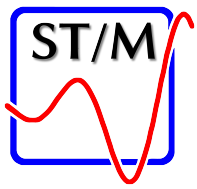

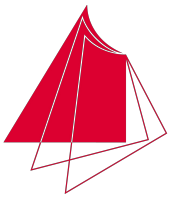

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Karlsruhe University of Applied Sciences
Karlsruhe, Germany

Department of
Electrical Sciences and Information Technology

Module Handbook

Master of Science
Degree Programme in

Sensor Systems Technology

(ST/M)

(As of summer 2013, new regulations V 5)

Overview

Module Name	SWS[1]	ECTS[2]	Lectures and Labs	Pg.	Semester	WS/SS
Advanced Physics	4	6	Physics Solid State Physics	3	First semester	Summer Term
Analog Signal Processing	4	6	Control Theory Analog Electronics Lab.	5		
Digital Signal Processing	4	6	Computer Science Digital Electronics Lab.	6		
Advanced Chemistry	6	6	Chemistry Physical Chemistry	7		
Management	6	6	Lectures by Career Center	8, 29		
Sensors A	6	6	Physical Sensors Optical Sensors	9	Second Semester	Winter Term
Sensor Actor Networks	4	6	Bus Systems & Local Area Networks Computer Aided Labs	10		
Real-time Data Processing	4	6	Digital Control Systems Native Signal Processors	11		
Focal Subjects	4	8	(Two modules of four are obligatory, duration 2 semesters)	12		
			1: Numerical Simulation & Advanced Programming	13		
			2: Micro Systems & Hybrid Technology	15		
			3: Medical Sensorics & Imaging Systems in Medicine	17		
			4: Environmental Process Technology & Environmental Sensorics	19		
Language (Part A)	4	8	German Language for Foreigners / Foreign language (Germans)	21		
Project (Part A)	4	8	Project I	22		
Sensors B	6	6	Chemical Sensors and Sensor Materials Process Analytic Systems Chemical and Bio sensors	23	Third Semester	Summer Term
Automotive Sensors Application	4	6	Automotive Sensors Safety and Reliability Computer Aided Labs	25		
System Integration	4	6	Communication and Visualisation Pattern Recognition	26		
Focal Subjects (Part B)	4		See above, semester 2	12		
Language (Part B)	4		See above, semester 2	21		
Project (Part B)	4		See above Semester 2	22		
Thesis Project	6 Mon.	30	Thesis and Project Evaluat. Final Examination	27 28	Fourth Semester	Winter Term

[1] SWS is hours per week contact time.

[2] 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)

Module Name:	**Advanced Physics**
Module Number:	ST1811
Lectures and Laboratories:	*. Physics* *2. Solid State Physics + Exercise*
Semester:	1st Semester
Period:	Each year, summer semester
Responsible:	Prof. Dr. Görlichr
Lecturer:	1. Prof. Dr. Görlich 2. Dr. Weidler
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	1. Experimental lecture / 2 SWS / 25 2. Experimental lecture and homework / 2 SWS / 25
Workload:	Contact time 56h, homework 56h during semester, homework 68h during semester break
Credit Points (ECTS):	6
Prerequisites:	4 ECTS - Basic Physics at university level
Recommended Requirements:	Basic physical knowledge at Bachelor level
Objectives:	The students can assign causes and effects of electro-magnetic interactions. They know the general laws of classical electro-magnetic effects inclusive the general mathematical descriptions (Maxwell-Laws). Some quantum mechanical descriptions are introduced for better understanding of the behaviour of magnetic materials. After having successfully completed the course, the students should •know how to model physical systems, in particular in the context of solid state physics / semiconductors •know the theoretical background of some sensor applications
Summary / Outline:	Lecture 1: Electrostatics (7h), moving charges (2h), electrical dipoles and dielectric polarization (3h), generation of magn. fields (2h), quantum mech. description of magnetic moments (4h), magnetization of materials (4h), Faraday´s induction law (3h), Maxwell equations and electromagnetic waves (3h). Lecture 2: •Aspects of Modern Physics – Quantum Theory •Photons and LASER •Some Principles of Solid State Physics •Diffusion Theory
Examination:	Written examination 180 minutes with mark
Media:	Lecture supported by transparencies, slide presentation, blackboard, experiments, animations plus exercises
Literature:	Part1: Serway, Jewett; Physics for scientists and Engineers, with modern Physics, 6th ed., Brooks/cole Thomson 2004 Part 2: Feynman, Richard Phillips, The Feynman Lectures on Physics, 3 Vols.*, Addison-Wesley, ISBN 0201500647

	Sternheim, Morton M., General physics, New York: John Wiley, 1991, ISBN 0-471-52278 Charles Kittel, Introduction to Solid State Physics, John Wiley & Sons, Inc. Charles Kittel, Herbert Kroemer, Thermal Physics, W.H. Freeman and Company New York, ISBN 0-7167-1088-9 Neil W. Ashcroft, N. David Mermin, Solid State Physics, Harcourt Brace College Publisher Charles C. Coleman, Modern Physics for Semiconductor Science, WILEY-VCH, ISBN 978-3-527-40701-9 S.M.Sze, Semiconductor devices, Wiley 2002, ISBN 0-471-33372-7

Module Name:	**Analog Signal Processing**
Module Number:	ST1821
Lectures and Laboratories:	*1. Control Theory* *2. Analog Electronics Lab*
Semester:	1st Semester
Period:	Every year, summer term ????
Responsible:	Prof. Dr. Keller
Lecturer:	1. Prof. Dr. Keller 2. Prof. Dr. Alex
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	1. Lecture / 2 SWS / 30 2. Laboratory / 2 SWS / 15
Workload:	Contact time 56h, homework 56h during semester, homework 68h during semester break
Credit Points (ECTS):	6
Prerequisites:	6 ECTS Basic Mathematics at university level, 4 ECTS Electrical Engineering at university level.
Recommended Requirements:	
Objectives:	1.The student can use transformations, develops feeling for dynamic procedures and can judge stability. 2.The student is able to understand electronic circuits and to work with operational amplifiers.
Summary / Outline:	1.Modelling, Linearisation, Laplace transformation, Evaluation of the Transfer function and the Frequency Characteristic, Stability and Stability Criteria, Control Loop evaluation, Design of Control Loops, Analog Controller, Root Locus Analysis and Frequency Response 2.Experiments with Resistors, Capacitors, Inductors, Networks, Bridge Circuits, Operational Amplifier (OP), OP principal Circuits, Diode and Transistor, Rectifier Circuits, Transistors principal Circuits.
Examination:	Written examination 120 minutes with mark, Laboratory passed or failed.
Media:	2. Evaluation boards and computer measurement interfaces. Booklet with description of the experiments and theory. Computer based tests of the preparation for the experiments.
Literature:	1.Frederik, Dean / Chow, Joe H. - Feedback control problems using Matlab - Pacific Grove: Brooks/Cole 2000 Nise, Norman S. - Control systems engineering - New York: Wiley 3rd Ed. 2000 Lindner, Douglas - Introduction to signals and systems - New York: WCB/McGraw Hill 19992.1. Introduction to Electrical Engineering -Online E-book 2.2. Experiments with Operational Amplifiers - Online E-book

Module Name:	**Digital Signal Processing**
Module Number:	ST1822
Lectures and Laboratories:	*1. Computer Science* *2. Digital Electronics Lab*
Semester:	1st Semester
Period:	Every year, summer term
Responsible:	Prof. Dr. Herwig
Lecturer:	1. Dr. Hugelmann 2. Prof. Dr. Herwig
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	1. Lecture / 2 SWS / 25 2. Laboratory / 2 SWS / 15
Workload:	Contact time 56h, homework 56h during semester, homework 68h during semester break
Credit Points (ECTS):	6
Prerequisites:	4 ECTS Basic Computer Science at university level, 4 ECTS Electrical Engineering at university level.
Recommended Requirements:	
Objectives:	1.The students can differentiate between operation oriented and object-oriented programming style and are able use both styles, they can design state machines and recognize data structures. 2.The students can convert numbers and can use logic gates. They know the principles of A/D and D/A conversion and understand the basic elements and functions of a microcomputer.
Summary / Outline:	1.Classes, Interfaces, Programming Paradigm, functional Programming, imperative Programming, object orientated Programming, Data structures and Algorithms, Design of Systems and State Machines. 2.Digital Numbers, Logic Gates, Boolean Expressions, combinatory Logic, sequential Logic, Analog / Digital and Digital / Analog Converters, Programming of Microcomputers.
Examination:	Written examination 120 minutes with mark. Laboratory passed or failed.
Media:	2. Evaluation boards and computer measurement interfaces. Booklet with description of the experiments and theory. Computer based tests of the preparation for the experiments.
Literature:	2. Kleitz, William - Digital and microprocessor fundamentals - London: Prentice Hall Basic Experiments in Digital technology - Online E-book

Module Name:	**Advanced Chemistry**
Module Number:	ST1812
Lectures and Laboratories:	*1. Physical Chemistry* *2. Chemistry*
Semester:	1st Semester
Period:	Every year, summer term
Responsible:	Dr. Hefer
Lecturer:	1. Dr. Hefer 2. Dr. Hefer
Language:	English
Part of Curriculum:	Sensor Systems Technology (M. Sc.)
Method / SWS / No. of Students:	1. Lecture / 4 SWS / 30 2. Experimental lecture / 2 SWS / 30
Workload:	Contact time 84h, homework 28h during semester, homework 68h during semester break.
Credit Points (ECTS):	6
Prerequisites:	2 ECTS Basic Chemistry at university level, 4 ECTS Basic Physics at university level
Recommended Requirements:	
Objectives:	The students know and understand the interaction between classical chemistry and physics; they get knowledge about simple sensors for chemical parameters and develop a sense for energy and dynamic effects in chemical reactions. They know the main characteristics of electrolytes.
Summary / Outline:	1.Thermodynamics, , Enthalpy, Entropy, Gibbs free Energy, Law of Mass Action, simple Galvanic Cells, Electrode – Electrolyte Interface, Fluid Electrolytes, Dissociation of Salt, Solubility Product, Ion Product, pH Value, Ionic Conductivity, Ionic Mobility, Phase Diagrams. 2.Atoms and Periodic System, Chemical Binding and intermolecular Forces, Chemical Reactions, Energy Balance, Electro Chemistry, Organic Compounds.
Examination:	Written examination 180 minutes with mark.
Media:	
Literature:	1. Hamann, Carl H. / Hamnett, Andrew / Vielstich, Wolf - Electrochemistry - Weinheim: Wiley 1998 2. Harris, Daniel - Quantitative chemical analysis - New York, Freeman 2000

Module Name:	**Management**
Module Number:	ST1831
Lectures and Laboratories:	6 ECTS courses of the 'Career Center' in English language. For subjects see special part Career Center.
Semester:	1st to 3rd Semester
Period:	Every semester
Responsible:	Programme Director
Lecturer:	Lecturers of the "Career Services – Studium Generale" (CC)
Language:	English
Part of Curriculum:	Open program
Method / SWS / No. of Students:	Lectures / equivalent to 6 ECTS / -
Workload:	Contact time 84h, homework 28h during semester, homework 68h during semester break.
Credit Points (ECTS):	6
Prerequisites:	Specified by CC
Recommended Requirements:	Specified by CC
Objectives:	See special part CC
Summary / Outline:	See special part CC
Examination:	Written examinations with mark, duration specified by "Career Services – Studium Generale" (CC)
Media:	See special part CC
Literature:	See special part CC

Module Name:	**Sensors A**
Module Number:	ST2841
Lectures and Laboratories:	*1. Physical Sensors* *2. Optical Sensors* *3. Chemical Sensors*
Semester:	2nd Semester
Period:	Every year, winter term
Responsible:	Prof. Dr. Karnutsch
Lecturer:	1. Prof. Dr. Sehr 2. Prof. Dr. Karnutsch 3. Prof. Dr. Kohler
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	1. Experimental lecture / 4 SWS / 25 2. Lecture / 2 SWS / 25
Workload:	Contact time 84h, self-study 28h during semester, self-study 68h during semester break.
Credit Points (ECTS):	6
Prerequisites:	ST1811
Recommended Requirements:	Broad knowledge of physics with emphasis on solid state physics and semiconductor physics.
Objectives:	Students will be acquainted with the most important sensor principles for physical parameters and can critically evaluate their application in different environments. They know the special requirements of signal processing, understand the theoretical models and are able to combine sensors to evaluate not directly measurable parameters.
Summary / Outline:	1.Principles, applications and signal conditioning for physical Sensors: Resistive Sensors, capacitive sensors, thermoelectric sensors piezoelectric sensors, pyroelectric sensors, galvanomagnetic sensors, inductive sensors, eddy-current sensors, magnetization sensors 2.Physical Properties, Concepts and Techniques, Fiberoptic Sensors, Integrated Optical Sensors, Optical Sensing Systems and Applications
Examination:	Written examination 180 minutes
Media:	Blackboard, software slides
Literature:	Fraden, Handbook of Modern Sensors, AIP Press, Springer Doebelin, Measurement Systems, McGraw-Hill

Module Name:	**Sensor Actor Networks**
Module Number:	ST2851
Lectures and Laboratories:	*1. Bus Systems & Local Area Networks* *2. Computer Aided Labs A*
Semester:	2nd Semester
Period:	Every year, winter term
Responsible:	Prof. Dr. Leize
Lecturer:	1. Prof. Dr. Leize 2. Prof. Dr. Langen
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	1. Lecture and laboratory / 2 SWS / 25 2. Laboratory / 2 SWS / 15
Workload:	Contact time 56h, homework 84h during semester, homework 40h during semester break.
Credit Points (ECTS):	6
Prerequisites:	ST1821, ST1822
Recommended Requirements:	
Objectives:	1. The students understand the organization of messages on a bus system, know the most important bus systems and their pro and cons and can estimate the expenditure of the bus system. They are able to configure a network and know the different classes and topologies of networks. 2. proficient use of laboratory measurement equipment, especially digital storage oscilloscopes
Summary / Outline:	1.Examples of Networked Systems, Transmission Media, Access Control Strategies, Error Handling, Bus Systems in Automation and Automotive Applications. Basic communication problems in sensor actor networks, Seven layer model, Intelligent network nodes, NEURON network processor, Programming of Sensor Actor networks in NEURON-C 2.Laboratory experiments set-up with modern measurement tools and computer control. Application of software tools for sensor signal evaluation.
Examination:	Written examination 120 minutes with mark. Laboratory with report, passed or failed.
Media:	1. Blackboard, ilias, software slides, distributed learning environment with online information and tutorials together with primary data. Integrated laboratory. 2. Detailed laboratory instructions
Literature:	3. Stonick, Bradly, Labs for signals and systems using MATLAB, PWS 2000

Module Name:	**Real time Data Processing**
Module Number:	ST2861
Lectures and Laboratories:	*1. Digital Control Systems* *2. Native Signal Processors*
Semester:	2nd Semester
Period:	Every year, winter term
Responsible:	Prof. Dr. Langen
Lecturer:	1. Prof. Dr. Keller 2. Prof. Dr. Langen
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	2. Lecture with laboratory / 2 SWS / 25 (15 Lab.)
Workload:	Contact time 56h, homework 56h during semester, homework 68h during semester break.
Credit Points (ECTS):	6
Prerequisites:	ST1822
Recommended Requirements:	
Objectives:	The students know the substantial algorithms of digital signal processing and are able to design a digital control. They know how to realize such algorithms together with sequential controls based on multitasking in a microcomputer and know the essential structures and possibilities of a microcomputer. They can judge if a micro-computer is applicable for a given problem and are able to use behavioural description programming.
Summary / Outline:	1.Introduction to Discrete-Time Control Systems Analog Control in Contrast to Digital Control z Transform Theory, PID-control algorithms Stability of Discrete-Time Control Systems Deadbeat Control, State-Space Analysis 2.The nature of processes and signals in the real world. Implications for the structure of a microcomputer. Von Neumann and Harvard architecture. RISC and CISC instruction sets. Processing of real-time signals. Architecture of Digital Signal Processors. Design of programs at register level. Structured programming. The finite state machine. Task oriented programming. Software security.
Examination:	Written examination 120 minutes with mark.
Media:	2. Distributed learning environment with online information and tutorials together with primary data. Integrated microcomputer application laboratory (ADC Microlink, Group work 2 students)
Literature:	1. Zilouchian, Ali / Jamshidi, Mo - Intelligent control systems using soft computing methodologies - London: CRC Press 2001

Module Name:	**Focal Subjects**
Module Number:	ST2871
Lectures and Laboratories:	*Choice of 2 out of 4 modules.*
Semester:	2nd Semester (winter), 3rd Semester (summer)
Period:	Every year
Responsible:	Program Director
Lecturer:	See single modules
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	Lecture / 4 SWS / 15
Workload:	Contact time 112h, homework 56h during semester, homework 72h during semester break.
Credit Points (ECTS):	8 (4 in 2nd semester and 4 in 3rd semester)
Objectives:	The students become acquainted with the methodology of approximation to scientific borders, know the research areas of the department and are able to participate in a qualified discussion in the special area.
Description and Details:	The students have to chose two out of four options for Focal Subjects A and Focal Subjects B. The choice of two subjects for Focal Subjects A also defines the subjects for Focal Subjects B. The options are: 1. Numerical Simulation & Advanced Programming 2. Microsystems & Hybrid Technology 3. Imaging Systems in Medicine & Medical Sensorics 4. Environmental Process Technology & Environmental Sensorics. For informations and details on these options please see the following pages.

Module Name:	**Focal Subjects** **Module 1: Numerical Simulation & Advanced Programming**
Module Number:	ST2871 & ST3871
Lectures and Laboratories:	*1. Numerical Simulation (2nd semester)* *2. Advanced Programming (3rd semester)*
Semester:	2nd + 3rd semester
Period:	Every year
Responsible:	Programme Director
Lecturer:	A. Prof. Dr. Westermann B. Prof. Dr. Leize
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	Lecture / 2 SWS / 15
Workload:	Contact time 56h, homework 28h during semester, homework 36h during semester break.
Credit Points (ECTS):	4 (for this module)
Prerequisites:	
Recommended Requirements:	
Objectives:	The students become acquainted with the methodology of approximation to scientific borders, know the research areas of the department and are able to participate in a qualified discussion in the special area.
Summary / Outline:	1.The Finite Difference Method Electrostatic systems with two and three electrodes Iterative methods for solving linear equations Boundary Fitted Coordinates The Finite Element Method The variation principle for 1d electrostatic problems The variation principle for 2d electrostatic problems Finite Element Simulations 2.Design Patterns Java Java GUI Java TCP/IP programming
Examination:	Written examination 60 minutes with mark after each semester
Media:	Blackboard, PC (Powerpoint), Computer Aided Laboratory, experiments
Literature:	1.Manuscript (T. Westermann) Westermann, T.; Modellbildung und Simulation, Springer Heidelberg, ISBN 978-3-642-05460-0, 2010. 2.Ilias Ressources availabe online Books: •Bernd ; Dutoit Allen Henry Brügge. Object-oriented software engineering : using UML, patterns, and Java. Pearson, Boston, 3. ed., international ed. edition, 2010. •Erich Gamma et al. Design patterns : elements of reusable object-oriented software. Addison-Wesley professional computing series. Addison-Wesley, Boston, Mass., 38. print edition, 2010.

	•Preparation: ◦ See Ilias ressources online ◦ Martin Fowler. UML distilled : a brief guide to the standard object modeling language. The Addison-Wesley object technology series. Addison-Wesley, Boston, Mass. [u.a.], 3. ed., 9. printing edition, 2006.

Module Name:	**Focal Subjects Module 2: Microsystems & Hybrid Technology**
Module Number:	ST2871 & ST3871
Lectures and Laboratories:	*1: Microsystems* *2: Hybrid Technology*
Semester:	2nd (1) and 3rd (2) Semester
Period:	Every year, winter (1) and summer (2) term
Responsible:	Programme Director
Lecturer:	1: Prof. Dr. Ehinger 2: Prof. Dr. Schönauer
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	Lecture / 2 SWS / 15
Workload:	Each, 1 and 2: Contact time 56h, homework 28h during semester, homework 36h during semester break.
Credit Points (ECTS):	4 (for this module)
Prerequisites:	
Recommended Requirements:	
Objectives:	
Summary / Outline:	***Microsystems:*** Introduction: Realized Examples and Classification Comparison with Microelectronics Lithography: Optical Lithography Alternative Lithographies Deposition Technologies: Physical and Chemical Vapour Deposition Thermal Oxidation Properties of Differently Deposited Films Bulk Micro machining: Basic Process Sequences Wet Isotropic and An isotropic Etching Surface Micro machining: Basic Process Sequences Additional Structuring Techniques Comparison of Bulk vs. Surface Micro machining LIGA: Basic LIGA Process LIGA Extensions: Movable and 3d-Structures Comparison: Alternative Materials Processing Batch vs. Serial ***Hybrid Technology (Focal Subject B):*** Thick-film and hybrid technology in sensor production Introduction to thick-film technology Basic materials, components, manufacturing Layer systems, Production, quality control Circuit lay-out, Design rules, Print cycles,

	Screen manufacturing, Screen printing, Parameters, Quality control, Drying and sintering Comparison: thick- vs. thin-film technology Structure dimensions, Assembly and packaging Surface mount technology (SMT) Active and passive devices (SMD), Connection technologies, Soldering processes Adhesive employment, Chip-on-board processes Die- and wire-bonding, Welding processes, Packaging
Examination:	Written examination 60 minutes with mark after each semester
Media:	Blackboard, PC (Powerpoint), Computer Aided Laboratory, experiments
Literature:	Marc J. Madou: "Fundamentals of Microfabrication. The Science of Minituarization.", Boca Raton: CRC Press LLC (2002) Wolfgang Menz, Jürgen Mohr, Oliver Paul: "Microsystem Technology", Weinheim: Wiley-VCH (2001) Bharat Bushan (Ed.): "Springer Handbook of Nanotechnology", Berlin: Springer-Verlag (2004) Yogesh B. Gianchandani, Osamu Tabata, Hans Zappe: "Comprehensive Microsystems", Volume 1,2,3, Amsterrdam: Elsevier (2008)

Module Name:	**Focal Subjects** **Module 3: Medical Sensorics & Imaging Systems**
Module Number:	ST2871 & ST3871
Lectures and Laboratories:	*Imaging Systems in Medicine* *Medical Imaging Systems*
Semester:	2nd (1) and 3rd (2) Semester
Period:	Every year, winter (1) and summer (2) term
Responsible:	Programme Director
Lecturer:	Prof. Dr. Höpfel Dr. Hey
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	Lecture / 2 SWS / 15
Workload:	Contact time 56h, homework 28h during semester, homework 36h during semester break.
Credit Points (ECTS):	4 (two lectures out of four)
Prerequisites:	
Recommended Requirements:	
Objectives:	
Summary / Outline:	1.Introduction: Physiology of Vision, Image Quality Imaging with Ultrasound X-Ray Systems; Computed Tomography (CT) Nuclear Medicine: Single Photon Emission CT (SPECT) Positron Emission Tomography (PET) Magnetic Resonance Imaging (MRI) 2.Analytical control of blood and serum by High Performance Liquid Chromatography (HPLC), Electrophoresis, Electro analytical methods and Immuno Assays Creation and Flow of Electrical Signals in the Nerves Electrical Signals from Muscles - the Electromyogram Electrical Signals from the Heart – the Electrocardiogram Electrical Signals from the Brain – the Electroencephalogram Measurement of the Blood Pressure Biological Sensors for the Supervision of Breath
Examination:	Written examination 120 minutes with mark.
Media:	Blackboard, PC (Powerpoint), Computer Aided Laboratory, experiments
Literature:	Manuscript (D. Höpfel) Frederick W. Kremkau Ph. D.: Diagnostic Ultrasound: Principles and Instruments, W. B. Saunders & Co. ISBN 0721671438; 2005 SPECT: Single Photon Emission Computed Tomography: A Primer, 1996 Principles and Practice of Positron Emission Tomography, Richard L. Wahl, Julia W. Buchanan, 2002 Romans L. E.; Introduction to Computed Tomography, Wiliams & Wilkins, ISBN: 0683073532, 1995

	Computertomographie. Grundlagen, Gerätetechnologie, Bildqualität, Anwendungen (Gebundene Ausgabe), Willi A. Kalender, 2006 Hubner Karl F., Collmann J., Buonocore E., Kabalka G.: Clinical Positron Emission Tomography, 1991 Vlaardingerbroek M. T., den Boer J. A., Luiten A., Knoet F.: Magnetic Resonance Imaging Springer-Verlag Berlin Heidelberg New York; ISBN 3-540-60080-9; 2004 O. Dössel, Bildgebende Verfahren in der Medizin, Springer-Verlag Heidelberg, Berlin 2000, ISBN 3-540-66014-3 Dilcher, Venator, Dilcher: Handbuch der Kernspintomographie; Edwin Ferger Verlag 2004 Imaging Systems for Medical Diagnostics: Fundamentals, Technical Solutions and Applications for Systems Applying ionizing Radiation, Nuclear Magnetic Resonance and Ultrasound, Arnulf Oppelt, 2006 Computertomographie. Grundlagen, Gerätetechnologie, Bildqualität, Anwendungen (Gebundene Ausgabe), Willi A. Kalender, 2006

Module Name:	**Focal Subjects** **Module 4: Environmental Process Technology & Environmental Sensorics**
Module Number:	ST2871 & ST3871
Lectures and Laboratories:	*Environmental Process Technology* *Environmental Sensorics*
Semester:	2nd (1) and 3rd (2) Semester
Period:	Every year, winter (1) and summer (2) term
Responsible:	Programme Director
Lecturer:	1 Prof. Dr. Hoinkis 2 Prof. Dr. Schönauer l
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	Lecture / 2 SWS / 15
Workload:	Contact time 56h, homework 28h during semester, homework 36h during semester break.
Credit Points (ECTS):	4 (for this module)
Prerequisites:	
Recommended Requirements:	
Objectives:	
Summary / Outline:	1.Introduction Toxicology Human Toxicology Ecotoxicology Waste Water Pollution Sources Waste Water Cleaning Municipal Treatment Plant Industrial Waste Water Treatment Drinking Water Waste Air Pollution Sources Flue Gas Cleaning Industrial Treatment Power Stations Solid Waste Management Waste incineration Recycling Technologies Production Integrated Technologies Ecological Balance and Management 2.***1st Part*** Basics of Radiation: decay, nucleus, nuclear reaction, statistics, interaction with matter Radiation Protection: sources, doses, contamination, protection, shields Sensors: gas counters.. i.e. ion chamber, proportional and GM-Counter. Scintillators, semiconductors. ***2nd Part*** Introduction: Engine Combustion Process Catalytic Exhaust After treatment, Emission Limits

	Exhaust Sensors and Engine Control, Emission Test Cycles On-Board Diagnose OBD: Diagnose Strategies Exhaust Sensors for OBD of CAT and Control Sensors Hydro-Carbon Sensors, NOx-Sensors, Temperature Sensors, Wide range Oxygen Sensors etc., Control Strategies for Diesel and SI-Engines New Approaches to Lower Fuel Consumption Control Strategies and Sensors in DI and Lean Burn Application
Examination:	Written examination 120 minutes with mark.
Media:	Blackboard, PC (Powerpoint), Computer Aided Laboratory, experiments
Literature:	

Module Name:	**Language**
Module Number:	ST2881, ST3881
Lectures and Laboratories:	*German Language for Foreigners (DaF 1–6) / Foreign Language for Germans (not English)*
Semester:	2nd (Language A) and 3rd semester (Language B)
Period:	Every semester
Responsible:	Program Director
Lecturer:	Lecturer of the Institute for Foreign Languages (IFS)
Language:	German or other selected Language
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	Lecture / 4 SWS / -
Workload:	Contact time 56h, homework 28h during semester, homework 36h during semester break. Each semester.
Credit Points (ECTS):	4 each semester = 8 total
Prerequisites:	Placement Test by the IFS
Recommended Requirements:	The students improve their ability in the application of the German language / the foreign language (German students only)
Objectives:	Described in the criteria for DaF Courses.
Summary / Outline:	
Examination:	Examinations ruled by the regulations of the IFS
Media:	
Literature:	

Module Name:	**Project**
Module Number:	ST2881
Lectures and Laboratories:	*Project A* *Project B*
Semester:	2nd Semester (Project A), 3rd Semester (Project B)
Period:	Special agreement
Responsible:	The supervising professor
Lecturer:	The professors of the department
Language:	English
Part of Curriculum:	Sensor Systems Technology (M. Sc.)
Method / SWS / No. of Students:	Self organized work on an unstructured problem supervised by a member of the department. Maximum group size is 2 students.
Workload:	120 hours self organized
Credit Points (ECTS):	4 each semester = 8 total
Prerequisites:	Advanced knowledge in the area of the project. ST1811, ST1821, ST1822, ST 1812
Recommended Requirements:	The students are able to structure a problem, to gather information, to provide a time schedule for solving the problem and to work independently on it. They are able to prepare purchase of material and equipment.
Objectives:	Special agreement
Summary / Outline:	Special agreement
Examination:	Written report and public oral presentation with mark.
Media:	
Literature:	

Module Name:	**Sensors B**
Module Number:	ST3841
Lectures and Laboratories:	*1. Physical Sensors* *2. Optofluidic Sensors* *3. Chemical and Bio Sensors*
Semester:	3rd Semester
Period:	Every year
Responsible:	Prof. Dr. Kohler
Lecturer:	1.. Prof. Dr. Sehr 2. Prof. Dr. Karnutsch 3. Prof. Dr. Kohler
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	1. & 2. & 3. Lecture / 2 SWS / 25
Workload:	Contact time 28h, homework 28h during semester, homework 68h during semester break.
Credit Points (ECTS):	2
Prerequisites:	ST1812
Recommended Requirements:	1. Basic knowledge of thermodynamics and electrochemistry
Objectives:	The students know the most important sensor principles for measurement of chemical and biochemical parameters, understand the theoretical models and material aspects of the underliying physico-chemical sensing concept, can critically judge applications in different environments. – Extension of the lecture chemical Sensors and Sensor Materials.
Summary / Outline:	1.Motivation and impact of chemical sensor applications (2h) Chemical Sensors as thermodynamic systems (2h) Basic concepts of ion selective electrodes (ISEs) (2h) Solid electrolytes as ion selective membrane materials (3h), theories of interface potential generation (3h), pH-monitoring, the concept, pH-sensitive glass membrane, applications in environmental monitoring and process control (3h) More about ISEs, ISFETs (4h) High temperature oxygen gas sensor (Lambda-probe) for exhaust gas monitoring of automobile engines, combustion furnaces etc. (3h) Amperometric sensor concepts (theory), membrane covered amperometric sensor cells (5h), High temperature amperometric sensor concepts (2h). 2.The experimental lecture comprises highly-innovative optoelectronic sensor-systems for the detection of nearly all substances in gaseous-, liquid- and solid-state-mixtures as they are important in chemical-, pharmaceutical-, printing- and process- industry. All sensor systems were developed in cooperation with different international companies within the framework of technology-transfer from the University of Technology Karlsruhe to industry. 3.Dissolved oxygen monitors (3h) Electrochemical gas sensors ; gas detection method, cell

	materials, sensor properties and applications: toxic gas monitors, analysis of the exhaust gas of combustion furnaces etc. (4h) Introduction of the fundamental aspects of heterogeneous catalysis (catalysis based gas sensors) (5h) Gas sensors of the tin oxide type - surface catalytical processes, specific sensor properties, production technologies, applications (6h) Calorimetric chemical sensors (catalytic sensors, pellistors) for continuous monitoring of flammable (explosive) gases (4h). Sensor system for continuous hypochlorous acid (HOCl) monitoring - applications in control circuits for drinking water and swimming pool water processing (3h). Biosensors - the sensor concepts and survey of their (potential) applications in biotechnology, environmental monitoring and medical diagnostics (3h).
Examination:	Written examination 180 minutes with mark.
Media:	Slide presentation and blackboard
Literature:	Bard, Allan J / Faulkner, Larry R. Electrochemical methods: Fundamentals and applications New York: Wiley 2nd Ed. 2001 P. W. Atkins; Physical Chemistry

Module Name:	**Automotive Sensors Application**
Module Number:	ST3851
Lectures and Laboratories:	*1. Automotive Sensors* *2. Safety and Reliability* *3. Computer Aided Lab B*
Semester:	3rd Semester
Period:	Every year, summer term
Responsible:	Prof. Dr. Keller
Lecturer:	1. Prof. Dr. Keller 2. Prof. Dr. Keller 3. Prof. Dr. Alex
Language:	English
Part of Curriculum:	Sensor Systems Technology
Method / SWS / No. of Students:	1. Lecture / 1 SWS / 25 2. Lecture / 1 SWS / 25 3. Laboratory / 2 SWS / 15
Workload:	Contact time 56h, homework 84h during semester, homework 40h during semester break.
Credit Points (ECTS):	6
Prerequisites:	ST1821, ST1822
Recommended Requirements:	
Objectives:	1., 2. The students know the special requirements for electronic technology in modern vehicles and the sensors and actuators applicable under mobile conditions. They understand the interaction of the components in the system, are able to analyse weak points in the systems security and know concepts how to avoid them. 3. The students are able to apply advanced software to evaluate information from laboratory measurement systems.
Summary / Outline:	1. Electronics in Automobiles - An Overview Sensorics in Drive train Control Safety Systems Comfort Systems Communication Systems Bus Systems for Automotive Applications 2. Reliability Analysis Architecture of Fault-Tolerant Systems Safety, Reliability and Availability Failure Modes and Effects Analysis Fault Tree Analysis 3. Laboratory experiments set-up with modern measurement tools and computer control. Application of software tools for sensor signal evaluation.
Examination:	Written examination 120 minutes with mark. Laboratory with report, passed or failed.
Media:	
Literature:	3.1 Stonick, Virginia L / Bradly, Kevin Labs for signals and systems using MATLAB Boston: PWS 2000 3.2 Doeblin, Ernest O Measurement Systems Mc Graw Hill 1990 4th Edition

Module Name:	**System Integration**
Module Number:	ST3861
Lectures and Laboratories:	*1. Communication and Visualization* *2. Pattern Recognition*
Semester:	3rd Semester
Period:	Every year, summer term
Responsible:	Prof. Dr. Leize
Lecturer:	1. Prof. Dr. Leize 2. Prof. Dr. Langen
Language:	English
Part of Curriculum:	Sensor Systems Technology (M.Sc.)
Method / SWS / No. of Students:	1. Lecture and laboratory / SWS / 25 (15 Lab.) 2. Experimental lecture / 2 SWS / 25
Workload:	Contact time 56h, homework 56h during semester, homework 68h during semester break.
Credit Points (ECTS):	6
Prerequisites:	2 ECTS Computer Science at university level 4 ECTS Mathematics at university level
Recommended Requirements:	
Objectives:	1. The students know different possibilities to represent data and to transfer it in different ways. They can write simple interface programs and are able to design process control terminals using visualisation programs. 2. The students can use transformations and filters, in order to evaluate hidden information in signals.
Summary / Outline:	1. Wide area network (WAN), TCPIP Transport, Interface between process and TCPIP, Data visualization in HTML, Data visualization and process control by specialized programs, Wireless communication in networks. 2. With the help of the PC and experiments the use of digital signal processing to extract hidden information out of digital signals is illustrated. Features of the Discreet Fourier Transform (DFT), Applications of the DFT, Convolution and LTI-systems, Features of the Discreet Correlation (DC), Applications of the DC, Cepstrum, Adaptive Filtering
Examination:	Written examination 120 minutes with marks
Media:	1. Distributed learning environment with online information and tutorials together with primary data. Laboratory experiments using different PC interface techniques.
Literature:	

Module Name:	**Thesis and Project Evaluation**
Module Number:	ST4892
Lectures and Laboratories:	*Thesis Project*
Semester:	4th Semester
Period:	Special agreement.
Responsible:	The supervising Professor (first supervisor).
Lecturer:	Two of the Professors of the department.
Language:	Mainly English spoken environment.
Part of Curriculum:	Sensor Systems Technology
Method / SWS / No. of Students:	Project
Workload:	6 months
Credit Points (ECTS):	27
Prerequisites:	All modules of semesters 1 to 3. The Projects A and B must be finished.
Recommended Requirements:	
Objectives:	Proof of the capability for scientific working under guidance.
Summary / Outline:	Work on the final project and documentation by the thesis.
Examination:	Written documentation.
Media:	
Literature:	

Module Name:	**Final Examination**
Module Number:	ST4893
Lectures and Laboratories:	
Semester:	4th Semester
Period:	Special agreement
Responsible:	The supervising Professor (first supervisor).
Lecturer:	Two of the Professors of the department.
Language:	English
Part of Curriculum:	Sensor Systems Technology
Method / SWS / No. of Students:	
Workload:	Homework 90 h
Credit Points (ECTS):	3
Prerequisites:	ST4892
Recommended Requirements:	
Objectives:	Proof of the capability for scientific working under guidance.
Summary / Outline:	Preparation of the Thesis Presentation
Examination:	Presentation (20 min.) and oral discussion (>=40 min.)
Media:	
Literature:	

Elective Lectures in Module Management by “Career Services – Studium Generale”

This is an example as of summer semester 2010. The lectures are due to changes. Each lecture gives 2 two ECTS credits. For the module Management the student has to pass three of these courses.

No.	Course title
S9911	Intercultural Management Communication
S9914	International Economics
S9916	International Financial Markets
S9915	International Marketing
S9956	Presentation Techniques
S9957	Supply Chain Management

Certificate „International Business“: There are at least four courses to complete.

S 9911 Intercultural Management Communication

In international business, the seller must usually adapt to the buyer, and the visitor is expected to adapt to local customs. This involves not only legal and commercial procedures, but equally important, effective rapport management. In many major markets, the interpersonal relationship
is a prerequisite for any business transaction and can initially be more important than the quality of the product itself. What cultural factors influence how people think and behave in the global workplace? This seminar introduces students to key variables influencing the process of intercultural communication (e.g., norms, behaviors, values, verbal and non-verbal communication). The impact
of culture on international business relationships is analyzed, including such topics as conceptions of leadership, decision-making processes, preferred negotiating styles, conflict resolution in the workplace, etc. Various countryspecific profiles are used to illustrate the general concepts. Students will thus not only learn what people in other cultures do, but why they do it that way and what we can learn about each other in order to become more effective managers in the globalized workplace.
Lecturer: Dr. Brenda Hart Bohne, M.A.

S 9914 International Economics

Globalisation is one of the most discussed trends in the world economy. This „buzz-word“ characterises a process„by which markets and production in almost all countries become more and more mutually dependent of each other - thanks to the dynamics of trade with goods and Services and by the movements of capital and technology“ (OECD). This seminar deals with the theoretical foundations of open economies and the macroeconomic policy consequences of globalisation. Investigation of the empirical evidence of globalisation and discussion of some theories of international economies will be in the foreground of this course.
• Megatrend globalisation: new dimensions of an old phenomenon
• The reason for international trade: the theory of comparative advantage, modern theories of trade (economies of scale, trade and geography)
• Macroeconomics of open economies: international flows of goods and capital, real and nominal exchange rates, the theory of purchasing-power parity, international finance, capital and foreign exchange markets
Lecturer: Prof. Dr. Hagen Krämer

S 9916 International Financial Markets

On the evening news you have heard that the Central Bank is raising the fund rate. What affect might this have on you and your objectives? Does it mean that your innovation is going to be more expensive in future? Will it make it easier or harder for you to get a job next year? What effects have technical innovations on the capital markets, the costs of corporate finance and competing companies. This course provides answers to these and other questions by examining how financial markets work. After this course you will have a better understanding of the financial news in the television and newspaper. You will have the opportunity to make your own experience in the capital markets by opening a test account and see how your play money increases or decreases depending on your decision. We will award the best portfolio manager in class.
Lecturer: Christian de Lamboy

S 9915 International Marketing

International Marketing is the key to success in the global village and guarantees a higher customer satisfaction. Customer relationship management, new product and service development, an innovative spirit and cultural understanding constitute the basis for a company in a globalized world. The local needs of the customers and the international value chain of research and development, production and distribution emphasize that international marketing is a core competence to survive. The market has to be analyzed to reach higher competitiveness and profitability and develop customer-driven marketing strategies. This course will give you a deep understanding of the opportunities provided by international marketing and give you scientific tools and instruments to reach more efficient decisions.
Lecturer: Dr. Philipp Plugmann, Msc.

S 9956 Presentation Techniques

International business often involves the presentation of new, occasionally controversial, ideas and information. English language presentations are integral to communication in the international workplace. The effectiveness of such presentations can be evaluated in terms of their purpose, structure and communication techniques. For example, English presentations are as varied as reporting to in-house project groups, or international meetings or prospective clients or consumers. While students and professionals are normally competent at giving oral presentations in their national languages, the dual challenges of preparing and delivering English presentations, can seem quite daunting; time consuming and stressful. In this seminar, students will have the opportunity to practice various communication techniques for improving the structure and delivery of their presentations in English. Each student‘s verbal style will be video recorded. Presentation techniques will be practiced as well as critically reviewed for their effectiveness. Factors such as stage fright, gestures and mimic will be explicitly discussed.
Lecturer: Dr. Brenda Hart Bohne, M.A.

S 9957 Supply Chain Management

The core concept of this logistics training programme is a computer simulation that allows the participants to face the main problems of supply planning and control in industrial production systems. For this purpose serves a computer simulated model, in which decisions regarding the main targets of an industrial company have to be taken. The concept allows simulation and training in the field of extensive logistical methods and measures using new information technologies combined with new logistical concepts for supply chain management. Traditional aspects are enhanced by current methods and concepts so that new interdisciplinary work methods can be applied in business networks. Students work together in teams of 3 to 5 participants. Adequate knowledge in business organization / business administration is required.
Lecturer: Prof. Dr.-Ing. Karl-Robert Graf

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