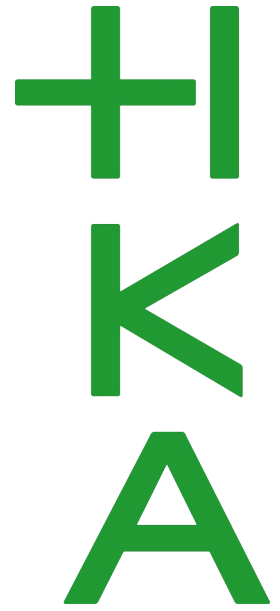


Hochschule Karlsruhe
University of
Applied Sciences

Fakultät für
**Elektro- und
Informationstechnik**



Module Handbook – Exam Regulations version 6

M.Sc. degree programme in Sensor Systems Technology

State of April 2026

Abbreviations:

- ECTS European Credit Transfer and Accumulation System
- CP Credit Points, ECTS-Points
- h hours
- SWS semester periods per week
- SoSe Summer semester
- WiSe Winter semester
- SPO examination regulations
- HsKA Hochschule Karlsruhe – Technik und Wirtschaft
- PH Pädagogische Hochschule Karlsruhe
- SSTM M.Sc. degree programme Sensor Systems Technology

Explanations:

Module: Combination of several courses to form a unit with a common learning objective.

Workload: Information on the workload includes the attendance times and the preparation times before and after the actual course. The workload is measured in hours (h), which result from the credits (ECTS): in the form of performance points, so-called credit points (see below).

ECTS: is credit points defined in the European Credit Transfer System (30 Credit points per ½ year). Each credit point is equivalent to 30 hours total workload

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Courses of Focal Subject will be added later

1. Semester

Module title: *Advanced Physics*

Module summary
Module code: SSTM110
Module coordinator: Prof. Dr. Christian Karnutsch
Credits (ECTS): 6
Semester: 1
Pre-requisites with regard to content: Basic knowledge in mathematics and physics (Bachelor level)
Pre-requisites according to the examination regulations: --
Learning outcomes and competencies: After successful completion of the module <ul style="list-style-type: none">• Students understand the causes and effects of electromagnetic interactions• They know the phenomena of classical electrodynamics and understand their general mathematical descriptions (Maxwell laws) as well as their applications• Students have an understanding of the quantized form of electromagnetic waves (photons) and their interaction with matter• Students have knowledge of the description of quantum mechanical systems• Students will be able to understand and analyze sensor principles based on theoretical models, giving them a deeper understanding of the underlying physical mechanisms• Students are able to link different phenomena with the help of theoretical models and thus structure the field of knowledge• Students are qualified for more complex tasks in the development of sensors
Assessment: Written exam of 120 min plus Lab

Course: Physics
Module code: SSTM111
Lecturer: Dr. Weidler
Contact hours: 4
Semester of delivery: 1
Type/mode: Lecture
Language of instruction: English
Content: <ul style="list-style-type: none">• Mathematical foundation of Electrodynamics: Vector Analysis / Introduction of del-operator / Scalar and Vector Potentials• Electrostatics / Electromagnetic Fields (Gauss's Law) / Networks

<ul style="list-style-type: none"> • Magnetostatics / . Magnetic Fields (Ampere's Law) / mag. Dipole • DC and AC Circuits • Maxwell Equations / Solution of Maxwell Equations
<p>Recommended reading:</p> <ul style="list-style-type: none"> • Feynman, Leighton, Sands: Lectures on Physics Electromagnetism and Matter, Vol. II, Part I, Addison Wesley, R. Oldenbourg Verlag, 1965 • Serway, Jewett: Physics for Scientists and Engineers (9th ed.), Brooks/Cole Thomson, 2014 • Griffiths: Introduction to Electrodynamics (5th ed.), Pearson Cambridge University Press, 2023 • Shadowitz: The electromagnetic field, Dover Publications, 1975
<p>Comments:</p> <p>The lecture requires a good knowledge of basic calculus, basics of analytical geometry and physics equivalent to secondary/grammar school graduation</p>

Course: Solid State Physics
Module code: SSTM112
Lecturer: Prof. Dr. Christian Karnutsch
Contact hours: 2
Semester of delivery: 1
Type/mode: Lecture
Language of instruction: <i>English</i>
<p>Content:</p> <ul style="list-style-type: none"> • Atoms & Electrons • Crystal properties and growth of semiconductors • Doping of semiconductors • Charge carrier transport • Physics of p-n-junctions • Metal-semiconductor interfaces • Optical processes in semiconductors • Introduction to quantum mechanics
<p>Recommended reading:</p> <ul style="list-style-type: none"> • "Introduction to Solid State Physics" by Charles Kittel, Covers fundamental concepts with a clear structure • "Solid State Physics" by Neil W. Ashcroft and N. David Mermin More in-depth and rigorous than Kittel • "Solid State Physics: An Introduction" by Philip Hofmann Modern and concise, with clear explanations and good illustrations • "Principles of the Theory of Solids" by J. M. Ziman Focuses on the theoretical foundations of solid-state physics. • More mathematical and conceptual—ideal for those interested in theory • "Electronic Properties of Materials" by Rolf E. Hummel Connects solid-state physics with materials science and electronic engineering • "Fundamentals of Semiconductors" by Peter Y. Yu and Manuel Cardona Especially useful for solid-state physics of semiconductors
Comments:

Module title: Advanced Chemistry

Module summary

Module code: SSTM120

Module coordinator: Prof. Dr. Pinkwart

Credits (ECTS): 6

Semester: 1

Pre-requisites with regard to content:

A basic understanding of general chemistry and introductory physics, including fundamental concepts of thermodynamics and chemical bonding, is recommended as a pre-requisite for this module.

Pre-requisites according to the examination regulations:

There are no specific pre-requisites defined for this module in the examination regulations.

learning outcomes and competencies:

- Students have knowledge of the physical and chemical foundations of sensors and biosensors, including their operating principles.
- Students understand key concepts of physical chemistry (e.g. properties of gases, liquids and solutions, thermodynamics, chemical energetics, chemical affinity) and can relate them to sensor systems.
- Students are familiar with central topics of general chemistry (e.g. chemical reactions, bonding types, hydrogen bonding, acids and bases, buffer systems, redox reactions, electrochemistry, polymers) and can connect them to sensor materials and functionalities.
- Students are able to use theoretical models to understand and analyze sensor principles, enabling a deeper grasp of the underlying physical and chemical mechanisms.
- Students can link different chemical and physical phenomena with the help of theoretical models and thus structure the knowledge field of sensor and biosensor technology.
- Students are qualified to take on more complex tasks in the development and evaluation of (bio)sensors.

Assessment: Written exam, 120 min

Course: Physical Chemistry

Module code: SSTM121

Lecturer: Dr. C. Cremers

Contact hours: 2

Semester of delivery: yearly, summer semester

Type/mode: Lecture

Language of instruction: English

Content:

- Spectroscopy
- Properties of ideal and real gases
- Properties of liquids and solutions
- Chemical energetics
- Pellistor sensor
- 2nd and 3rd law of thermodynamics
- Chemical Affinity

<p>Recommended reading: P. Atkins, L. Jones: Chemical Principles, W.H. Freeman and Company D.C. Harris: Quantitative Chemical Analysis, W.H. Freeman and Company</p>
<p>Comments: This course provides a focused introduction to key concepts of physical chemistry that are directly relevant for understanding and designing sensor systems. It is particularly well suited as a foundation for students who wish to deepen their knowledge of thermodynamics, spectroscopy and gas/liquid properties in the context of advanced (bio)sensing applications.</p>

Course: Chemistry
Module code: SSTM122
Lecturer: Dr. Saadia Ilhem Knipping
Contact hours: 4
Semester of delivery: yearly, summer semester
Type/mode: lecture
Language of instruction: English
<p>Content:</p> <ul style="list-style-type: none"> • Matter and Properties • Chemical Reactions • Materials, • Type of chemical bonds • Hydrogen bonding • Bonding of models bands • Acids and bases • Buffer • Redox Reactions • Electrochemistry Polymers
<p>Recommended reading: P. Atkins, L. Jones: Chemical Principles, W.H. Freeman and Company D.C. Harris: Quantitative Chemical Analysis, W.H. Freeman and Company</p>
<p>Comments: This course offers a broad overview of general chemistry topics, ranging from bonding and reaction types to acids–bases, electrochemistry and polymers, thereby supporting a systematic understanding of materials and processes used in sensor technologies. It is especially valuable for students who need to consolidate and expand their chemistry background for further studies in sensor systems and related fields.</p>

Module title: Computer Science

Module summary

Module code: SSTM130

Module coordinator: Prof. Dr. Thorsten Leize

Credits (ECTS): 6

Semester: 1

Pre-requisites with regard to content: Basic C programming knowledge

Pre-requisites according to the examination regulations:

learning outcomes and competencies:

The students know about the object-oriented paradigm and can apply and use it in the programming language C++. They are able to construct object-oriented software designs. Furthermore the students can convert numbers into different representations and understand the principles of A/D and D/A converters as well as microcomputers and can apply these.

Assessment: Written exam 60 min + lab work (passed/not passed, 1 semester), which one will be announced at start of lectures.

Course: Computer Science

Module code: SSTM131

Lecturer: Prof. Dr. Thorsten Leize

Contact hours: 2

Semester of delivery: yearly, summer semester

Type/mode: lecture with integrated lab

Language of instruction: English

Content:

- Repetition about basic concepts
- Differences between C and C++
- The object oriented programming paradigm
- classes, methods, inheritance, operator overloading, polymorphy, UML
- Introduction to modern concepts of C++ from new standard versions 11,14 and 20.

Recommended reading: Current version of any C++ text book. E-books recommended, see Ilias

Comments: It highly is recommended to do exercises by yourself throughout the semester

Course: Digital Electronics Lab

Module code: SSTM132

Lecturer: Leticia Garcia Herrera

Contact hours: 2

Semester of delivery: yearly in summer semester

Type/mode: online lab

Language of instruction: English

Content:

- *Digital Numbers*
- *Logic Gates*
- *Boolean Algebra*
- *Combinatory Logic*
- *Data control Devices / Flip – Flops*
- * *Counters and Shift Registers*
- *Analog / Digital and Digital / Analog Converters*

Recommended reading:

- Kleitz, William - Digital and microprocessor fundamentals - London: Prentice Hall Basic
- Kleiz, William - Digital Electronics a practica approach with VHDL
- Basic Experiments in Digital technology - Online E-book DIGILab

Comments:

Module title: *Control Theory***Module summary**

Module code: SSTM140

Module coordinator: Prof. Dr. Daniel Braun

Credits (ECTS): 6

Semester: 1

Pre-requisites with regard to content:

Strong foundation in mathematics and differential equations at university level (> 4 ECTS), basics of integral transformations and systems modelling, Electrical/Electromechanical engineering at university level (> 4 ECTS)

Pre-requisites according to the examination regulations:

none

learning outcomes and competencies:

With the successful completion of the module Control Theory, the student is able to perform system modelling tasks for single input/single output systems for gathering further insight into the system's static and dynamic behavior. The student is able to apply systems analysis tools for judging the systems stability and response to varying input signals. The student is enabled to choose an appropriate controller structure and apply methods for selecting and tuning the controller parameters to achieve a desired system behavior.

The resulting controller can be designed as continuous time system as well as a discrete time system, methods for assessing the system properties in both domains are available to the student.

The student is able to understand electronic circuits and to work with operational amplifiers. With this module the participants learn to use mathematical transformations, have an understanding of dynamic processes, can judge stability of systems and tune controller parameters. Students can design analogue and digital control systems and can create commercially-viable control applications.

Assessment:

Lectures of the module share a joint written examination (duration 120 min) with mark + lab work (passed/not passed, 1 semester)

Course: Control

Module code:SSTM141

Lecturer: Prof. Dr. Daniel Braun

Contact hours: 4 SWS

Semester of delivery: yearly, summer

Type/mode: lecture

Language of instruction: English

Content:

The lecture introduces the student to systems modelling and analysis as well as to the design of analog controllers:

- Process modelling, Laplace Transformation and Linearization
- Transfer Functions
- Stability and Basic Stability Criteria
- Frequency Response and Root Locus Analysis
- Control Loops and Control System Analysis
- Analog Controller Techniques and Control Loop Design
Comparison of digital control and analog control systems
- Definition and properties of the z-transform, inverse z-transform
- stability of discrete-time systems
- Deadbeat control algorithms
- PID control algorithms and transformation for analog to digital controllers
- Modelling and simulation of control loops
- Parameter Optimization with CA tools
- Basics of system identification

Recommended reading:

- Frederik, Dean / Chow, Joe H. - Feedback control problems using Matlab
- Nise, Norman S. - Control systems engineering – New York: Wiley 3rd Ed. 2000
- Lindner, Douglas - Introduction to signals and systems
- Zilouchian, Ali / Jamshidi, Mo - Intelligent control systems using soft computing methodologies
- Ogata, Katsuhiko – Discrete-Time Control Systems
- Nise, Norman S. - Control systems engineering – New York: Wiley 3rd Ed. 2000

Comments:

Course: Analogue Electronics Lab

Module code: SSTM142

Lecturer: Carlos Fernando Sánchez Ruiz
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Contact hours: 2 SWS

Semester of delivery: yearly, summer

Type/mode: online lab

Language of instruction: English

Content: Experiments with Resistors, Capacitors, Inductors, Voltage Sources, Diodes and Transistors, Operational Amplifiers (OP), OP basic Circuits.
--

Recommended reading: See Ilias

Comments:

Module title: Language and Culture

Module summary

Module code: SSTM150

Module coordinator: Director of the programme

Credits (ECTS): 6

Semester: 1

Pre-requisites with regard to content: ---

Pre-requisites according to the examination regulations: none

learning outcomes and competencies:

The competencies result from the module descriptions for the modules German as a Foreign Language, which are offered by the Institute for Foreign Languages (IFS) at the University of Karlsruhe. The module descriptions can be viewed at <https://www.h-ka.de/en/study/additional-skills/languages/deutsch>

Assessment:

The language part is assessed by the IFS. Intercultural Communication is a portfolio assessment

Course: Deutsch als Fremdsprache

Module code: SSTM151

Lecturer: IFS

Contact hours: 4

Semester of delivery: yearly in summer

Type/mode: defined and organised by IFS

Language of instruction: English / German

Content:

Depending on language level, defined by IFS

Recommended reading: see IFS

Comments: Exam regulations are defined by IFS. Entrance language level is tested and defined by IFS

German native speakers and others on C level choose a different language, not German, not English.

Course: Intercultural Communication

Module code: SSTM152

Lecturer: Prof. Dr. Andrea Cnyrim

Contact hours: 2

Semester of delivery: yearly in summer

Type/mode: lecture, seminar with mandatory attendance

Language of instruction: English

Content:

Language Issues

- Culture: Basic Concepts – Cross-Cultural Approaches – The Kulturstandard Method -

Multiculturality / Transculturality

- German Cultural Standards
- Nonverbal Communication
- Perception and Stereotypes
- Communicative Styles
- Intercultural Competence
- Conflict Management
- Adaptation
- Studying and living in Germany

Recommended reading:

Course books or a student reader of printed materials according to the recommendation of the instructor or texts and materials provided on the University's e-learning-platform Ilias.

Comments:

2. Semester

Module title: Physical Sensors

Module summary

Module code: SSTM210

Module coordinator: Prof. Dr. Harald Sehr

Credits (ECTS): 6

Semester: 2nd semester

Prerequisites with regards to content: Basic knowledge in physics and electronics

Prerequisites according to the examination regulations: none

learning outcomes and competencies: Upon successful completion, the students...

- understand the different working principles of sensors and are able to choose a suitable sensor for a given application
- can design electronic circuits for signal conditioning
- are able to evaluate transfer functions and sensor characteristics of resistive, capacitive and inductive sensors.
- are able to apply advanced software to evaluate information from laboratory measurement systems.

Assessment:

Assessment is done by a written exam (120 minutes) + lab work (passed/not passed, 1 semester)

Course: Physical Sensors

Module code: SSSTM211

Lecturer: Prof. Dr. Harald Sehr

Contact hours: 4 SWS

Semester of delivery: yearly, winter semester

Type/mode: Lecture, mandatory

Language of instruction: English

Content:

The fundamentals of sensor technology are given, working principles of physical sensors are explained and methods of signal conditioning are discussed. The topics in detail are:

- sensor characteristics and transfer function
- resistive temperature sensors
- strain gauges
- resistive force sensors
- resistive pressure sensors
- signal conditioning
- capacitive sensors
- inertial sensors
- thermocouples
- magnetic field sensors

<ul style="list-style-type: none"> • induction sensors • inductance sensors • eddy current sensors • magnetisation sensors
<p>Recommended reading:</p> <ul style="list-style-type: none"> • Fraden: Handbook of Modern Sensors, AIP Press, Springer • Niebuhr, Lindner: Physikalische Messtechnik mit Sensoren, Oldenburg • Hoffmann: Taschenbuch der Messtechnik, Hanser
<p>Comments: -</p>

Course: Sensors Lab A
Module code: SSTM212
Lecturer: Prof. Dr. Helfried Urban
Contact hours: 2 SWS
Semester of delivery: yearly, winter semester
Type/mode: Laboratory, mandatory
Language of instruction: English
<p>Content:</p> <p>Laboratory experiments set-up with modern measurement tools and computer control. Application of software tools for sensor signal evaluation.</p>
<p>Recommended reading:</p> <ul style="list-style-type: none"> • Stonick, Virginia L / Bradly, Kevin, Labs for signals and systems using MATLAB • Doebelin, Ernest O, Measurement Systems
<p>Comments: -</p>

Module title: Chemical and Biosensors**Module summary**

Module code: SSTM220

Module coordinator: Prof. Dr. Karsten Pinkwart

Credits (ECTS): 6 CP

Semester: 2

Pre-requisites with regard to content:

Basic knowledge of sensor system technology and chemistry

Pre-requisites according to the examination regulations:

none

learning outcomes and competencies:

Upon successful completion, the students...

... comprehend the fundamentals of chemo- and biosensors and can illustrate communalities and differences between these two sensor classes

... can describe their technological implementation in particular of current and miniaturized sensor approaches,

... are able to describe sensor applications and respective challenges of practical measurements

This module extends the knowledge in sensor technology by the important field of chemo- and biosensors, which have a wide range of innovative applications. These sensor types are crucial not only in industrial processes and environmental monitoring, they are also vital for measuring certain parameters of living systems — e.g. in medical engineering. Furthermore, the development of miniaturized chemo- and biosensors as well as novel sensor materials is an active area of research. Consequently, students are introduced to recent sensor trends in academia and industry.

Assessment:

Assessment is done by a written exam (120 minutes)

Course: Chemosensors

Module code: SSTM221

Lecturer: Prof. Dr. Markus Graf

Contact hours: 3 SWS

Semester of delivery: yearly, winter semester

Type/mode: lecture

Language of instruction: English

Content:

An overview on the significance of chemical sensing for a wide range of applications such as environmental monitoring, process automation, human health, comfort and energy efficiency is given.

Furthermore, a practical and highly relevant framework for assessing the requirements and performance of chemosensors is introduced.

Fundamental chemical concepts are applied to understand typical sensor characteristics.

Sensors are categorized according to their transduction principles: Mechanical, thermal and optical chemosensors including the recent miniaturization trends.

The chemosensor portfolio is further extended by the electrochemical transduction principle including potentiometric, amperometric and conductometric sensor types for e.g. pH, Oxygen and other important measurands.

Recommended reading:

Lecture slides will be provided in the online learning system

- Further Literature:
- J. Janata, Principles of Chemical Sensors, Springer
- P. Gründler, Chemical Sensors, Springer
- F.-G. Banica, Chemical Sensors and Biosensors, Wiley
- Fundamentals:
- T. Brown et. al., Chemistry – The Central Science, Pearson, (SI units)
- P. Atkins, J. de Paula & J. Keeler, Physical Chemistry, Oxford University Press

Comments: -

Course: Biosensors

Module code: SSTM222

Lecturer: Prof. Dr. Karsten Pinkwart

Contact hours: 1 SWS

Semester of delivery: yearly, summer / winter semester

Type/mode: lecture

Language of instruction: English

Content:

- Elaboration of the special features of biochemical sensors as a subclass of chemical sensors and the necessary transduction processes
- Comparison of biocatalytic and bioaffinity sensors and introduction of specific knowledge about antibodies and enzymes
- Different possibilities for binding biomolecules to a sensor surface using self-assembly monolayers (SAM) and Langmuir-Blodgett layers (LBL)
- Presentation of the routine steps for the complete construction of a biosensor using the example of nitroaromatic sensor technology
- Examination of the various transduction methods using the example of the biosensor detection of β -D-glucose as the world's most common biosensor

Recommended reading:

Lecture slides will be provided in the online learning system.

Comments:

-

Module title: Networks**Module summary**

Module code: SSTM230

Module coordinator: Prof. Dr. Thorsten Leize

Credits (ECTS): 6

Semester: 2

Pre-requisites with regard to content: Computer Science

Pre-requisites according to the examination regulations: ---

learning outcomes and competencies:

Students will be able to understand different bus systems and choose an appropriate bus system. Furthermore they know how to design and configure applications of bus systems in sensor systems. Students know the design and working principals of data exchange in internet and about the display and presentation of sensor data. They can organise, structure and store the data in different formats. They know how to program web applications (especially the backend)

Assessment: Written exam (60 min) or portfolio (1 Semester), which one will be announced at start of lectures. + lab work (passed/not passed, 1 semester)

Course: Bus Systems

Module code: SSTM231

Lecturer: Prof. Dr. Thorsten Leize

Contact hours: 2 SWS

Semester of delivery: yearly, each winter

Type/mode: lecture

Language of instruction: English

Content:

- Signal propagation, signal formatting, error detection
- Bus access types
- ISO/OSI layer model and devices
- Different bus systems for different application areas:
- Ethernet and TCP/IP family
- Field bus systems (serial, HART, Profibus)
- Automotive bus systems, especially CAN
- I²C as an example of short range bus systems.

Recommended reading: All information is on Ilias and updated frequently

Comments: Strongest focus on Ethernet and TCP/IP family

Most of total contact time in first half of the semester is on SSTM231, of second half most is SSTM232.

Course: Communication and Visualisation

Module code: SSTM232

Lecturer: Prof. Dr. Thorsten Leize

Contact hours: 2 SWS

Semester of delivery: yearly, every winter
Type/mode: Lab with portfolio
Language of instruction: English
<p>Content:</p> <ul style="list-style-type: none"> • HTTP transport • HTML description language • Graphics • Perl scripts on the server for dynamic web pages • Other languages for the backend on students' choice • Storage of data in text files, json, xml • Relational databases
Recommended reading: All information is on Ilias and updated frequently.
Comments: Assignments in Ilias. Most of total contact time in first half of the semester is on SSTM231, of second half most is SSTM232.

Module title: Real-Time Signal Processing

Module summary
Module code: SSTM240
Module coordinator: Prof. Dr.-Ing. Christian Langen
Credits (ECTS): 6
Semester: 2 nd semester
Pre-requisites with regard to content: Computer Science, Control Theory, Analog Signal Processing
Pre-requisites according to the examination regulations: --
learning outcomes and competencies: Upon successful completion, the students <ul style="list-style-type: none">• know real-time signal processing frameworks as computing platforms• understand basic concepts of digital signal processing as sampling, reconstruction and aliasing• understand fundamental filtering algorithms such as FIR, IIR, FFT and adaptive filters• can assess real-time software programming basics and principles for digital signal processing• have the ability to choose between different digital signal processing algorithms for different applications• have the ability to use different design methods to achieve better results• have the ability to evaluate experimental results (e.g. quality, speed power) and correlate them with the corresponding design and programming techniques• can implement digital signal processing and design methods on computing platforms• can use commercial hardware and software tools to develop real-time signal processing applications
Assessment: Assessment is done by an oral examination (20 minutes) for the seminary on a course project + lab work (passed/not passed, 1 semester)

Course: Real-Time Signal Processing Seminar
Module code: SSTM241
Lecturer: Prof. Dr.-Ing. Christian Langen
Contact hours: 2 SWS
Semester of delivery: yearly, winter semester
Type/mode: seminar
Language of instruction: English
Content: <ul style="list-style-type: none">• Discrete-time Signals and Systems: Convolution and Correlation• Sampling, Reconstruction and Aliasing• Review of Complex Exponentials and Fourier Analysis• Time and Frequency Domains• Z-Transform: Time and Frequency Domains

<ul style="list-style-type: none"> • FIR Filters: Moving Average Filters, Window Method of Design • IIR Filters: Impulse Invariant and Bilinear Methods of Design, Simple Design Example • Fast Fourier Transform: Review of Fourier Transforms, Derivation of Radix-2 FFT Algorithm • Adaptive Filters: Prediction and System Identifications, Equalization and Noise Cancellation
<p>Recommended reading:</p> <ul style="list-style-type: none"> • Chassaing, Rulph; Reay, Donald: Digital Signal Processing and Applications with the C6713 and C6416 DSK, Wiley 2008 • Kuo, Sen M.; Lee, Bob H.; Tian, Wenshun: Real-Time Digital Signal Processing. Fundamentals, Implementations and Applications. Wiley 2013 • Pirkle, Will C.: Designing Audio Effect Plugins in C++ for AAX, AU and VST3 in DSP Theory, Taylor and Francis, 2019 • Reay, Donald: Digital Signal Processing Using the ARM Cortex-M4. Wiley 2016 • Robinson, Martin: Getting started with JUCE. Levering the power of the JUCE framework to start developing applications, Pact Publishing 2013 • Yee-King, Matthew John: Build AI-Enhanced Audio Plugins with C++, Focal Press 2024
<p>Comments:</p>

<p>Course: Real-Time Signal Processing Lab</p>
<p>Module code: SSTM242</p>
<p>Lecturer: Prof. Dr.-Ing. Christian Langen</p>
<p>Contact hours: 2 SWS</p>
<p>Semester of delivery: yearly, winter semester</p>
<p>Type/mode: Laboratory</p>
<p>Language of instruction: English</p>
<p>Content:</p> <ul style="list-style-type: none"> • Introduction to the Real-Time Signal Processing Framework and Development Tool Chain • Signal Quantization and Aliasing • Sine, Rectangular and Pulse Signal Generation • Non-Recursive Systems. Example: Delay • Recursive Systems. Example: Echo • Non-Recursive Filters with Finite Impulse Response (FIR) • Recursive Filters with Infinite Impulse Response (IIR) • Fast Fourier Transform (FFT) • Adaptive Filters. Least Mean Square (LMS) Algorithm
<p>Recommended reading:</p> <ul style="list-style-type: none"> • Chassaing, Rulph; Reay, Donald: Digital Signal Processing and Applications with the C6713 and C6416 DSK, Wiley 2008 • Kuo, Sen M.; Lee, Bob H.; Tian, Wenshun: Real-Time Digital Signal Processing. Fundamentals, Implementations and Applications. Wiley 2013 • Pirkle, Will C.: Designing Audio Effect Plugins in C++ for AAX, AU and VST3 in DSP Theory, Taylor and Francis, 2019 • Reay, Donald: Digital Signal Processing Using the ARM Cortex-M4. Wiley 2016 • Robinson, Martin: Getting started with JUCE. Levering the power of the JUCE framework to start developing applications, Pact Publishing 2013

- Yee-King, Matthew John: Build AI-Enhanced Audio Plugins with C++, Focal Press 2024

Comments:

Module title: Focal Subjects A

Module summary
Module code: SSTM250
Module coordinator: Course director
Credits (ECTS): 6
Semester: 2
Pre-requisites with regard to content: --
Pre-requisites according to the examination regulations: --
learning outcomes and competencies: The two modules of focal subjects can be filled with subjects on the interest of the student. See comments below.
Assessment: Assessment rules are those of the module chosen as focal subject.

Course: Single focal subject
Module code: various
Lecturer: various
Contact hours:
Semester of delivery: depending on the focal subject
Type/mode: depending on the focal subject
Language of instruction: English or German
Content: depending on the focal subject
Recommended reading:
Comments: The department publishes a list of available focal subjects of this course (including possibilities in the Ingenium frame). Additionally the students can use management courses of the CC. Also other subjects of other departments maybe chosen, but have to be approved by the course director. It is highly recommended that also one ethics subject from ZEF21 (was rtwe) is added to Focal Subjects A or B

3. Semester

Module title: Sensor Miniaturization

Module summary
Module code: SSTM310
Module coordinator: Prof. Dr.-Ing. Christian Karnutsch
Credits (ECTS): 6 CP
Semester: 3
Pre-requisites with regard to content: Basic knowledge of solid state physics and chemistry
Pre-requisites according to the examination regulations: none
learning outcomes and competencies: <ul style="list-style-type: none">• Upon successful completion, the students...• understand fabrication technologies for optofluidic sensor systems• can independently assess which effects can be used to realize micro-, nano- and optofluidic systems• are able to assess the potential for miniaturization of advanced and complex analysis systems• are able to select the correct measuring instrument to be used based on the structural size and geometry of a component• can design the microtechnological process route required for the fabrication of miniaturized sensor systems• understand the fundamental engineering principles of micro- and nanosystems
Assessment: Assessment is done by a written exam (120 minutes)

Course: Optofluidic Sensor Systems
Module code: SSTM311
Lecturer: Prof. Dr.-Ing. Christian Karnutsch
Contact hours: 2 SWS
Semester of delivery: yearly, summer
Type/mode: lecture
Language of instruction: English
Content: <ul style="list-style-type: none">• Thin-film deposition and structuring techniques that are widely used in the fabrication of polymer-based, semiconductor-based and glass-based micro-scale sensor systems• Instruments for micro- and nanomeasurements to study, measure, analyze and image structures at the micro- and nanoscale• Selected analysis systems and their miniaturization
Recommended reading: [1 Fabrication Engineering at the Micro- and Nanoscale Stephen A. Campbell; Oxford University Press

[2] MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering Tai-Ran Hsu; John Wiley & Sons

[3] Optofluidics: Fundamentals, Devices, and Applications Yeshaiahu Fainman, Luke Lee, Demetri Psaltis, Changhuei Yang; McGraw Hill Professional

[4] Scanning Electron Microscopy and X-Ray Microanalysis Joseph Goldstein, Dale Newbury, David Joy, Charles Lyman, Patrick Echlin, Eric Lifshin, Linda Sawyer, and Joseph Michael; Springer

Comments: -

Course: Micro- and Nanotechnology

Module code: SSTM312

Lecturer: Prof. Dr. Markus Graf

Contact hours: 2 SWS

Semester of delivery: yearly, summer

Type/mode: lecture

Language of instruction: English

Content:

- Introduction to microsystem and nanotechnology
- Scaling effects in microsystem technology
- Fundamental microsystem process sequence
- Photolithography
- Silicon as enabling material for microtechnology
- Thin film deposition methods
- Etching methods
- Process examples (e.g. pressure sensors and accelerometers)
- Hybrid System Integration: Bridging the micro- and nanoscale to the macroscopic world
- Principles and applications of microfluidics
- Small is beautiful: Further miniaturization and novel functionalities by Nanotechnology

Recommended reading:

Lecture slides will be provided in the online learning system.

G. Gerlach & W. Dötzel: Introduction to Microsystem Technology - A Guide for Student, Wiley, 2008S.

Globisch: Lehrbuch Mikrotechnologie, Carl Hanser Verlag, 2011 (only available in German)

M. Madou: Fundamentals of Microfabrication & Nanotechnology, Volume I & II, CRC Press, 2011

J. Ramsden: Nanotechnology, Elsevier, 2011

Comments:

Module title: Advanced Sensors

Module summary
Module code: SSTM320
Module coordinator: Prof. Dr. Harald Sehr
Credits (ECTS): 6
Semester: 3 rd semester
Pre-requisites with regards to content: Basic knowledge in physics, optics and electronics
Pre-requisites according to the examination regulations: none
learning outcomes and competencies: Upon successful completion, the students... <ul style="list-style-type: none">• understand the different working principles of sensors and are able to choose a suitable sensor for a given application• understand the physics and technology of modern light sources and optical detectors• can design advanced optical sensing systems• can design electronic circuits for signal conditioning understand ...• are able to evaluate transfer functions and sensor characteristics of flow and fill level sensors.• are able to apply advanced software to evaluate information from laboratory measurement systems.
Assessment: Assessment is done by a written exam (120 minutes) + lab work (passed/not passed, 1 semester)

Course: Optical Sensors
Module code: SSTM321
Lecturer: Prof. Dr.-Ing. Christian Karnutsch
Contact hours: 2 SWS
Semester of delivery: yearly, summer semester
Type/mode: Lecture, mandatory
Language of instruction: English
Content: <ul style="list-style-type: none">• Light sources for optical sensing• detection of optical radiation• advanced optical sensing systems• fiberoptic sensors• interferometric sensors• modern application examples
Recommended reading: Light-emitting Diodes, EF Schubert, Cambridge University Press Understanding Fiber Optics, J Hecht, Prentice Hall International Fiber Optic Sensors: An Introduction for Eng. and Scientists, E Udd, Wiley Advanced Photonic Structures for Biological and Chemical Detection, X Fan, Springer

Optics, Eugene Hecht, Addison-Wesley

Comments: Lecture notes and all other course materials are available on ILIAS.

Course: Sensor Applications

Module code: SSTM322

Lecturer: Prof. Dr. Harald Sehr

Contact hours: 2 SWS

Semester of delivery: yearly, summer semester

Type/mode: Lecture, mandatory

Language of instruction: English

Content:

- Fluid mechanical basics of flow measurement technology
- Characteristics and measuring principles of flow measurement technology
- Design and operating principles of flow measurement systems
- Characteristics and measuring principles of level sensors
- Design and operating principles of level measurement systems
- Surface wave sensor technology
- Wireless sensor systems
- Energy harvesting
- Application examples

Recommended reading:

- Liptak: Instrument Engineers' Handbook, Process Measurement and Analysis, CRC Press
- Considine: Process Instruments and Controls Handbook, McGraw-Hill
- Fraden: Handbook of Modern Sensors, AIP Press, Springer
- Niebuhr, Lindner: Physikalische Messtechnik mit Sensoren, Oldenburg
- Hoffmann: Taschenbuch der Messtechnik, Hanser
- Tränkler: Taschenbuch der Messtechnik, Oldenbourg
- Finkenzeller: RFID Handbuch, Hanser

Comments: -

Course: Sensors Lab B

Module code: SSTM323

Lecturer: Prof. Dr. Helfried Urban

Contact hours: 2 SWS

Semester of delivery: yearly, summer semester

Type/mode: Laboratory, mandatory

Language of instruction: English

Content:

Laboratory experiments set-up with modern measurement tools and computer control.
Application of software tools for sensor signal evaluation.

Recommended reading:

- Stonick, Virginia L / Bradley, Kevin, Labs for signals and systems using MATLAB
- Doebelin, Ernest O, Measurement Systems

Comments: -

Module title: Focal Subjects B

Module summary
Module code: SSTM330
Module coordinator: Course director
Credits (ECTS): 6
Semester: 3
Pre-requisites with regard to content: --
Pre-requisites according to the examination regulations: --
learning outcomes and competencies: The two modules of focal subjects can be filled with subjects on the interest of the student. See comments below.
Assessment: Assessment rules are those of the module chosen as focal subject.

Course: Single focal subject
Module code:
Lecturer: various
Contact hours:
Semester of delivery: depending on the focal subject
Type/mode: depending on the focal subject
Language of instruction: English or German
Content: depending on the focal subject
Recommended reading:
Comments: The department publishes a list of available focal subjects of this course (including possibilities in the Ingenium frame). Additionally the students can use management courses of the CC. Also other subjects of other departments maybe chosen, but have to be approved by the course director. It is highly recommended that also one ethics subject from rtwe is added to Focal Subjects A or B

Module title: Project**Module summary**

Module code: SSTM340

Module coordinator: Course director

Credits (ECTS): 6

Semester: 3

Pre-requisites with regard to content: --

Pre-requisites according to the examination regulations: --

learning outcomes and competencies:

The participants can independently work on a task alone or in small groups and

- understand the task and develop the technical implementation in a solution-oriented manner
- implement the project with all technical designs and ideally simulate and test it
- learn to work together in the team structure
- write the documentation as a scientific paper
- present the work and discuss questions in order to be able to work out and implement a task in a team systematically and in a targeted manner in professional practice.

Assessment:

Project (1 Semester) as prerequisite plus presentation (20 mins) and oral exam (20 mins)

Module title: Language and Management

Module summary

Module code: SSTM350

Module coordinator: course director

Credits (ECTS): 6

Semester: 3

Pre-requisites with regard to content: --

Pre-requisites according to the examination regulations: --

learning outcomes and competencies:

The competencies result from the module descriptions for the modules German as a Foreign Language, which are offered by the Institute for Foreign Languages (IFS) at the University of Karlsruhe. The module descriptions can be viewed at

<https://www.h-ka.de/en/study/additional-skills/languages/deutsch>

The students should be able to use the German language on highest possible level to be able to live and work in Germany.

They also acquire further qualifications in the area of management and ethics in engineering in order to be able to use their personal skills better in the professional life

Assessment:

Defined by IFS and Center of Competence

Course: Deutsch als Fremdsprache 2

Module code: SSTM351

Lecturer: IFS

Contact hours: 4

Semester of delivery: each semester

Type/mode: Defined by IFS

Language of instruction: German and English

Content: Defined by IFS

Recommended reading:

Comments: Students with C level of German language knowledge and above choose another foreign language, neither English nor German.

Course: Management

Module code: SSTM352

Lecturer: Center of Competences

Contact hours: 2

Semester of delivery: each semester

Type/mode: Defined by the focal subject

Language of instruction: English

Content: Defined by Center of Competences

Recommended reading:

Comments:

4. Semester

Module title: Thesis

Module summary
Module code: SSTM410
Module coordinator: Director of the programme
Credits (ECTS): 27
Semester: 4
Pre-requisites with regard to content: --
Pre-requisites according to the examination regulations: Completed first semester, completed module project, max 15 CP missing from semesters 2 and 3 in sum.
learning outcomes and competencies: The students can work on an engineering topic in a given time frame independently, result-oriented and appropriately according to scientific criteria by <ul style="list-style-type: none">• analyze and structure information given by literature, independently acquire the relevant specialist and methodological knowledge,• select scientific methods and procedures and use and solve the question of the master thesis,• interpret, evaluate and critically reflect on the results obtained,• formulate the content of the master thesis in a clearly structured manner according to scientific procedures using the specialist terminology• be able to work on topics independently in professional practice and write reports
Assessment: The students work performance and documentation are evaluated (MT) (6 months)

Course: Thesis
Module code: SSTM411
Lecturer: 2 Professors
Contact hours: by arrangement
Semester of delivery: by arrangement
Type/mode: Thesis
Language of instruction: English
Content: Defined by the examiners
Recommended reading:
Comments: Usually done in industry or in a research project of HKA or another university

Module title: Final Exam

Module summary
Module code: SSTM420
Module coordinator: Director of the programme
Credits (ECTS): 3
Semester: 4
Pre-requisites with regard to content: --
Pre-requisites according to the examination regulations: --
learning outcomes and competencies: The participants can independently prepare a presentation and present the questions and the work of the thesis by <ul style="list-style-type: none">• give a short introduction to the topic and present the main questions and tasks• present the solutions and technical developments• discuss possible solutions and results• being able to present, discuss and answer questions on the own work.
Assessment: The presentation and the discussion are evaluated. (presentation/20 min and oral exam/20 min)

Course: Final Examination
Module code: SSTM421
Lecturer: same as SSTM411
Contact hours: by arrangement
Semester of delivery: by arrangement
Type/mode: Presentation and discussion
Language of instruction: English or German
Content: same as SSTM411
Recommended reading:
Comments: See exam regulations