Handbook for modules of the Master study programme “Advanced Semiconductor Nanotechnologies” of the Otto-von-Guericke-University Magdeburg – Released on 12.06.23

Module descriptions

Module	Entrance Harmonization course I+II
Module level acc. to DQR	6
Module number	
Courses	V + Ü Electronic circuits V + Ü Introduction to chemistry V + Ü Introduction to quantum mechanics
Study semester	1.
Recurrence	Winter semester
Module organisator	Prof. André Strittmatter
Lecturers	Prof. Kulak (FVST) Prof. A. Strittmatter (FNW) N. N.
Language	englisch
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS Lecture and 1 SWS tutorial
Workload	150 h (42 h attendence and 108 h self-learning)
Duration	1 Semester
Credit Points	5
Preconditions for CPs	Passing module examination
Admission	None
Recommendation for admission	None
Aims	Students acquire basic knowledge that is missing in their previous study programme but relevant to this master programme.
Content	Specific courses are determined by an examination board based on entrance level examination results to close knowledge gaps between students holding B. Sc. from different disciplines. Content (dependent on entrance examination) - Introduction to quantum physics link - Introduction to chemistry - Electronic circuits link
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Solid state physics
Module level acc. DQR	7
Module number	
Courses	V+Ü “Solid State Physics”
Study semester	1
Recurrence	Winter term
Module organisator	Prof. J. Christen (FNW)
Lecturer(s)	Prof. J. Christen (FNW)
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS lecture +1 SWS tutorial
Workload	150 h (42 h attendance + 108 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	None
Recommendation for admission	None
Aims	Students acquire knowledge and competencies about: Basics of semiconductor physics as determined by the system of electrons Application of physical methods and routines Scientific analysis of problems related to electronic semiconductor properties Efficient mathematical tools to analyze electronic properties
Content	Semiconductor crystals: chemical bonding and structure Electrons in crystals: Fermi-statistics, band structure and density of states Motion of electrons: effective mass, mobility, Drude model Intrinsic semiconductors: electron and hole concentration Doping of semiconductors: donors/acceptors, deep traps, degeneracy Temperature dependence of conductivity: scattering processes Metal-semiconductor contact and pn-junction; Semiconductor heterostructures
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Semiconductor quantum structures
Module level acc. DQR	7
Module number	
Courses	V+Ü “Semiconductor quantum structures”
Study semester	2.
Recurrence	Summer term
Module organisator	Prof. F. Bertram
Lecturer(s)	Prof. F. Bertram
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS lecture +1 SWS tutorial
Workload	150 h (42 h attendance + 108 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	None
Recommendation for admission	Module “Solid State Physics”
Aims	Participants acquire knowledge and competencies about: • quantum mechanical foundations of solid state and semiconductor physics • application of physical methods and routines at nanoscale dimensions • scientific analysis of problems related to semiconductor physics • efficient mathematical tools to analyze experimental data of semiconductor quantum structures
Content	Physics of quantized semiconductor structures (2D,1D-,0D-systems); Structural, optical, electronic properties of quantum structures and transport ; Properties of semiconductor devices with embedded quantum structures; Effects of potential barriers and tunneling
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Semiconductor devices I
Module level acc. DQR	7
Module number	
Courses	V+Ü “Semiconductor devices I”
Study semester	2.
Recurrence	Summer term
Module organisator	Prof. F. Bertram
Lecturer(s)	Prof. F. Bertram
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS lecture +1 SWS tutorial
Workload	150 h (42 h attendance + 108 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	Module “Solid State Physics”
Recommendation for admission	
Aims	Participants acquire knowledge and competencies about: • foundations of solid state and semiconductor physics • application of physical methods and routines • scientific analysis of problems related to semiconductor devices • efficient mathematical tools to analyze experimental data of semiconductor devices
Content	Basic unipolar devices 1. Physics of metal-semiconductor interfaces 2. Schottky-contact, negative electron affinity concept, depletion regions 3. Schottky-diodes, MIS-diodes and CCDs 4. Ohmic contacts Bipolar devices 1. pn-diodes 2. Real diodes 3. Heterointerfaces and superlattices 4. Bipolartransistors
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Semiconductor devices II
Module level acc. DQR	7
Module number	
Courses	V+Ü “Semiconductor devices II”
Study semester	3.
Recurrence	Winter term
Module organisator	Prof. F. Bertram
Lecturer(s)	Prof. F. bertram
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS lecture +1 SWS tutorial
Workload	150 h (42 h attendance + 108 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	Module “Solid State Physics”
Recommendation for admission	Module “Semiconductor devices I”
Aims	Participants acquire knowledge and competencies about: • foundations of solid state and semiconductor physics • application of physical methods and routines • scientific analysis of problems related to semiconductor devices • efficient mathematical tools to analyze experimental data of semiconductor devices
Content	Field effect transistors (JFET, MESFET, MISFET/MOSFET,HEMT, finFET); CMOS; Hetero-Bipolartransistor, IGBT, Memory devices Optoelectronics 1. Basics of optical properties of semiconductors (Band structure, excitons, impurities, complexes, quantum effects), photon absorption and emission 2. Application in optoelectronic devices 3. Technology and characteristics of light-emitting and light detecting semiconductor devices (Light emitting diodes, optical receivers, solar cells) 4. Laser diodes (Fabry-Perot, DBR, DFB, surface emitting, microcavity, GRINSCH)
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Semiconductor process technologies
Module level acc. DQR	7
Module number	
Courses	V “Semiconductor process technologies“
Study semester	2.
Recurrence	Summer term
Module organisator	N.N.
Lecturer(s)	N.N.
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS lecture +1 SWS tutorial
Workload	150 h (42 h attendance + 108 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	None
Recommendation for admission	Module “Solid State Physics”
Aims	Students acquire knowledge about principles of different process technologies for semiconductor integration and can identify proper technological recipes for a given processing task. They understand constraints set by physics and their related technologies for scaling down device sizes.
Content	Lithography; Oxidation; Diffusion; Etching; Metallization; Failure identification; CMOS and BiCMOS process chain
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Advanced semiconductor characterization
Module level acc. DQR	7
Module number	
Courses	V “Advanced semiconductor characterization“
Study semester	2.
Recurrence	Summer term
Module organisator	Prof. A. Strittmatter
Lecturer(s)	Different experts
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS lecture +1 SWS tutorial
Workload	150 h (42 h attendance + 108 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	Module “Solid State Physics”
Recommendation for admission	
Aims	Students are familiar with typical application scenarios where semiconductor materials or devices need qualification/quantification. They know the functionality of advanced characterization tools that are required to collect the necessary information about the material or device.
Content	Selected topics of X-ray analysis; SIMS; AFM; Static and dynamic current-voltage-capacitance characterization; Microwave measurement technologies; Electron microscopy; Optical spectroscopy
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Advanced electronic circuits
Module level acc. DQR	7
Module number	
Courses	V+Ü „Advanced electronic circuits”
Study semester	3.
Recurrence	Winter term
Module organisator	N.N.
Lecturer(s)	N.N.
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS lecture +1 SWS tutorial
Workload	150 h (42 h attendance + 108 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	None
Recommendation for admission	Module “Solid State Physics”
Aims	Students know and understand the design and functionality of digital integrated circuits within computers as well as current design and scaling strategies
Content	Based on the operation principles of discrete CMOS devices and their implementation into essential components of digital ICs approaches for design and down-scaling are discussed towards performance optimization of computers.
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Machine Learning
Module level acc. DQR	7
Module number	
Courses	V+Ü “Machine Learning“
Study semester	1.
Recurrence	Winter term
Module organisator	Prof. A. Nürnberger
Lecturer(s)	Prof. A. Nürnberger
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	2 SWS lecture +2 SWS tutorial
Workload	150 h (42 h attendance + 108 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	None
Recommendation for admission	None
Aims	Introduction to the principles, techniques, and applications of Machine Learning.
Content	Topics covered include among others (subject to change): value functions; concept spaces and concept learning; instance based learning; clustering; decision trees; neural networks; Bayesian learning; reinforcement learning; association rule learning; genetic algorithms
Type of examination	Oral examination or written test (K90). Will be announced by lecturer at beginning of course
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Cleanroom lab course
Module level acc. DQR	7
Module number	
Courses	P “Cleanroom lab course“
Study semester	2.
Recurrence	Summer term (Block at end of summer term)
Module organisator	N.N.
Lecturer(s)	N.N.
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	3 SWS lab course
Workload	150 h (20 h attendance + 130 h self-learning) Attendance: 5 consecutive lab days (either morning or afternoon session) Self-learning: Script reading for preparation, protocol
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	Semiconductor process technology
Recommendation for admission	Solid State Physics, Harmonization course I+II, Semiconductor devices I
Aims	Students develop hands-on experience with fundamental semiconductor processing in a clean room environment. They are able to describe, plan and perform a processing sequence leading to an electronic device. Students can evaluate the process chain by the characteristics of device operation.
Content	Basic steps of MOSFET fabrication by applying photolithography, oxidation, etching, diffusion, and metallization, current-voltage characterization.
Type of examination	Successful attendance of all lab days, Written protocols rated between 0-10 points Module grade detemined by point average, 3-5 points = 4 5-7 points = 3 7-9 points = 2 10 points = 1
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Academic skils development (Scientific communication)
Module level acc. DQR	7
Module number	
Courses	Seminar
Study semester	3.
Recurrence	Winter term
Module organisator	Prof. R Goldhahn
Lecturer(s)	tba
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	4 SWS seminar
Workload	180 h (56 h attendance + 124 h self-learning)
Duration	1 term
Credit Points	5
Preconditions for CPs	Attendance of seminar and of additional topical seminars organized by departments
Admission	None
Recommendation for admission	
Aims	Participants acquire knowledge in current research topics by studying available literature and convert that knowledge into an introductory presentation for a scientific audience. They prepare themselves to be able to discuss relevant scientific aspects of their talk. Thereby, students become mature of free speech in scientific discussions, conferences, meetings and workshops.
Content	Current topics of research
Type of examination	Presentation and discussion of current research topics (30 min)
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Introduction to research
Module level acc. DQR	7
Module number	
Courses	none
Study semester	3.
Recurrence	Unbound
Module organisator	Prof. A. Strittmatter
Lecturer(s)	-
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	Scientific project
Workload	300 h (170 h project work, 100 h self-study, 30 h presentation preparation)
Duration	1 term
Credit Points	10
Preconditions for CPs	Passing module exam
Admission	None
Recommendation for admission	None
Aims	Students get introduced into a current research topic related to semiconductor technology and acquire in-depth understanding of current research challenges. Students can outline a roadmap to solve a given problem in a timely and scientific manner. They are able to discuss possible issues along the roadmap and to develop alternative routes towards the solution of the given task.
Content	Current research topic embedded in a broader scientific context Planning and execution of essential steps towards successful realization of the given topic
Type of examination	Project presentation (30 min)
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Master thesis
Module level acc. DQR	7
Module number	
Courses	none
Study semester	4.
Recurrence	unbound
Module organisator	Prof. A. Strittmatter
Lecturer(s)	-
Language	English
Implementation	Mandatory module in M. Sc. “Adv. Semicon. Nanotechnol.”
Type of course	Project
Workload	900 h (600 h project work, 250 h thesis writing, 50 h preparation for defence),
Duration	6 month
Credit Points	30
Preconditions for CPs	Written thesis
Admission	None
Recommendation for admission	
Aims	Students solve a current research topic by applying their acquired knowledge and skills. They select proper methods and develop an appropriate workplan for individual sub-tasks. The impact of each method as well as the applicability of the workplan is regularly checked to allow for decisions about alternatives. Students document progress of their work by preparing intermediate reports, perform scientific data evaluation, and by writing a final thesis. Thereby, students are skilled to work on similar problems both in a scientific as well as in an industrial environment.
Content	Self-introduction into research topic Literature research Method selection Development of workplan Intermediate reports Written thesis of work and oral defence
Type of examination	Written thesis and oral defense (50 min)
Exam ID	
Literature	Will be announced by lecturer at beginning of course
Published on	12.06.23
Other information	

Module	Compulsory electable modules
Module level acc. DQR	7
Module number	
Courses	Acc. to individual course description
Study semester	1.-3.
Recurrence	Depending on course
Module organisator	Prof. A. Strittmatter
Lecturer(s)	Acc. to course
Language	English
Implementation	Mandatory electable module in M. Sc. "Adv. Semicon. Nanotechnol."
Type of course	Depending on course
Workload	Depending on course
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	Depending on course
Recommendation for admission	Depending on course
Aims	Depending on course
Content	Depending on course
Type of examination	Depending on course
Exam ID	
Literature	Depending on course
Published on	12.06.23
Other information	Current choices (Details can be found in respective module handbooks - use links below). **Information- and communication technology (Module handbook)** Process control Digital communication systems Digital information processing **Semiconductor physics (Module handbook)** Optische Eigenschaften von Halbleitern Semiconductor epitaxy Laser diodes X-ray analysis Electron microscopy Microfluidics 1 Microfluidics 2 **Informatics (Module handbook)** Introduction to Software Engineering Data Mining I

Module	Non-technical electable modules
Module level acc. DQR	7
Module number	
Courses	Acc. to individual course description
Study semester	1.-3.
Recurrence	Depending on course
Module organisator	Prof. A. Strittmatter
Lecturer(s)	Acc. to course
Language	English
Implementation	Freely electable module in M. Sc. "Adv. Semicon. Nanotechnol."
Type of course	Depending on course
Workload	Depending on course
Duration	1 term
Credit Points	5
Preconditions for CPs	Passing module exam
Admission	Depending on course
Recommendation for admission	Depending on course
Aims	Depending on course
Content	Depending on course
Type of examination	Depending on course
Exam ID	
Literature	Depending on course
Published on	12.06.23
Other information	Non-technical electives should not be chosen from the fields of physics/electrical engineering/engineering/computer science

Legend

SWS - Semester hours per week
V - Lecture
Ü - Exercise
S - Seminar
CP - Credit Points
LN – Proof of performance (mandatory, if indicated by the * symbol)
PF - Form of examination
Type - Type of course
P – Lab course
WiP - Scientific project
M - Oral examination
K - written exam (Klausur, K90= 90 mins duration)
ÜL – Exercises in the performance system of the course
SV - Seminar presentation