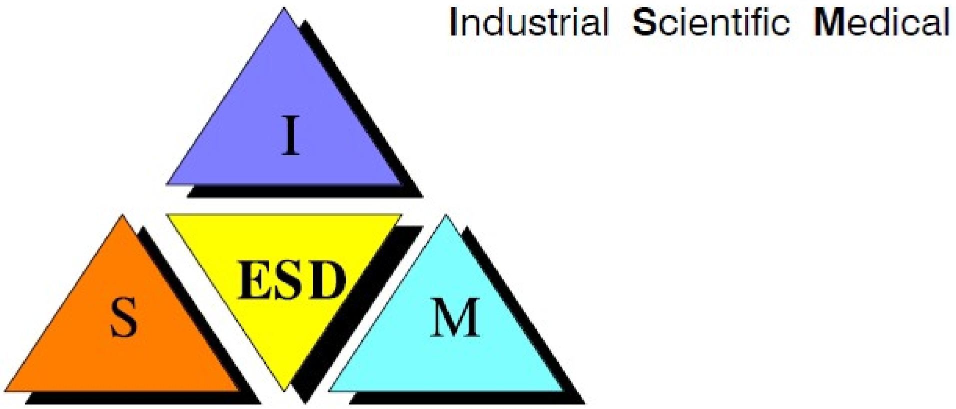
Master Program M.Sc.

“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.

Abbreviations

SL: "Studienleistung" (non-graded examination),
PL: "Prüfungsleistung" (graded examination),
GF: "Gewichtungsfaktor" (weighting factor for the calculation of the module grade),
CP: Credit-Points according to the European Credit Transfer and Accumulation System (ECTS)

Non-graded and graded examinations:
K: "Klausur" (written exam under surveillance),
M: "Mündliche Prüfung" (oral exam),
R: "schriftlich ausgearbeitetes Referat" (presentation with script),
H: "Hausarbeit" (paper),
P: "Projektarbeit" (project work),
PB: "Praktikumsbericht" (internship report),
V: "Praktischer Versuch" (experiment),
MA: "Masterarbeit" (master thesis).
„ , ": The separating commas in between the abbreviations for graded examinations indicate possible types of exams for the corresponding module. It will be specified by the lecturer at the be-ginning of the semester.

C. MODULE HANDBOOK

Module Name	**C.1. Mechatronics**	Abbreviation	**SY-MEC**
Module Group	Systems	mandat. [X]	option []
Summer / Winter	Summer	Semester Term	**1**
Master Program	ESD		
Group	30 students		
Teaching 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 / others	Lab	Home work / presentation	Preparation	Industry
	42	7	7	0	94	0
Language	English					
Remarks						
Credits	**5**					

Module Name	**C.2. Discrete Control Systems**	Abbreviation	**AU-DCS**
Module Group	Systems	mandat. [X]	option []
Summer / Winter	Summer	Semester Term	**1**
Master Program	ESD		
Group	30 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 discrete), 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, Ackermann's formula, PI-state-feedback controls, • state-observers (time continues and discrete), 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	Exercises / seminars / others	Lab	Home work / presentation	preparation	industry
	42	0	14	0	94	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.3. Digital Systems / VHDL**				Abbreviation	**ET-DTV**
Module Group	Digital Systems				mandat. [X]	option []
Summer/Winter	Summer Term				Semester Term	**1**
Master Program	ESD					
Group	30 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 and 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 Xilinx Vivado Users's Guide. Xilinx Corp., 2015					
Exams	written or oral exam					
Workload (h)	class	Exercises / seminars / others	Lab	Home work / presentation	preparation	industry
	28	0	28	0	94	0
Language	English					
Remarks						
Credits	**5**					

Module Name	**C.4. 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	30 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 interated 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 MicroBlaze™ Users's Guide. Xilinx Corp., 2015 Xilinx Vivado™ Users's Guide. Xilinx Corp., 2015		
Exams	written or oral exam		

Workload (h)	class	Exercises / seminars / others	Lab	homework/ presentation	preparation	industry
	28	0	28	0	94	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.5. Model Based Software Development / Real-time Software**		Abbreviation	**IT-MRT**
Module Group	Informatics		mandat. [X]	option []
Summer / Winter	Summer		Semester Term	**1**
Master Program	ESD			
Group	30 students			
Teaching Staff	M. Lindemann			
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 Sequential 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				
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	Exercises / seminars / others	Lab	Home work / presentation	preparation	industry
	28	0	28	0	94	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.6. Industrial Systems**				Abbreviation	**ES-IND**
Module Group	Systems Applications				mandat. [X]	option []
Summer / Winter	Winter				Semester Term	**2**
Master Program	ESD					
Group	30 students					
Teaching Staff	U. Werner					
Person in Charge	K. Mueller					
Requirements						
Course Types	class		2 h		GF = 1.0	
	Lab		2 h		SL	
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	Exercises / seminars / others	Lab	Home work/ presentation	preparation	Industry
	28	0	28	0	94	0
Language	English					
Remarks						
Credits	**5**					

Module Name	**C.7. Medical Systems**	Abbreviation	**ES-MED**
Module Group	Systems Applications	mandat. [X]	option []
Summer / Winter	Winter	Semester Term	**2**
Master Program	ESD		
Group	30 students		
Teaching Staff	K. Mueller		
Person in Charge	K. Mueller		
Requirements			
Course Types	Class	2 h	GF = 1.0
	Lab	2 h	SL
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	Exercises / seminars / others	Lab	Home work / presentation	preparation	industry
	28	0	28	0	94	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.8. Maritime Systems**	Abbreviation	**ES-MAR**
Module Group	Systems Applications	mandat. [X]	opt. []
Summer / Winter	Winter	Semester Term	**2**
Master Program	ESD		
Group	30 students		
Teaching Staff	A. Bochert		
Person in Charge	K. Müller		
Requirements			
Course Types	Class	2 h	GF = 1.0
	Lab	2 h	SL
Course Objectives	The module enables the students to design and implement typical instrumentation circuits and sensors for maritime systems. With the work in the laboratory, the students will be able to design electronics to operate sensors for maritime applications. They are able to simulate their own designed electronical circuits with SPICE prior to implementation. They will be able to build a system to read analog sensor data and process this data with a microcontroller programed in the language C. Connecting this microcontroller to the circuit will result in an intelligent data acquisition system. The students will be able to analyze the acquired data. The lectures support the students with all relevant details for the work in the laboratory. They will be able to identify and choose the right sensors and circuit types. The students know the importance of system theory and can design active filters. They will learn the problems of analog to digital conversion, and how to solve these. The students will get an overview of basic oceanographic and advanced maritime instrumentation.		
Contents	• **Introduction** (observations and measurements, measurement setup, signal types) • **Electrical instrumentation** (measurement of resistance, operational amplifiers, circuit design with multiple operational amplifiers, Fourier analysis / transformation , system theory, active filters) • **Non-electrical instrumentation** (temperature, acceleration, distance via acceleration) • **Digital instrumentation** (sample & hold, sampling theorem and aliasing, quantification, analog to digital converter) • **Basic oceanographic instrumentation** (temperature, salinity and depth, current, water level) • **Advanced maritime systems** (floats as marine observers, tsunami early warning, precision salinometer)		
Methods	Class, Lab		
Literature	Tietze, Ulrich; Schenk, Christoph: Electronic Circuits, Springer, 2002 Oppenheim, Alan V.; Schafer, Ronald W.: Discreate-Time Signal Processing, Pearson Education Limited, 2013 Kernighan, Ritchie: The C programming language, Prentice Hall		

Exams		written or oral exam				
Workload (h)	class	Exercises / seminars / others	Lab	Home work / presentation	preparation	industry
	28	0	28	0	94	0
Language		English				
Remarks						
Credits		**5**				

Module Name	**C.9. Safety and Reliability**	Abbreviation	**ES-SAR**
Module Group	Systems	mandat. [X]	option []
Summer / Winter	Summer	Semester Term	**1**
Group	ESD		
Teaching Staff	K. Peter		
Person in Charge	K. Peter		
Requirements			
Course Types	class (2h), lab (1h)		
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		
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 / seminars / others	Lab	Home work / presentation	Preparation	Industry
	28	0	14	14	64	0
Language		English				
Remarks						
Credits		**4**				

Module Name	**C.10. Requirements Engineering**	Abbreviation	**ES-REQ**
Module Group	Systems	mandat. [X]	option []
Summer / Winter	Winter	Semester Term	**2**
Master Program	ESD		
Group	30 students		
Teaching Staff	K. Peter		
Person in Charge	K. Peter		
Requirements			
Course Types	class (1h), seminar (2h)		
Course Objectives	The module provides the skills for requirements engineering The students • can read and write specification of products, systems and equipment • can read and write compliance matrices • know the importance of correct wording of requirements • know how to apply techniques for traceability of requirements and requirements validation • know how to handle derived requirements • know which acceptable means of compliance to demonstrate for the requirements verification • understand configuration management • understand risk management • understand change management		
Contents	• Applicability of Requirements, Requirements Working Logic, Requirements Numbering Scheme, Functional Requirements, Design Requirements, Interface Requirements, Environmental Requirements, Reliability Requirements, Availability Requirements, Maintainability Requirements, Safety Requirements, Security Requirements, Requirements to Build-In-Test-Equipment, Manufacturing Requirements, Operational Requirements, Configuration Management Requirements, Logistics Requirements, Dispose and Waste Requirements • Acceptable means of Compliance • Requirement Engineering Software Tools (e.g. DOORS) • DO160F and the related requirements • DO254 and the related requirements • DO178B/C and the related requirements • SysML in systems engineering - how to create requirements with SysML (e.g. with Rhapsody) • MisraC, CERT, ISO C / C90 / C99 and the related requirements to programming • Formal Proofs (e.g. with SCADE) and how to use it for compliance demonstration		

Methods		Class, Seminar				
Literature		J. Dick, E. Hull, K. Jackson, "Requirements Engineering", Springer, 2017 C. Hood, S. Wiedemann, S. Fichtinger, U. Pautz, „Requirements Management", Springer, 2008 C. Ebert, „Systematisches Requirements Engineering", dpunkt Verlag, 2014 C. Hobbs, "Embedded Software Development for Safety-Critical Systems", CRC Press, 2015 DO160F Environmental Conditions and Test Procedures for Airborne Equipment"DO178B/C Software Considerations in Airborne Systems and Equipment Certification DO254 Electronic Hardware DO-330 Software Tool Qualification Considerations				
Exams		Seminar Presentation and Report				
Workload (h)	class	Exercises / seminars / others	Lab	Home work / presentation	Preparation	Industry
	14	28	0	14	34	0
Language		English				
Remarks						
Credits		**3**				

Module Name	**C.11. Embedded Systems Project**	Abbreviation	**ES-PRO**
Module Group	Systems	mandat. [X]	option []
Summer / Winter	Winter	Semester Term	**2**
Master Programs	ESD		
Group	30 students		
Teaching Staff	K. Peter, M. Lindemann, K. Mueller		
Person in Charge	K. Mueller		
Requirements			
Course Types	Labor ESD	4 h	GF = 0,50
	Colloquium	3 h	GF = 0,50
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 / seminars / others	Lab	home work / presentation	preparation	Industry
	0	0	112	222	56	0
Language	English					
Remarks						
Credits	**13**					

Module Name	**C.12. Master Thesis**					Abbreviation	**MA-ESD**
Module Group	Master Thesis					mandat. [X]	option []
Summer / Winter	Summer				Semester Term		**3**
Master Program	ESD						
Group	30 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**						