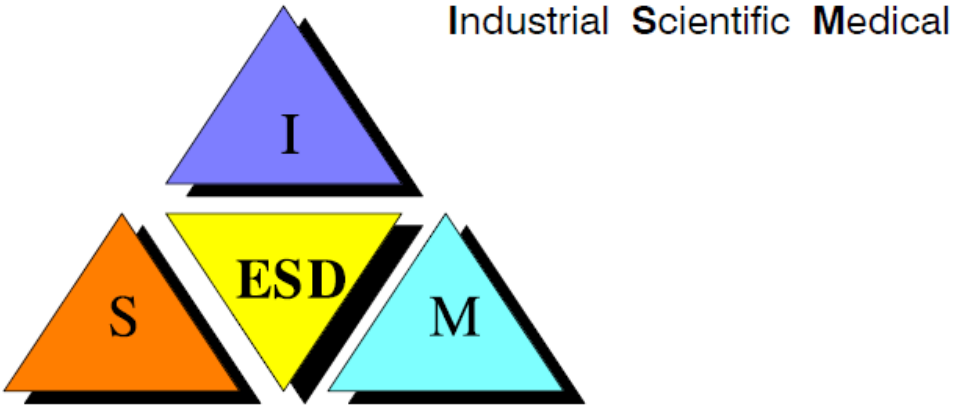
Master Program M.Sc.

"Embedded Systems Design [ESD]"



Module Handbook

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Explanations

Frequency of Modules:
All modules are offered once per year. In the module descriptions it is outlined if a module takes place in 1. semester (summer semester) or in 2. semester (winter semester).

Module duration:
All modules finish within one semester. Examinations are offered two times per year.

Workload:
A credit point (CP) corresponds to 30 hours of work (including self-learning).

Credits are earned after passing the academic records (exams and/or assessed assignments of the courses).

The compulsory course can be any course from a master program or from the list of general studies.

C. MODULE HANDBOOK

Module Name	**C.1. System Theory and Identification**		Abbreviation	**SY-SID**
Module Group	Systems		mandat. [X]	option []
Summer / Winter	Summer		Semester Term	**1**
Master Program	ESD			
Group	15 students			
Teaching Staff	K. Müller, K. Peter			
Person in Charge	K. Peter			
Requirements				
Course Types	Class	3 h	GF = 0,5	
	Exercise / Lab	1 h	GF = 0,5	
Course Objectives	The module provides the skills for description and identification of complex systems (time continues and discrete) for electrical, mechanical and thermal systems. The students can - set up the differential equations (time continues and discrete) for dynamic systems and analyze the dynamic behavior - set up state-space descriptions (time continues and discrete) - can linearize non-linear systems - can transform systems form time domain to frequency domain for continues and discrete systems - apply parameter identification algorithms in order to determine parameters from measured values - apply numeric and symbolic software for modeling, simulation, analysis and identification of dynamic systems			
Content	- signals and systems (time continues and discrete) - description of the system in time domain: Differential equations and state-space representation (time continues and discrete) of non-linear systems, time-variant systems, time delay, linear systems, linearization, linear time-invariant systems (LTI) - description of the system in the frequency domain (time continues and discrete): Laplace Transform, Z-Transform, Autocorrelation, Cross-Correlation, DFT, FFT, Power-Spectral-Density (PSD) - parameter identification methods: Least square (DLS and RLS), Maximum Likelihood, test signals and test signal generation			
Methods	Class, Lab			

Literature		Bernd Girod, Rudolf Rabenstein, Alexander Stenger: Einführung in die Systemtheorie. Teubner, 2003 Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab: Signals and Systems. Prentice-Hall, 1996 Rolf Isermann: Identifikation dynamischer Systeme: Grundlegende Methoden, Springer, 1992 Heinz Unbehauen: Regelungstechnik III, Identifikation, Adaption, Optimierung, Vieweg+Teubner 2011 Alberto Isidori: Nonlinear Control Systems, Springer 1995				
Exams		Written or oral Examination				
Workload (h)	class	Exercises /Seminars / other,	lab	Home work / presentation	Preparation	Industry
	45	15	0	0	90	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.2. Mechatronics**		Abbreviation	**SY-MEC**
Module Group	Systeme		mandat. [X]	option []
Summer / Winter	Sommer		Semester Term	**1**
Master Program	ESD			
Group	15 students			
Taeching Staff	N. Buro, K. Peter, K. Müller			
Person in Charger	K. Peter			
Requirements				
Course Types	Class	3 h	GF = 1,0	
	Exercise / Lab	1 h	SL	
Course Objectives	The module provides the skills for modeling of electro-mechanical systems. It gives a deeper understanding of the properties of mechanical systems combined with electrical actuators for the design of controls with embedded systems. The students • can describe mechanical and electrical systems by differential equations • know the basic strategies for the control of electro-mechanical systems • understand the relationship between, electric fields, electric currents, magnetic fields and the forces • know the basic types of electro-mechanical actuators • know the basics of tribology			
Content	• Hamiltonian mechanics • mechanical constraints: Holonomic constraints, Non-holonomic constraints, Pfaffian constraints, scleronomous constraints, rheonomous constraints • non-relativistic Lagrangian mechanics • Energy und coenergy, coordinate systems, Lagrange's equations, D'Alembert's principle, conserved momenta, energy conservation, conservative forces, methods to include dissipation and friction, methods to include non-conservative forces • Modeling of friction: Solid/boundary friction, mixed friction, fluid friction, Stribeck effect, sliding-contact bearings, roller bearings • Deriving the equations of motion for several examples • Basic modeling of electric drive systems: DC-drives, AC-drives, frequency converters, gears, linear drives • Simulation of simple controls of electro-mechanical systems: Effects of nonlinearities (e.g. Stribeck effect)			
Methods	Class, Lab			
Literature	Herbert Goldstein, Charles P. Poole, John L. Safko: Klassische Mechanik. Wiley-VCH, 2006 Cornelius Lanczos: The Variational Principles of Mechanics. Dover Publ. Inc., 1986			

		F. Cellier: Continuous System Modeling, Springer Verlag, 1991 Landau, L.D./E.M. Lifshitz: Mechanics Volume 1 (Course of Theoretical Physics), Butterworth-Heinemann, Reprint of 1976 Feynman, R. P.: Lectures on Physics, Basic Books 2014				
Exams		Written or oral Examination				
Workload (h)	class	Exercises / Seminars / other	lab	Home work / presentation	Preparation	Industry
	45	7	8	0	90	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.3. Discrete Control Systems**			Abbreviation	**AU-DCS**
Module Group	Systems			mandat. [X]	option []
Summer / Winter	Summer		Semester Term		**1**
Master Program	ESD				
Group	15 students				
Teaching Staff	K. Peter, K. Müller				
Person in Charge	K. Peter				
Requirements					
Course Types	Class	3 h	GF = 1,0		
	Exercise / Lab	1 h	SL		
Course Objectives	The module provides the skills for designing sophisticated controls. The students • can design state-feedback controls, PI-state-feedback controls • can analyse the stability of control systems and can distinguish between BIBO-, BIBS- and lyapunov stability • can design state-observers • can design combinations of observers and state-controls • can design optimal controls and optimal observers (LQRs, LQEs and LQGs) • can design MIMO controls				
Contents	• state-space representation of dynamic systems: D'Alembert's principle, differential equation, linearization, state-space (time continues and discret), continues to discrete transformations (ZOH, bilinear transformation), eigenvalues, eigenvectors, solutions for IVPs, canonical forms, Jordan form, trajectories, Cayley–Hamilton theorem, transfer function • stability: BIBO-, BIBS- and lyapunov stability • state-feedback controls: Pole placement, Ackermanns formula, PI-state-feedback controls, • state-observers (time continues and discret), discrete parallel model, combinations of observers and state-controls • Optimal controls: LQR design, Cost function, Matrix-Riccati Equation, solution by Hamiltonian matrix, • Optimal observers: LQEs, Kalman filtering for noise suppression, reliability of measurements, LQGs • MIMO controls: Full modal synthesis (according to Roppenecker)				
Methods	Class, Lab				
Literature	Karl Johan Aström, Richard M. Murray: Feedback Systems, Princeton University Press 2008 Franklin, G. F.; Powell, J. D.; Emami-Naeini, A.: *Feedback Control of Dynamic Systems*, Prentice Hall, 2002 Ludyk, G.: *Theoretische Regelungstechnik 1 u. 2*, Springer-Verlag, 1995 Unbehauen, H.: *Regelungstechnik I, II u. III*, Vieweg, 1998 Föllinger, O.: *Regelungstechnik*, Hüthig, 1994				

		O. Föllinger, G. Roppenecker: Optimale Regelung und Steuerung, Dezember 1994 von Otto Föllinger (Autor), Günter Roppenecker (Mitwirkende) Maciejowski, J. M.: Multivariable Feedback Design. Addison-Wesley, Wokingham, England, 1989 Li Tan: Digital Signal Processing: Fundamentals and Applications. Academic Press, 2007				
Exams		written or oral exam				
Workload (h)	class	seminars/ others	labs	Home work / presentation	preparation	industry
	45	0	15	0	90	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.4. Digital Systems / VHDL**		Abbreviation	**ET-DTV**
Module Group	Digital Systems		mandat. [X]	option []
Summer/Winter	Summer Term	Semester Term		**1**
Master Program	ESD			
Group	15 students			
Teaching Staff	K. Mueller			
Person in Charge	K. Mueller			
Requirements				
Course Types	Class (2 h) , Lab (2 h)			
Course Objectives	The module deepens the knowledge on digital systems and enables the students to design, simulate und implement programmable logic using VHDL. The students • can design complex sequential logic • handle optimization and minimization of digital logic • know microprocessor architectures and can develop programs in assembly and C/C++ language • know the elements of VHDL can implement logic systems on FPGAs			
Contents	• elements of digital systems • sequential systems, state machine graphs • CISC- und RISC-architectures, DSPs • memory and memory controllers • CPLDs und FPGAs internals • VHDL programming und applications • communication protocols			
Methods	class, labs			
Literature	K. Urbanski u. R. Woitowitz: Digitaltechnik. Springer, 2000 J. Wakerly: Digital Design: Principles and Practices. Prentice-Hall, 1999 S. Yalamanchili: VHDL Starter's Guide. Prentice-Hall, 1998 P. J. Ashenden: The Designer's Guide to VHDL. Elsevier/Morgan Kaufmann, 2011 V. A. Pedroni: Circuit Design and Simulation with VHDL. MIT Press, 2010 R. Lipsett, C. Schaefer and C. Ussery: VHDL: Hardware Description and De sign. Kluwer Academic Publishers, 1990 Xilinx Vivado Users's Guide. Xilinx Corp., 2015			
Exams	written or oral exam			

Workload (h)	class	seminars/ others	labs	Home work / presentation	preparation	industry
	30	0	30	0	90	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.5. System-on-Chip-Design**		Abbreviation	**SY-SOC**
Module Group	Digital Systems / Computer Science		mandat. [X]	option []
Summer / Winter	Summer Term	Semester Term		**1**
Master Program	ESD			
Group	15 students			
Teaching Staff	K. Mueller			
Person in Charge	K. Mueller			
Requirements				
Course Types	class (2 h), lab (2 h)			
Course Objectives	The complete digital logic and control of systems can be included on a single device (System-on-Chip design). This results in very high speed, very reliable solutions at low cost. This module teaches all required techniques to create SoCs with custom logic, microcontrollers and the required interfaces. The students • can integrate custom logic and interfaces on a single chip • handle integration von microcontrollers (embedded softcore) • can solve control problems in hardware and software.			
Contents	• Interfaces to sensors and actuators • AD and DA converters • advanced communication protocols • intellectual properties • embedded microcontroller, 8 bit, 32 bit • integration of digital components to a complete control system • Application examples in the industrial/scientific/medical area			
Methods	Class, Labs			
Literature	J. Wakerly: Digital Design: Principles and Practices. Prentice-Hall, 1999 Xilinx PicoBlaze™ Users's Guide. Xilinx Corp., 2014 Xilinx Vivado™ Users's Guide. Xilinx Corp., 2015 Pong P. Chu: FPGA Prototyping By VHDL Examples (Xilinx Spartan-3 Version) Wiley Interscience, 2008 R. Reis, M. Lubaszewski, J.A.G. Jess: Design of Systems on a Chip: Design and Test Springer 2010 B.M. Al-Hashimi: System-on- Chip: Next Generation Electronics (Circuits, Devices and Systems) Instit. of Eng. and Technology, 2006			
Exams	written or oral exam			

Workload	class	Seminar/others	labs	homework/ presentation	preparation	industry

(h)	30	0	30	0	90	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.6. Model Based Software Development/ Real-time Software**		Abbreviation	**IT-MRT**
Module Group	Informatics		mandat. [X]	option []
Summer / Winter	Summer		Semester Term	**2**
Master Program	ESD			
Group	15 students			
Teaching Staff	M. Lindemann, T. Umland			
Person in Charge	K. Müller			
Requirements				
Course Types	class	2 h	GF = 1,0	
	Exercise / Lab	2 h	SL	
Course Objectives	The module provides the skills for designing real-time software. This includes the skills in model based software development. The students • know the principles of parallel data processing • understand typical failures in parallel data processing and understand the need for formal proofs for parallel algorithms • can develop synchronization concepts as „Monitor“, „Semaphore“ and „CSP" and are able to develop solutions for parallel data processing in programming languages • understand the need for real-time signal processing • know the principles of hardware and software interrupts, interrupt controllers and interrupt handling • understand typical failures in real-time data processing • understand the principals of real-time operating systems			
Contents	• motivation for parallel data processing • examples for parallel/distributed algorithms • examples of failures (dead-lock, priority inversion) • theoretical description of parallel models in state-space • proof for mandatory properties of parallel systems with „model checkers“ • comparison of synchronization concepts „Monitor“, „Semaphor“ and „Communicating Sequentiell Processes (CSP)“ • rules for transformation of the theoretical models into in programming language • programming of examples of synchronization concepts • need of real-time signal processing for control applications, discrete integration and differentiation in control loops • hardware and software interrupts, interrupt controllers and interrupt handling • known multi-processor concepts in servo drive applications: Inter-Processor Communication (IPC), Dual-Port-RAM			

		• real-time operating systems: QNX, RTLinux • Networks and Real-Time Ethernet				
Methods		Class, lab				
Literature		E. W. Dijkstra: Cooperating sequential processes. In: F. Genys (Ed.), Programming Languages, Academic Press, New York (1968) 43-112 P. B. Hansen, Java's insecure parallelism, ACM SIG-PLAN Notices, (4) 23 (1999) 38-45. C. A. R. Hoare: Monitors: An operating system structuring concept, Communications of the ACM, (10) 17 (1974), 549-557. C. A. R. Hoare: Communicating sequential processes, Communications of the ACM, (8) 21 (1978), 666-677. D. Lea: Concurrent Programming in Java - Design Principles and Patterns, The Java Series, Addison-Wesley, Reading, Massachusetts, 2. Auflage (2000). J. Magee, J. Kramer: Concurrency - State Models and Java Programs, John Wiley & Sons, West Sussex, 2. Auflage (2006). B. Sanden: Coping with java threads, IEEE Computer, (4) 37 (2004), 20-27. B. Goetz: Java Concurrency in Practice, Addison-Wesley, Upper Saddle River, New Jersey (2006). T. Rauber, G. Rünger: Parallele Programmierung, Springer-Verlag, Berlin, Heidelberg, 2. Auflage (2007).				
Exams		written or oral exam,				
Workload (h)	class	Übungen, Seminar, sonstige Kontaktstunden	Labor-Praktikum	Hausarbeit/ Referat/ Masterarbeit	Vor- und Nachber.	Industriepraktikum
	30	0	30	0	90	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.7. Industrial Systems**			Abbreviation	**ES-IND**
Module Group	Systems			mandat. [X]	option []
Summer / Winter	Winter		Semester Term		**2**
Master Program	ESD				
Group	15 students				
Teaching Staff	K. Mueller K. Peter, n.n.				
Person in Charge	K. Mueller				
Requirements					
Course Types	class	2 h	GF = 0,5		
	Lab	2 h	GF = 0,5		
Course Objectives	The module enable the students to design and implement typical embedded systems for industrial applications. This covers electrical drives systems, sensors and signal processing for power electronics.				
Contents	Industrial systems will presented in detail. The applications are: • electrical drives (stepper motor, BLDC, AC-servo drive) • field-oriented control scheme • digital signal processing for control and power electronics • hardware/software realization • building automation • motor management • robotics • tool machines • condition-monitoring • real-time networks				
Methods	class, labs				
Literature	Leonhard W.: Control of electrical Drives. Springer, 1997 Isermann, R.: Mechatronische Systeme, Springer, 2008 System Generator for DSP User's Guide, Xilinx Corp., 2011 System Generator for DSP Reference Guide, Xilinx Corp., 2011				
Exams	written or oral exam				

Workload (h)	class	Seminars / other	lab	Home work/ presentation	preparation	Industry
	30	0	30	0	90	0

Language	English
Remarks	
Credits	**5**

Module Name	**C.8. Medical Systems**			Abbreviation	**ES-MED**
Module Group	Systems			mandat. [X]	option []
Summer / Winter	Winter		Semester Term		**2**
Master Program	ESD				
Group	15 students				
Teaching Staff	K. Mueller, K. Peter				
Person in Charge	K. Mueller				
Requirements					
Course Types	Class	2 h	GF = 0,5		
	Lab	2 h	GF = 0,5		
Course Objectives	The module enables the students to design typical embedded systems for medical applications.				
Contents	Embedded medical devices for diagnosis and treatment will be presented in technical detail: • blood pressure devices • oximetry • ECG/EEG systems and signal analysis, cardiac rhythm management • digital x-ray • ultrasonic actuation and measurement, flow measurement • flow cytometry, impedance tomopgaphy (EIT) • digital signal processing for medical signals - FFT, IFFT - IIF and FIR filter design and high speed implementation CORDIC algorithm and hardware • automatic code generation				
Methods	class, lab				
Literature	Northtrop, R.: Noninvasive Instrumentation and Measurement in Medical Diagnosis (Biomedical Engineering) CRC Press, 2002 Prutchi, D. und Norris, M.: Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices. John Wiley & Sons, 2005				
Exams	written or oral exam				

Workload (h)	class	seminars / other	labs	Home work / presentation	preparation	industry
	30	0	30	0	90	0

Language	English
Remarks	
Credits	**5**

Module Name	**C.9. Maritime Scientific Systems**			Abbreviation	**ES-MAR**
Module Group	Systems			mandat. [X]	opt. [X]
Summer / Winter	Winter			Semester Term	**2**
Master Program	ESD				
Group	15 students				
Teaching Staff	A. Bochert				
Person in Charge	K. Müller				
Requirements					
Course Types	Class	2 h	GF = 0,5		
	Lab	2 h	GF = 0,5		
Course Objectives	The module provides the skills for designing and applying embedded systems for scientific maritime systems.				
Contents	Maritime measurement and control systems will be taught in detail. Typical applications are: • remotely operated vehicles (ROV) • autonomous underwater vehicles (AUV) • measurement systems for environmental condition over and under water • floater/lander				
Methods	Class, Lab				
Literature	Christ, D. und Wernli, L.: The ROV Manual: A User Guide for Observation Class Remotely Operated Vehicles. Butterworth Heinemann/Elsevier, 2007 Richard L. Miller, R., Del Castillo, C. und McKee, B: Remote Sensing of Coastal Aquatic Environments: Technologies, Techniques and Applications (Remote Sensing and Digital Image Processing) Springer, 2005				
Exams	written or oral exam				

Workload (Stunden)	class	seminars / other	labs	Home work / presentation	preparation	industry
	30	0	30	0	90	0

Language	English
Remarks	
Credits	**5**

Module Name	**C.10. Safety and Reliability**		Abbreviation	**ES-SAR**
Module Group	Systems		mandat. [X]	option []
Summer / Winter	Winter	Semester Term		**2**
Group	ESD			
Teaching Staff	K. Peter			
Person in Charge	K. Peter			
Requirements				
Course Types	class (1h), lab (1 h)			
Course Objectives	The module provides the skills for designing, assessing and certifying of safety critical systems The students • can design safety critical systems • can plan and apply safety critical development processes • can assess safety critical systems • can create a safety analysis • can create a reliability analysis • know the certification process for safety critical systems • know how to enhance safety • know how to enhance reliability I			
Contents	• basic probability calculations (distribution functions, Gaussian-, chi-square- Weibull- and exponential, confidence radius, median, safety and reliability benchmarks, boolean models, fault trees, dormant failures, average risk) • architecture of safety critical systems (dissimilar independence, separation and segregation, zonal analysis, common mode failures, active and passive redundancy) • safety and reliability project planning (determination of the development process for hard- and software, DAL, SIL) • safety and reliability assessments (top down assessments, functional hazard assessment FHA, bottom up analysis, failure modes and effects analysis FMEA/FMES, fault trees FT, reliability block diagrams RBD, markov processes) • quality management (random sample testing, Weibull curve fitting, HALT/HASS testing) • certification of safety critical systems (safety critical hard- and software, complex electronic hardware, acceptable means of compliance)			
Methods	Class, Lab			

Literature		Meyna, A; Pauli, B.: Taschenbuch der Zuverlässigkeits- und Sicherheitstechnik Birnolini, A.: Quality and Reliability of Technical Systems IEC 61508 - Funktionale Sicherheit sicherheitsbezogener elektrischer/elektronischer/programmierbar elektronischer Systeme (sowie IEC 61511, IEC 61513, EN 50128, IEC 62061, IEC 60601, ISO/DIS 26262) DO160, Environmental Conditions and Test Procedures for Airborne Equipment DO178 Software Considerations in Airborne Systems and Equipment Certification ARP4761 Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment ARP 4754 Certification Considerations for Highly-Integrated Or Complex Aircraft Systems MIL STD 785B Reliability Program for Systems and Equipment Development and Production MIL HDBK 217F Reliability Prediction of Electronic Equipment				
Exams		written or oral exam				
Workload (h)	class	Exercises, / Seminar other	lab	Home work / presentation	Preparation	Industry
	15	0	15	15	45	0
Language		English				
Remarks						
Credits		**3**				

Module Name	**C.11. Embedded Systems Project**			Abbreviation	**ES-PRO**
Module Group	Systems			Pflicht [X]	Wahl []
Summer / Winter	Winter			Semester Term	**2**
Master Programs	ESD				
Group	15 students				
Teaching Staff	K. Peter, M. Lindemann, K. Mueller				
Person in Charge	K. Mueller				
Requirements					
Course Types	Labor ESD	3 h	GF = 0,5		
	Kolloquium	1 h	GF = 0,5		
Course Objectives	The students should learn about the complete development cycle on embedded systems. The embedded design must be fully function on real systems (cart/-pendulum plant, magnetic levitation, cart on beam, pulse oximetry device, thermal generator etc.) Students will know about project management, teamwork, presentation and documenting.				
Content	• Programmable logic design (DSP, process interface) • Hardware design • Real-time software • GUI programing • System modeling • System simulation • System identification • Legacy C code verification • Technical documentation • Presentation				
Methods	Class, lab, team work, presentation, technical report				
Literature	Noergaard, T.: Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers (Embedded Technology). Elsevier, 2005 Vahid, F. und Givargis, T.: Embedded System Design: A Unified Hardware/Software Introduction. Wiley, 2001 Ganssle, J.: The Art of Designing Embedded Systems. Newnes, 2008 Siewert, S.: Real-Time Embedded Components and Systems (Computer Engineering). Charles River Media, 2006 Berger, A.: Embedded Systems Design: An Introduction to Processes, Tools and Techniques, CMP Books, 2001				
Exams	Colloquium and Report				

Workload (h)	class	exercises / semiars / other	lab	home work / presentation	preparation	Industry
	0	0	45	190	125	0

Language	English
Remarks	
Credits	**12**

Module Name	**C.12. Optional Course**				Abbreviation	**ES-OPT**
Module Group	Commercial, Soft-Skill, Techniques				mandat. []	opt. [X]
Summer / Winter	Winter				Semester Term	**2**
Master Programs	ESD, other students of the University of Applied Sciences Bremerhaven					
Group	15 students of ESD, other students, Studium Generale					
Teaching Staff	All Professors and lecturers of the University of Applied Sciences Bremerhaven					
Person in Charge	K. Müller					
Requirements						
Course Types	Class, lab, exercise					
Objective	In order to individualize their capabilities, each student can select a module, which has 5 credits, of another master program of the University of Applied Sciences Bremerhaven including Studium Generale.					
Content	Refer to the module description of the selected course					
Methods	Class, lab, exercise, group work, seminar					
Literature	--					
exam	Refer to the module description of the selected course					
Workload (hours)	class	exercises / semiars / other	lab	home work / presentation	preparation	Industry
	ca. 30	ca. 15	ca. 15	ca. 20	60	0
Language	English					
Remarks						
Credits	**5**					

Module Name	**C.13. Master Thesis**			Abbreviation	**MA-ESD**
Module Group	Master Thesis			mandat. [X]	option []
Summer / Winter	Summer			Semester Term	**3**
Master Program	ESD				
Group	15 students				
Teaching Staff	A. Bochert, K. Peter, M. Lindemann, K. Müller, other Professors				
Person in Charge	K. Mueller				
Requirements	40 credits acquired from courses				
Course Types	Master Thesis	0 h	GF = 0,8		
	Colloquium	4 h	GF = 0,2		
Objectives	The students should verify that they could solve complex design tasks with scientific methods at master level.				
Content	The content depends on the scientific or industrial assignment.				
Methods	Self-contained research and development, individual support by supervisors.				
Literature					
Exams	Written Master Thesis, Colloquium				

Workload (h)	class	Exercises / seminars / others	lab	home work / presentation	preparation	Industry
	0	0	0	900	0	0

Language	German / English
Remarks	
Credits	**30**