td>Prof. Dr. Sascha Kreiskott</td>
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**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 Program**

IE-09 Technical Mechanics II

IE-16 Energy Technology

IE-23 Plant Engineering

IE-Elective Energy and Resource Efficiency

IE-Elective Process Engineering

**Applicability in this and other Programs**

Applicable in Bachelor Health Informatics and all similar study programs.

**Entrance Requirements**

Advanced mathematics (Analytical Principles of Engineering IE-01)

**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:


All other books on Physics (namely for engineering) are suited as well.

### PHYSICS

**Objectives**

Workload:

Time of attendance: 60 hours, self-study: 60 hours, Total: 120 hours

**Type of Examination**

written ex. 90 min.

### LAB WORK IN PHYSICS

**Objectives**

Workload:

Time of attendance: 30 hours, self-study: 30 hours, Total: 60 hours

**Type of Examination**

report/presentation
IE-12 FOREIGN LANGUAGE II

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|                      | self-study: 30 hours  
|                      | Total: 60 hours     |
| Type of Examination  | written ex. 60 min. |
| Duration of Examination | 60 min.         |
| 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 industrial engineering sector. As a specialty the students can either choose an English course or vote between other languages such as Italian, Spanish or French.

**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 industrial 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 industrial 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 package 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 team work, integrity, and reliability.

- They will have reflected on the learning benefits derived from several immersion projects

Other language course

Please see the respective course descriptions.

Applicability in this and other Programs

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

Entrance Requirements

English course: The minimum entry-level requirement is a B2/C1-level of English according to the Common European Framework of Reference for Languages (CEFR) or A-level language skills according to the standards of the German education system. Alternatively, experience living abroad or successful participation in a study exchange may be sufficient.

Other language: Please see the respective course descriptions.

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 topic

**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**

Recommended reading for Business English: Writing and communication skills


Business Spotlight: <www.business-spotlight.de>


Recommended reading for other language

Please see the respective course descriptions for literature references.
IE-13 COMPULSORY ELECTIVE SUBJECTS OF A GENERAL ACADEMIC NATURE (AWP) I

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**Module Objective**

The AWP subjects 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.
### IE-14 APPLIED MATHEMATICS

<table>
<thead>
<tr>
<th>Module code</th>
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<tbody>
<tr>
<td>Module coordination</td>
<td>Prof. Dr. Robert Feicht</td>
</tr>
<tr>
<td>Course number and name</td>
<td>Applied Mathematics</td>
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<tr>
<td>Lecturer</td>
<td>Prof. Dr. Robert Feicht</td>
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<tr>
<td>Semester</td>
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</table>

**Module Objective**

**Professional and methodological competence**
Based on the learning outcomes of Analytical Principles of Engineering (IE-01) and Mathematics for Engineering (IE-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 Program**

IE-20 Financing

IE-21 Logistics and Operations Research

IE-Elective Modelling Theory

**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 (IE-01) and Mathematics for Engineering (IE-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

Supplementary literature
IE-15 FUNDAMENTALS OF ELECTRICAL ENGINEERING

<table>
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<tr>
<th>Module code</th>
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<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
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<tr>
<td>Course number and name</td>
<td>Fundamentals of Electrical Engineering</td>
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<tr>
<td>Lecturer</td>
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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
- Calculating 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 from 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 Program

IE-23 Plant Engineering
IE-26 Fundamentals of Measurement and Control Engineering
IE-27 Applied Measurement and Control Engineering
IE-Elective Industrial Automation and Information Technology

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: Plant Engineering (IE-23), Fundamentals of Measurement and Control Engineering (IE-26), Industrial Automation and Information Technology (Elective), Data Acquisition and Processing (Elective), etc.).

**Entrance Requirements**

Analytical Principles of Engineering (IE-01) as well as Mathematics for Engineering (IE-07) and Physics (IE-11) are 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**

- Moeller Grundlagen der Elektrotechnik, 23 Auflage, Thomas Harriehausen, Dieter Schwarzenau, Springer Vieweg 2013
IE-16 ENERGY TECHNOLOGY

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<td>Course number and name</td>
<td>Energy Technology</td>
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<tr>
<td>Lecturer</td>
<td>Prof. Dr. Rui Li</td>
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Module Objective

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

Professional competences:

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

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 Program
IE-22 Renewable Energies
IE-23 Plant Engineering
IE-30 Sustainability
IE-32 Project Work
IE-Elective Energy Markets
IE-Elective Energy and Resource Efficiency
IE-Elective Process Engineering

Applicability in this and other Programs
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 (IE-01)
Mathematics for engineers (IE-07)
Physics (IE-11)

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
Langeheinecke K., Jany P., Thieleke G, Langeheinecke K., Kaufmann A.: 
Thermodynamik für Ingenieure, 9. überarb. u. erweiterte Auflage, Springer Vieweg, 2013
IE-17 SCIENTIFIC WRITING, RESEARCH METHODS AND PROJECT MANAGEMENT

<table>
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<td>Module coordination</td>
<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
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<tr>
<td>Course number and name</td>
<td>Scientific Writing, Research Methods and Project Management</td>
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<tr>
<td>Lecturer</td>
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<td>report/presentation</td>
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<td>Language of Instruction</td>
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**Module Objective**

**Professional Competence**

**Knowledge**

Students are able to:

- Assess interdisciplinary scientific research topics and applications
- Describe project phases and project management methods
- Discuss underlying theories of research models
- Explain strategies of research problem analysis
- Describe structure of scientific and technical publications

**Skills**

Students are capable to:

- Address theoretical and/or experimental work for solving practice-oriented problems
- Plan and structure project work and evaluate work in progress
Address research questions with quantitative research methods

- Analyse data by applying different methods and critically evaluate and interpret the results

- Employ software tools for data analysis, processing and scientific illustrations

- Document scientific work and results, present and discuss them

**Personal competence**

**Social competence**

The students will be able to:

- Apply concepts and models of intercultural communication for higher effectiveness in international environments

- Communicate and collaborate successfully and respectfully with others in a team

- Have constructive professional discussions

- Do collaborative work on a small research project and deliver results

- Present and defend the results of their work

**Autonomy**

The students will be able to:

- Apply theoretical concepts to practical applications

- Read and understand scientific literature

- Acquire knowledge in a specific context independently and to map this knowledge onto other problem fields

**Applicability in this Program**

IE-27 Applied Measurement and Control Engineering

IE-32 Project Work

IE-37 Bachelor Module

**Applicability in this and other Programs**

Directly applicable in all modules involving reports, scientific presentations and writings as well as involving practical activities and project works (e.g. Applied Measurement and Control Engineering (IE-27), Project Work (IE-32), Bachelor Thesis (IE-37)).
Entrance Requirements

None.

Learning Content

The module provides the basics for developing skills and competences in applying scientific and research methods in both individual and collaborative working contexts focusing on:

- Introduction to methods in scientific work
- Code of ethics of engineers, plagiarism
- Working in collaboration with others in a multicultural international environment
- Procedures and phases of project management
- Working efficiently, planning and scheduling
- Risk analysis and management
- Methodical and systematic approach to the handling of complex tasks
- Introduction to quantitative research methods
- Processing and presenting scientific data and results
- Dissemination of results, written and oral communication
- Practicing in teams addressing simple research questions under the form of small research projects
- Writing technical reports and scientific papers
- Oral presentation of the work and discussion of the results

Teaching Methods

Seminaristic teaching / team work / self-reliant working / home work

Students are closely cooperating to carry out a small research project as a team work, training their competences acquired during their studies, and in the first part of the course, in a self-responsible and self-guided manner, fulfilling to specific tasks of the small projects.

Team work also includes promoting intercultural competence development by reflecting on personal identities and differences, principles of collective strength and advantages of being supported by a team. Addresses language used depending on the context, what favours and inhibits communication, how to deal with critical situations as well as on attributions, responsibilities within a collaborative team working.
Recommended Literature

- Kate L. Turabian, A Manual for Writers of Research Papers, Theses, and Dissertations, 8th Ed., Chicago Press 2013
**IE-18 CHEMISTRY**

<table>
<thead>
<tr>
<th>Module code</th>
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<tr>
<td>Module coordination</td>
<td>Prof. Dr. Raimund Brotsack</td>
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</table>
| Course number and name | Chemistry  
Lab Work in Chemistry |
| Lecturer            | Prof. Dr. Raimund Brotsack |
| Semester            | 3                     |
| Duration of the module | 1 semester            |
| Module frequency    | annually              |
| Course type         | required course       |
| Niveau              | undergraduate         |
| Semester periods per week (SWS) | 6                  |
| ECTS                | 6                     |
| Workload            | Time of attendance: 90 hours  
self-study: 90 hours  
Total: 180 hours |
| 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

o Ability to understand chemical problems and translate them into equations and apply the principles of chemistry to solve the problems.

o Ability to analyse the context of material based technical problems and to apply this to the design and development of technical systems and processes.

o Ability to transfer the knowledge of chemical principles into understanding the behaviour of unknown systems.

Method 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:

o Ability to work in intercultural mixed teams and communicate their progress and results.

o Ability to communicate with peers about a complex topic and find a joint approach to solving it.

Applicability in this Program

IE-22 Renewable Energies

IE-23 Plant Engineering

IE-30 Sustainability

IE-32 Project Work

IE-Elective Process Engineering

Applicability in this and other Programs

D-1105 Chemie, BA Maschinenbau at THD

E-1101 Chemie, BA Bauingenieurwesen at THD

Y-1101 Chemie, BA Umweltingenieurwesen at THD
Entrance Requirements
Analytical Principles of Engineering (IE-01)
Physics (IE-11)

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 Learning; Boston; 2016
### CHEMISTRY

**Objectives**

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

**Workload:**

Time of attendance: 60 hours, self-study: 60 hours, Total: 120 hours

**Type of Examination**

written ex. 90 min.

**Methods**

seminaristic lectures

### LAB WORK IN CHEMISTRY

**Objectives**

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.

**Workload:**

Time of attendance: 30 hours, self-study: 30 hours, Total: 60 hours

**Type of Examination**

report/presentation
Module Objective

The modules Foreign Language I and III aim to equip students with specialized language skills necessary for independent performance in a globalized industrial engineering sector. In doing so, it strives to deepen students’ relationship with the English language in business and technical settings so that they can effectively and efficiently implement the language as a practical communication tool.

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

Central to the module is optimizing fluency and communication skills; so too is cultivating 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 business and technical processes. Particular emphasis will be placed on honing students’ public speaking and team skills through work on a team presentation project for each course.

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 industrial 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 industrial 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 package 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 team work, integrity, and reliability.

- They will have reflected on the learning benefits derived from several immersion projects.

Applicability in this and other Programs

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

Entrance Requirements

The minimum entry-level requirement is B2/C1-level of English according to the Common European Framework of Reference for Languages (CEFR) or A-level language skills according to the standards of the German education system. Alternatively, experience living abroad or successful participation in a study exchange may be sufficient.

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

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


IE-20 FINANCING

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<td>Duration of Examination</td>
<td>90 min.</td>
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<tr>
<td>Language of Instruction</td>
<td>English</td>
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</table>

Module Objective

Professional and methodological competence
Based on the knowledge of the module Accounting (IE-04), students can classify the functions of investment and financing into the operational sequences and understand their basic tasks, goals, and instruments.

Knowledge

- Students know and understand central methodological foundations and instruments of investment and financing, can explain them and apply them to typical operational problems.
- Students have deep knowledge about asset pricing concepts in capital markets.
- Students are familiar with the fundamental differentiation between equity and debt and understand how different capital structures affect a company's income and risk.

Skills

- Students are able to differentiate corporate finance from other business functions in terms of its contents and its conceptual framework.
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**

- 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 appropriately communicate their solutions of investment and financing problems to the team or other professionals, i.e. they gain target group appropriate communication skills.

- The interactive character of the lectures and tutorials strengthens the student's discussion skills in the academic context.

**Autonomy**

- 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.

- A thorough understanding of asset pricing models will concurrently improve the student’s ability to make smart financial decisions.

- Students are able to relate their acquired knowledge to other lectures and topics.

**Applicability in this Program**

IE-30 Sustainability

IE-31 Management

**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 investment and financing decisions.

**Entrance Requirements**

Principles in Business (IE-05), Accounting (IE-04), Business Law (IE-10), and Applied Mathematics (IE-14) are recommended.

**Learning Content**
1. Overview of financial management
2. Understanding financial statements and cash flow
3. Time value of money
4. Valuing stocks and bonds
5. Risk and the required rate of return
6. 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

Supplementary literature
IE-21 LOGISTICS AND OPERATIONS RESEARCH

<table>
<thead>
<tr>
<th>Module code</th>
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<td>Module coordination</td>
<td>Prof. Dr. Robert Feicht</td>
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<tr>
<td>Course number and name</td>
<td>Logistics and Operations Research</td>
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<tr>
<td>Lecturer</td>
<td>Prof. Dr. Robert Feicht</td>
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Module Objective

**Professional and methodological competence**

Based on the learning outcomes of Principles in Business (IE-05), after completing this module, students are familiar with the core concepts and requirements of operational management and the operational functions of procurement, production, distribution and logistics affected by supply chain management (SCM). Based on the learning outcomes of Analytical Principles of Engineering (IE-01), Mathematics for Engineering (IE-07), and Applied Mathematics (IE-14), in this module students will also expand and deepen their quantitative skills.

**Knowledge**

- Students understand the concepts of integrative logistics and SCM as optimizing cross-departmental functions and practice process-oriented thinking.
- The students are qualified to build up comprehensive and detailed mathematical models with a focus on linear optimization and graph theory.

**Skills**

- Students are able to analyze fundamental problems in the functional areas of a company considering adequate SCM-design requirements (e.g., determination of demand, ordering and inventory policies, short and long-term production planning) and solve them using powerful methods.
Students apply the acquired knowledge of Operations Research unerringly to problems in the field of logistics, estimate the complexity, and choose and apply appropriate solution methods. Knowing the advantages and disadvantages of individual methods, students can assess the approaches' plausibility under different conditions.

Students are able to model a linear programming problem using spreadsheet software packages and their implemented Solver add-ins.

**Personal competence**

**Social competence**

In group work, students master SCM-relevant tasks, which require the handling of conflicting goals of the company and the development of convincing argumentation.

Close cooperation deepens student's social competences and fosters a team-oriented working style.

The interactive character of the lectures and tutorials strengthens the student's discussion skills in the academic context.

**Autonomy**

In practice, students can analyze decision-making processes in companies on their own and in a structured manner, by applying appropriate modeling and problem-solving methods. They are equally familiar with quantitative and qualitative issues.

Students are able to relate their acquired knowledge to other lectures and topics.

**Applicability in this Program**

IE-30 Sustainability
IE-31 Management
IE-32 Project Work
IE-Elective Modelling Theory
IE-Elective Operational Processes

**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 logistics and quantitative decision support systems.

**Entrance Requirements**
Principles in Business (IE-05), Analytical Principles of Engineering (IE-01), Mathematics for Engineering (IE-07), and Applied Mathematics (IE-14) are recommended.

**Learning Content**

**Logistics**
1. Introduction to operations management
2. Competitiveness, strategy, and productivity
3. Forecasting
4. Product and service design
5. Strategic capacity planning
6. Process selection and facility layout
7. Work design and measurement
8. Location planning and analysis
9. Inventory management
10. JIT and lean operations
11. Supply chain management

**Operations Research**
1. Introduction
2. Linear programming
   - Introduction
   - Sensitivity analysis
   - Applications
3. Distribution and network models
4. Integer linear programming

**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**
**Logistics**


**Operations Research**


IE-22 RENEWABLE ENERGIES

Module code | IE-22
Module coordination | Prof. Dr. Raimund Brotsack
Course number and name | IE-22 Renewable Energies
Lecturer | Prof. Dr. Raimund Brotsack
Semester | 4
Duration of the module | 1 semester
Module frequency | annually
Course type | required course
Niveau | Undergraduate
Semester periods per week (SWS) | 4
ECTS | 5
Workload | Time of attendance: 60 hours
self-study: 90 hours
Total: 150 hours
Type of Examination | written ex. 90 min.
Duration of Examination | 90 min.
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. Calculation examples enhance these skills.
Method 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 Program
IE-30 Sustainability
IE-Elective Process Engineering

Applicability in this and other Programs
Y-09 Regenerative Energien 1, Bachelor Umweltingenieurwesen at THD
D-7106 Regenerative Energie- und Stofftechnik, Bachelor Maschinenbau at THD

Entrance Requirements
Recommended requirements
- Analytical Principles of Engineering (IE-01)
- Mathematics for Engineering (IE-07)
- Physics (IE-11)
- Energy Technology (IE-16)
- Fundamentals of Electrical Engineering (IE-15)
- Chemistry (IE-18)

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**

Demirel, Y., (2nd ed.), 2016, Energy: Production, Conversion, Storage, Conservation, and Coupling
IE-23 PLANT ENGINEERING

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<tr>
<td>Module coordination</td>
<td>Prof. Markus Hainthaler</td>
</tr>
<tr>
<td>Course number and name</td>
<td>Plant Engineering</td>
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<tr>
<td>Lecturer</td>
<td>Prof. Markus Hainthaler</td>
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<td>English</td>
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Module Objective

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 material balances, 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. The expertise of this module will create the basis for all subsequent lectures of Industrial Engineering which require a holistic view of plants, like Applied Measurement and Control Engineering (IE-27), Process Reliability (IE-28) and Sustainability (IE-30).

Skills

After completing this module, the students will be able to 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 profitability of the plant. Additionally, they are able to communicate and visualize the production systems by creating material balances and flow-sheets in different depth of detailedness.

**Personal and social competences:**

The solution of the given examples 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 Program**

IE-27 Applied Measurement and Control Engineering

IE-Elective Energy and Resource Efficiency

IE-Elective Industrial Automation and Information Technology

IE-Elective Process Engineering

IE-Elective Process Optimization

**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 (IE-01), Mathematics for Engineering (IE-07), Physics (IE-11), Chemistry (IE-18), Energy Technology (IE-16), Fundamentals of Electrical Engineering (IE-15), Technical Mechanics II (IE-09)

**Learning Content**

**Fluid Mechanics**

- Fluid characterization: classes of fluids, rheology, surface tension, utilization of 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
- Material balances: conservation of mass / volume / moles
- Incomplete chemical conversion
- Yield, process profitability
- 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
- Production site considerations

Teaching Methods
The lecture focuses on seminaristic teaching, but also applies sufficient 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 and home work 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, an excursion is offered to an industrial production site.

Recommended Literature


G. Vetter "Rotierende Verdrängerpumpen für die Prozesstechnik", Vulkan, 1st edition 2006


various German and international norms and standards
IE-24 COMPULSORY ELECTIVE SUBJECTS OF A GENERAL ACADEMIC NATURE (AWP) II

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<tr>
<td>Module coordination</td>
<td>Tanja Mertadana</td>
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<td>Course number and name</td>
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**Module Objective**

The AWP subjects 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.
IE-25 FOREIGN LANGUAGE IV

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<td>Course number and name</td>
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Module Objective

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

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 industrial 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 industrial 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 package 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 team work, integrity, and reliability.

- They will have reflected on the learning benefits derived from several immersion projects.

Other language course

Please see the respective course descriptions.

Applicability in this and other Programs

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

Entrance Requirements

The minimum entry-level requirement is C1-level of English according to the Common European Framework of Reference for Languages (CEFR) or A-level language skills according to the standards of the German education system. Alternatively, experience living abroad or successful participation in a study exchange may be sufficient.

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
o product and project management
o complaint management, service and repair
o the future of cars
o case study on an area related to technology/design/engineering
o review of some grammar items

**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**

Recommended reading for Presentation skills for technical purposes (C1)


e: Englisch für Ingenieure. Darmstadt. <www.engine-magazin.de>


Inch. *Inch, das neue Sprachmagazin für technisches English*. <inchbyinch.de>


Recommended reading for other language
Please see the respective course descriptions for literature references.
IE-26 FUNDAMENTALS OF MEASUREMENT AND CONTROL ENGINEERING

<table>
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<tr>
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<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
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<tr>
<td>Course number and name</td>
<td>Fundamentals of Measurement and Control Engineering</td>
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<tr>
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| Workload          | Time of attendance: 60 hours  
|                   | self-study: 90 hours       
|                   | Total: 150 hours           |
| Type of Examination | written ex. 90 min.       |
| Duration of Examination | 90 min.                 |
| 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 Program**

IE-27 Applied Measurement and Control Engineering
Applicability in this and other Programs

The module provides the background competences for the Applied Measurement and Control Engineering module (IE-27) and for all other modules and study programs that require the fundamentals in the measurement and control fields.

Entrance Requirements

Fundamentals of Electrical Engineering (IE-15), Physics (IE-11), Technical Mechanics I (IE-03) & Technical Mechanics II (IE-09) 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**


- Electrical Measurements in the Laboratory Practice, Bartiromo R., De Vincenzi M., Springer 2016


# IE-27 Applied Measurement and Control Engineering

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<td>Course number and name</td>
<td>Applied Measurement and Control Engineering</td>
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<td>Lecturer</td>
<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
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## Module Objective

### Professional Competence

#### Knowledge

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

- Measuring devices and instruments
- Principles for measuring electrical and non-electrical quantities
- Data analysis and processing methods, linearization of characteristics
- Action principles of open- and closed-loop control technologies
- Industrial discontinuous controllers with two and three-level outputs
- Industrial continuous signal controllers

#### Skills

Students are capable of:

- Employing measurement instruments
Implementing various measurement circuits

Employing software tools for measurement data acquisition, data analysis and processing

Recording characteristics and of dynamic responses

Recording characteristics and applying mathematical corrections

Characterisation of controlled systems based on their static and dynamic responses

Assessing of responses to set-point changes and disturbance variables of control systems

Applying time and frequency response methods for the analysis of control systems

Using software tools (Matlab, Octave, etc.) for carrying out control system analysis

Design and implementation of closed-loop controllers

Plan and structure practical work and evaluate work in progress

Analyse data by applying different methods and critically evaluate and interpret the results

Document experimental work and results, present and discuss them

**Personal competence**

**Social competence**

The students will be able to:

Work in small groups to jointly solve technical problems, and experimentally validate their measurement and controller designs

Compare theoretical results with experiments and discuss it within the group

Present and defend the results of their work

**Autonomy**

The students can:

Reflect their knowledge and discuss and evaluate their own results

Individually apply theoretical concepts to practical applications

**Applicability in this Program**

IE-Elective Industrial Automation and Information Technology
Applicability in this and other Programs

The module provides main competences for other courses of different study programs that require measurement and control engineering fundamentals.

Entrance Requirements

Fundamentals of Measurement and Control Engineering (IE-26), Fundamentals of Electrical Engineering (IE-15) and Plant Engineering (IE-23) are recommended.

Learning Content

- Analog and digital measurements
- Recording characteristics, dynamic response, linearization
- Measurements of current and voltage
- Measurement of apparent, reactive and active power
- Measuring electrical work
- Measuring frequency
- Temperature measurement
- Pressure measurement
- Force and torque measurement
- Analysis of measurement results, statistics, fitting
- Principles of open- and closed-loop control technology
- Characterisation of controlled systems based their static and dynamic responses
- Control loops with discontinuous controllers
- Design and operation of a PID controller and its sub-classes
- Structure of the closed control loop, assessment of responses to set-point changes and disturbance variables
- Practical exercises and applications in:
  - automatic temperature control
  - closed-loop speed control of an electrical drive
  - closed-loop control of illumination intensity in a room
  - automatic liquid level and flow rate control
programmable logic control 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 control systems and measurement 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 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**

- Electrical Measurements in the Laboratory Practice, Bartiromo R., De Vincenzi M., Springer 2016
# IE-28 PROCESS RELIABILITY

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<td>IE-28 Process Reliability</td>
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## Module Objective

The students understand the importance of process reliability, its key concepts and practical approaches needed to avoid potentially catastrophic incidents and to improve the efforts in managing process hazards. Upon completion of this module the students should have the following competences:

### Professional competence

**Knowledge**

- Students understand and explain why and how these process safety systems have been implemented in some certain way, what they are intended to achieve, how to apply them daily to achieve safe and reliable operations, and possibly, how to improve them as needed.

- Students should know three essential parts of a process safety system that focus on general concepts of “safety culture“.

- They know safety pyramid with different levels and the way to define process risk. They are able to carry out a risk assessment considering the frequency and consequence.

- The students should identify different pictograms with specific hazard information. Students understand and explain typical barrier protection layer models.
Operational disciplines should be well understood from both the organizational and personal point of view.

The students are familiar with personal protective equipment and hazardous materials, as well as the fire explosion.

**Skill**

- Ability to apply key concepts and methodologies to support effective process safety systems.
- Ability to transfer the knowledge to fill in potential gaps between the approaches presented in this course and the practices in facility.
- Ability to analyze the facility’s process safety program.

**Method competence:**

After participating in this module, students will be able to understand safety culture and obey the safe guidelines in any working place. Based on the basic fundamental aspects of safety methodology, they can also meet and overcome the challenges that the safety is needed to be further updated as the technology develops, e.g. further maintaining/improving the facility’s process safety program.

**Personal and social competence:**

- Students should be able to let themselves complete work safely everyday.
- They have the personal communication skills to find the potential hazard not only from themselves but also from the coworkers, thus prevent the incidents in the first place.
- They reflect their disciplines to use safely the hazardous materials and process.

**Applicability in this Program**

IE-Elective Operational Processes

IE-Elective Process Engineering

**Applicability in this and other Programs**

BA Wirtschaftsingenieurwesen at THD

The learning outcomes of this module can be applied in any lectures and other study programmes that deal with process reliability, work safety, and hazard protection.

**Entrance Requirements**

Physics (IE-11)
Chemistry (IE-18)

**Learning Content**
- Introduction to Process Safety and its importance
- Safety Culture, Safety Permit Systems
- Process Safety Systems, Process Risk Assessment
- Protection Layer Model (Swiss Cheese Model, Bow Tie Diagrams)
- Operational Discipline (Organizational and Personal OD)
- Personal Protective Equipment
- Gases, Vapors, Particulates, Toxic Metals, Hazards of Liquids
- Hazardous Chemical Identification
- Fire and Explosion

**Teaching Methods**
- seminaristic teaching / exercises / case study / home work

**Remarks**
- Excursion to companies can be offered

**Recommended Literature**
IE-29 INTERCULTURAL COMPETENCES

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<tr>
<td>Course number and name</td>
<td>Intercultural Competences</td>
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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 are expected to have the following competences and skills.

**Professional competence and skills:**

- Develop knowledge and understanding of key theories, concepts and models in intercultural communication
- Familiar with different cultural standardization model, and how to apply these to various cultures
- The ability to work with other cultures on a common level of understanding, based on an analysis of commonalities and differences
- To be more effective in international environments
- To better understand and solve cultural problems, and to recognize how these affect international working environments
- To recognize how stereotypes and prejudice play into interactions between cultures
- The ability to differentiate between the different types of cultures

**Method 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 are driving this behavior, thus being able to adapt their own behavior to be able to react appropriately. They are able to analyze the effectiveness of working with others on various levels, that go beyond skill sets, and look for cultural patterns that work well with their own patterns.

**Personal and social competences:**

- The ability to understand one’s own cultural patterns and attitude
- The possibility to increase one’s own tolerance for cultural differences
- Increased cultural and emotional intelligence

**Applicability in this and other Programs**

The students will be able to work more effectively in international environments and to communicate more effectively with colleagues from cultures other than their own.

Students will be more equipped to successfully solve intercultural problems and conflicts, as well as potential miscommunication in engineering processes, due to cultural communication differences.

Increased cultural and emotional intelligence will help them to recognize potential problems and conflicts more effectively, and give them the ability to deescalate these more effectively and quickly.
Entrance Requirements
Fluent in English and some intercultural experience

Learning Content
Content of the course:
- Defining what culture is
- Recognizing cultural patterns
- Responses to other cultures
- How culture functions
- Organizational Culture
- Different layers of culture
- How to create new cultural patterns in organizations
- Leadership and management in intercultural settings
- Cultural and emotional intelligence

Teaching Methods
Interactive teaching in a seminar environment / group exercises / case studies

Recommended Literature


Module code | IE-30
---|---
Module coordination | Prof. Dr. Raimund Brotsack
Course number and name | IE-30 Sustainability
Lecturers | Prof. Dr. Bernhard Bleyer
| Prof. Dr. Raimund Brotsack
Semester | 5
Duration of the module | 1 semester
Module frequency | annually
Course type | required course
Niveau | undergraduate
Semester periods per week (SWS) | 4
ECTS | 5
Workload | Time of attendance: 60 hours
| self-study: 90 hours
| Total: 150 hours
Type of Examination | written student research paper
Language of Instruction | English

Module Objective

Using selected examples out of the field of Sustainable Development 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-damaging 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 clean energy, responsible consumption and production and climate action.
Method 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 Program

IE-32 Project Work

Applicability in this and other Programs

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

Entrance Requirements

Chemistry (IE-18)

Renewable Energies (IE-22)

Learning Content

Environment and Climate

- Definition of sustainability

- History of sustainability (Club of Rome, Bruntlandt, Agenda 21, Millennium Development Goals, Climate Change, …)

- Chemistry 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 – perspectives on climate change and sustainability:


o DIN EN ISO 14001

o ENEV

o EVPG

o KrW-/AbfG

o EU Emissions Trading Scheme (EU ETS) - Greenhous gas emission trading act
IE-31 MANAGEMENT

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<tr>
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**Module Objective**

**Professional competence**

Knowledge

- Know and understand the basic principles and methods of HR management.
- Know and understand the basic principles and methods of quality management.
- Know and understand the fundamentals of German Labour Law.

Skills

- Ability to judge on legal questions with respect to German Labour Law.
- Ability to choose and apply quality management methods.
- Ability to define and conduct six sigma quality improvement measures.

**Personal competence**

Social competence

- Ability to apply personal feedback techniques.
• Ability to adjust self and public image.
• Ability to apply communication techniques in one-on-one settings.

Autonomy
• Understand roles and dependancies in hierarchy.
• Understand fundamental dimensions of personalities.

Applicability in this Program
IE-33 Internship including PLV 1 and PLV 2
IE-37 Bachelor Module

Applicability in this and other Programs
Internship, Bachelor Thesis

Entrance Requirements
Applied Mathematics (IE-14)

Learning Content
• Introduction into roles within a company
• Introduction into methods of people management
• Introduction into aspects of change management
• Introduction into personnel development
• Introduction into personality models
• Introduction into relevant communication settings and their application
• Introduction into management techniques/styles
• Forms of employment
• Cancellation of contracts
• Introduction into relevant legal situation
• Introduction into relevant HR processes
• 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

Teaching Methods
Seminaristic teaching / roleplay / discussions / assignments

Recommended Literature
J. E. Pynes, Human Resources Management, Possey-Bass
J. Rowold, Human Resource Management, Springer
S. Lingemann, R. von Steinau-Steinrück, A. Mengel, Employment & Labor Law in Germany, Beck
J. Kirchner, P. Kemp, M. Magotsch, Key Aspects of German Employment and Labour Law
Herzberg, Frederick; Mausner, Bernard; Snyderman, Barbara Bloch: The Motivation to Work. Wiley
J. Marques, S. Dhiman, Engaged Leadership, Springer
Buckingham, Coffman, Erfolgreiche Führung gegen jede Regel, Campus Verlag, 3.Auflage, 2005
Malik, Führen, Leisten, Leben - Wirksames Management für eine neue Zeit, Campus Verlag, 2006
Mathieu Weggemann, Wissensmanagement, mitp-Verlag, Landsberg
Gerhard Linß, Qualitätsmanagement für Ingenieure, Hanser, München-Wien
Pfeifer, Praxisbuch Qualitätsmanagement, Hanser, München-Wien
### IE-32 PROJECT WORK

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### Module Objective

#### Professional competence

**Knowledge**
- 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 dependance of the project.

#### Personal competence

**Social competence**
- Ability to work task-oriented in small mixed groups, leveraging different skills in the team.
Ability to prioritize tasks.

Ability to escalate problematic issues.

Autonomy

Show ability to structure, plan and execute tasks around a new project.

Show skills in issue management.

Ability to re-plan if issues cannot be solved.

**Applicability in this and other Programs**

Specific for IE 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
- Specification designing
- Building of items/electronics
- Programming
- Numerical simulation
- Technical implementation
- Operation
- Optimization

**Teaching Methods**

Independent work. Supervision by professors and technicians/lab engineers. Counseling if needed.
Recommended Literature

Varies - specific to the project.
IE-33 INTERNSHIP INCLUDING PLV 1 AND PLV 2

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**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
 o Ability to integrate into teams with more experienced professionals.

Autonomy
 o Succeed professionally in a new environment.
 o Learn how to autonomously achieve results.
 o 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: 120 ECTS and PLV1 finalized.
For PLV2: Internship finalized.

Learning Content
PLV 1 seminars: Six workshops, thereof three 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:
 o Application skills
 o Interview training
 o Communication training
 o Presentation trainings
 o MS-Office trainings
 o Intercultural training
 o Job skills
 o 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. Students 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.
IE-37 BACHELOR MODULE

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<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
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Module Objective

Professional Competence

Knowledge

- The students are in possession of necessary knowledge of theories and methods for addressing complex engineering problems
- 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 techniques 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 Industrial Engineering

**Entrance Requirements**

According to the study and examination regulations of the Bachelor of Industrial Engineering study programme, Section 11 - 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 training in applied 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 on applied communication techniques 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 / 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

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

**BACHELOR THESIS**

**Type of Examination**

bachelor thesis

**APPLIED COMMUNICATION TECHNIQUES**

**Type of Examination**

oral ex. 30 min.
IE-ELECTIVE PROCESS ENGINEERING

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<th>Module code</th>
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<td>Module coordination</td>
<td>Prof. Markus Hainthaler</td>
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<td>Process Engineering</td>
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<td>Lecturer</td>
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<td>Semester</td>
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</table>

**Module Objective**

**Professional and methodological competences:**

*Knowledge*

After being taught the broad fundamentals of Industrial Engineering, this elective module in the last semester 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 given examples 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 last semester of studies, 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 (IE-01), Mathematics for Engineering (IE-07), Physics (IE-11), Chemistry (IE-18), Technical Mechanics II (IE-09), Plant Engineering (IE-23), Energy Technology (IE-16), Renewable Energies (IE-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 sufficient 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 and home work 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, an excursion is offered to an industrial production site.

Recommended Literature


o H.S. Fogler "Essentials of Chemical Reaction Engineering", Prentice Hall, 2nd edition 2018


IE-ELECTIVE DATA ACQUISITION AND PROCESSING

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<th>Module code</th>
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<td>Module coordination</td>
<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
</tr>
<tr>
<td>Course number and name</td>
<td>Data Acquisition and Processing</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
</tr>
<tr>
<td>Semester</td>
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<td>Workload</td>
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</table>

Module Objective

Professional Competence

Knowledge

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

- Basics of data acquisition
- Discrete-Time Signals and Systems
- Discrete-Time System properties, Linear Time-Invariant (LTI) Systems
- $z$-Transform and its application to LTI systems
- Transient and Steady-State responses
- Frequency analysis of signals, the Fourier analysis
- Frequency response of LTI Systems
- Implementation of Discrete-Time Systems
Implementation of Finite-duration Impulse Response (FIR) and Infinite-duration Impulse Response (IIR) digital filters

Skills

- Ability to apply Digital Signal Processing methods in developing signal processing procedures
- Ability to design and implement Discrete-Time Systems, i.e. digital filters
- Ability to employ scientific graphing, data analysis, data processing and programming software tools

Personal competence

Social competence

- Team working on applying theoretical concepts of data processing to practical applications.
- Students jointly develop ideas and deal creatively with questions in workshops or working groups.
- Team coaching: Students help each other by giving feedback and objective criticism.

Autonomy

- Analytical thinking and attention to details
- Ability to consider different strategies to solve problems

Applicability in this and other Programs

Bachelor of Industrial Engineering

Entrance Requirements

Informatics for Engineering II (IE-08), Fundamentals of Electrical Engineering (IE-15) and Applied Measurement and Control Engineering (IE-27) are recommended

Learning Content

The module provides an introduction to data analysis and processing, addressing:

- Fundamentals of data acquisition and processing, advantages of digital over analog signal processing
- Introduction to Discrete-Time Signals and Systems
- Continuous-Time versus Discrete-Time signals
Continuous-Valued versus Discrete-Valued signals

Sampling of analog signals, the Sampling Theorem

Discrete-Time Processing of Continuous-Time Signals

Analog-to-Digital and Digital-to-Analog Converters

Quantization errors and coding

Oversampling A/D and D/A converters

Discrete-Time Systems, Block Diagram representation

Analysis of discrete-time Linear Time-Invariant Systems (LTI) and stability

Systems with Finite-duration and Infinite-duration Impulse Response (FIR and IIR)

Implementation of Discrete-Time Systems, recursive and nonrecursive realizations of FIR systems

The z-Transform and its application to the analysis of LTI systems

Analysis of LTI systems in the z-domain

Transient and Steady-State responses

Frequency analysis of signals, the Fourier analysis

Power Density Spectrum and Energy Density Spectrum

Frequency-Domain analysis of LTI systems

Frequency response of LTI systems

LTI systems as Frequency-Selective Filters and Resonators

Implementation of Discrete-Time Systems, FIR and IIR Structures

Direct-Form, Cascade-Form, Frequency-Sampling and Lattice Structures

Practical computer-based sessions are enabling the students to consolidate the theoretical knowledge as well as to develop practical skills in implementing and testing data processing algorithms as well as to learn to employ scientific graphing and data analysis software tool for that purpose. Team-working on assignments are further developing collaborative problem-solving skills and consolidating their knowledge base.

**Teaching Methods**

Seminaristic teaching / work on computer/ practical exercises and assignments / home work
Whiteboard, PowerPoint presentation, document camera (visualiser) and additional lecture materials in iLearn

Use of Computers: students work individually and in groups on practical examples and on implementations of digital processing algorithms.

**Recommended Literature**

- IgorPro a scientific graphic, data analysis and programming tool for scientists and engineers WaveMetrics Inc. [https://www.wavemetrics.com/](https://www.wavemetrics.com/)
# IE-ELECTIVE INDUSTRIAL AUTOMATION AND INFORMATION TECHNOLOGY

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<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
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<tr>
<td>Course number and name</td>
<td>Industrial Automation and Information Technology</td>
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<tr>
<td>Lecturer</td>
<td>Prof. Dr. Stefan Mátéfi-Tempfli</td>
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## Module Objective

### 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
- Systematical analysis of automation tasks and are able to use them
- Properties of processes and explain methods for process analysis
- Logical design of industrial automation
- How an industrial programmable logic controller operates
- Operation principles of various processing hardware used for automation
- Principles of process flow control and monitoring
- Software design concepts
- Industrial Networks
- Principles of field bus systems and how to use them
- Factory level control and supervision
- Smart Factory technologies and Industry 4.0
- Big Data aspects of industrial and factory business systems

**Skills**

Students are capable of:

- Developing application-based concepts and solutions in automation to solve technical problems
- Analysing complex automation tasks
- Comparing methods for process modelling and select an appropriate method for actual problems
- Developing programs for programmable logic controllers
- Designing and implement user interfaces and human machine interfaces
- Implementing communication using different field buses and network protocols
- Reflecting their knowledge in practical applications and document the results of their work

**Personal competence**

**Social competence**

Students are able to:

- Work out solutions together in small groups
- Develop solutions in a production environment with qualified personnel at technical level

**Autonomy**

Students are able to:

- Analyze automation tasks independently
- Develop programs for programmable logic devices autonomously
- Develop solutions for practice-oriented tasks of automation independently
- Assess consequences of their professional actions and responsibilities
Applicability in this and other Programs

Bachelor of Industrial Engineering

Entrance Requirements

Informatics for Engineering II (IE-08), Fundamentals of Electrical Engineering (IE-15), Applied Measurement and Control Engineering (IE-27) and Plant Engineering (IE-23) are recommended.

Learning Content

The Industrial Automation and Information Technology module is focusing to the following aspects:

- Introduction to automation technology
- Process systems and automated machinery
- Automation and manufacturing
- Basic Programming Principles of PLCs
- Fundamentals of PLC Logic Programming
- Analog and Digital Input/Output Configuration
- Analog Programming and Advanced Control
- Human Machine Interaction and User Interfaces
- Process Control and Monitoring
- Industrial automation networks
- Field bus systems and control networks
- Safety technologies in industrial networks
- Concepts of Industry 4.0
- Industrial and factory business systems
- Smart Factory 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 industrial 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 industrial automation where students work individually and in groups on practical examples and on assignments implementing various automation tasks.

**Recommended Literature**

- Stamatios Manesis, Introduction to industrial automation, CRC Press, Taylor & Francis 2018
- Jan Lunze, Automatisierungstechnik : Methoden für die Überwachung und Steuerung kontinuierlicher und ereignisdiskreter Systeme, De Gruyter Oldenbourg 2016
- Boca Raton, Industrial communication technology handbook, CRC Press Taylor & Francis 2017
IE-ELECTIVE ENERGY AND RESOURCE EFFICIENCY

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<th>Module code</th>
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<td>Prof. Dr. Rui Li</td>
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<td>Course number and name</td>
<td>Energy and Resource Efficiency</td>
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<tr>
<td>Lecturer</td>
<td>Prof. Dr. Rui Li</td>
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**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 competences:**

- 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.
Method 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:
o  Access and evaluate the ways of energy conservation in its various forms that are the cornerstones of a successful national energy strategy.
o  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 Program
IE-16 Energy Technology
IE-22 Renewable Energies

Applicability in this and other Programs
BA Wirtschaftsingenieurwesen at THD
Mechanical Engineering
And any other study programme that deals with energy technology, energy management standards.

Entrance Requirements
Energy Technology (IE-16)
Renewable Energies (IE-22)
Plant Engineering (IE-23)
Sustainability (IE-30)

Learning Content
o  Core concepts and basic points on resource and energy efficiency and management
o  Basic calculations of energy efficiency for different power cycles
o  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**

- Struchtrup, H., Thermodynamics and Energy Conversion, Springer, Heidelberg, 2014,
- Demirel, Y., Energy: Production, Conversion, Storage, Conservation, and Coupling, 2016,
IE-ELECTIVE MODELLING THEORY

<table>
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<td>Prof. Dr. Robert Feicht</td>
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<td>Modelling Theory</td>
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Module Objective

Professional and methodological competence
Based on the learning outcomes of Principles in Business (IE-05), Applied Mathematics (IE-14), and Logistics and Operations Research (IE-21), 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**

Principles in Business (IE-05), Applied Mathematics (IE-14), and Logistics and Operations Research (IE-21) 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**

**Supplementary literature**
IE-ELECTIVE GLOBALISATION

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<td>Globalisation</td>
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| Workload            | Time of attendance: 60 hours  
|                     | self-study: 90 hours  
|                     | Total: 150 hours      |
| Type of Examination | report/presentation  |
| Language of Instruction | English             |

**Module Objective**

Globalisation is a contested concept: for the students after successfully six semesters of study program, this elective course gives a solid intellectual foundation to prepare them to become global students.

**Professional competence:**

**Knowledge**

- Understand what is meant by the term globalization.
- Describe the changing nature of the global economy.
- Identify the macropolitical and economic changes occurring worldwide.
- Recognize how differences in social culture influence values in business.
- Understand why nations trade with each other.
- Summarize the different theories explaining trade flows between nations.
- Understand what is meant by spot exchange rates.
- Describe the historical development of the modern global monetary system.
- Explain the concept of international business strategy.
o Explain the promises and risks associated with exporting.

**Skill**

o Ability to understand and describe the changing nature of the global economy.

o Ability to identify the roles they should take in their lives to cope with global issues such as environmental deterioration, population explosion, and wealth gap.

o Ability to apply the concept of globalization and its impact in the areas where it has had an effect: production, governance, identity, knowledge.

**Method competence:**

After finishing this lecture, students will be able to understand how the process of globalization is creating opportunities and challenges for management practice. They can also explain the role played by the World Bank and the IMF in the international monetary system. Additionally, students are able to apply the basic steps involved in export and import financing.

**Personal and social competence:**

- Demonstrate and access the further knowledge of the interconnectedness of global dynamics from different perspectives (history, issues, processes, trends).

- Reflect their knowledge of the interconnectedness of global dynamics case by case.

**Applicability in this and other Programs**

This module is an elective lecture in the last semester of studies, 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 subject of globalization and international relations.

**Entrance Requirements**

IE-20 Financing

IE-29 Intercultural Competences

IE-31 Management

**Learning Content**

o Globalization and the impact of globalization

o National differences in economic development, differences in culture

o International trade theory

o The foreign exchange market and the international monetary system
The strategy of international business
Exporting, importing, and countertrade
Global production and supply chain management
Global human resource management

Teaching Methods

seminaristic teaching / exercises / group discussion / case study

Recommended Literature

Ulrich V.: Regional Integration, Economic Development and Global Governance, Edward Elgar 2011
Module Objective

The energy industry is one of the most capital-intensive and fastest-growing industries in the world. The course offers the understandings of energy and power systems in regulated and competitive environments and implications on business decisions for firms in these industries. As a typical cross-disciplinary course, it is assumed that these students, before the lecture, already are familiar with the physical structure of power systems, understand the purpose and principles of a power flow calculation with basic optimization theory. After completing the course, the students are expected to have the following competences.

Professional competence:

- Develop knowledge and understanding of key theories, concepts and models in energy marketing.
- Familiar with conventional and renewable energy resources in Europe and all over the world.
- Understand a solid working knowledge of the mechanisms of energy markets.
- Acquire the deep understanding of supply and demand dynamics.
- Obtain an overview over energy marketing communication and the steps to marginal cost.
Method competence:

The students are able to understand how the economics affect the physics and how the physics constrain the economics. They have a solid understanding of the basics and help them develop innovative solutions to problems that vary in subtle ways from country to country, from market to market and from company to company.

Personal and social competences:

- The students can apply economic fundamentals and the institutional knowledge needed to implement sound economic decisions relating to energy market.
- The students are expected to have the competence of the modeling, information acquisition, critical thinking and communication skill directly to the minds of the engineers, manager or decision makers.
- With a broader perspective, the students can read the related literature and to continue to grow and learn beyond this lecture.

Applicability in this and other Programs

This module is an elective lecture in the last semester of studies, so there will be no direct applicability within the same study programme. However, the learning outcomes can be applied in any other study programmes including the combination of energy and economics.

Entrance Requirements

IE-16 Energy Technology
IE-22 Renewable Energies
IE-20 Financing

Learning Content

- Analysis of the operation of power systems in a competitive environment
- Analysis of the operation of pure energy markets: gas, oil, coal, and electricity market architecture
- Smart grid and renewable energy in electricity markets
- Power system security and the effects that networks have on electricity prices
- Risk and risk management in energy market
- Issue of investments in power generation and transmission equipment in a competitive environment
- Impact of financial market trends
- Impact of political policy, energy transition (Energiewende) in Germany

**Teaching Methods**

seminaristic teaching / exercises / tutorials (case study) / group discussion

**Recommended Literature**

IE-ELECTIVE BUSINESS PLANNING AND START-UP MANAGEMENT

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<td>Module coordination</td>
<td>Prof. Dr. Raimund Brotsack</td>
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<tr>
<td>Course number and name</td>
<td>Business Planning and Start-Up Management</td>
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<tr>
<td>Lecturer</td>
<td>Prof. Dr. Raimund Brotsack</td>
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Module Objective

Students learn about the general aspects of building a start-up company and strategies regarding innovation management.

**professional competence:**

*Knowledge*

- Students know how to apply tools for analysis and management in business theory and praxis.
- They are familiar in entrepreneurial thinking and dealing.
- Students understand basic principles of business development, business planning and start-up and innovation management.

*Skills*

- Students understand the theoretical principles of strategic management.
- Students understand the importance of continuous and structured active business development and being able to choose and apply adequate business planning/management tools in professional practice.
Method competences:

- Students are able to structure a project independently and draw up a binding schedule with realistic milestones, as well as carry out a progress check.

- Through the teaching of the fundamental elements of innovation management, students should be in a position to analyse the innovation process in a company, recognize the opportunities and risks of innovations and be able to actively organise the innovation-management of a company.

- They are able to present their own ideas in form of a small business plan.

Social competence

- Ability to work in intercultural mixed teams and communicate their progress and results while creating an own small business plan.

Applicability in this Program

IE-37 Bachelor Module

Applicability in this and other Programs

W-7104 Gründungsmanagement und Businessplan, BA Wirtschaftsingenieurwesen at THD

A-6104 Management Business-Plan-Seminar, BA Betriebswirtschaft at THD

Entrance Requirements

Principles in Business (IE-05)
Scientific Writing, Research Methods and Project Management (IE-17)
Financing (IE-20)
Management (IE-31)

Learning Content

Business Planning and Start-Up Management

- application of the tools of analysis and management in business theory and practice

- structuring of projects with time and milestone planning

- set out realistic project targets with use of resources and cost-benefit analysis
o control of project development and monitoring of target achievement including fall-back solutions for emergencies

o training in entrepreneurial thinking and dealing

_Innovation Management_

o principles of innovation management and strategic innovation planning

o customer benefits through innovation

o creative processes and systematic brainstorming

o evaluation and selection of ideas, feasibility check and development planning

o intellectual property tools

**Teaching Methods**

seminaristic teaching / project work in groups

**Remarks**

Business planning in small groups in the basis of own ideas.
IE-ELECTIVE OPERATIONAL PROCESSES

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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
**Method 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**

W-26 Betriebliche Informationssysteme, BA Wirtschaftsingenieurwesen at THD

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

**Entrance Requirements**

Principles in Business (IE-05)

Management (IE-31)

**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

- Eversheim, W., Organisation in der Produktionstechnik, Arbeitsvorbereitung, VDIVerlag, Düsseldorf