TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Electrical and Computer Engineering

Study regulations for the consecutive Master programme Nanoelectronic Systems

as of 11th July, 2017

Pursuant to § 36 sec. 1 of the Law Governing the Universities in the Free State of Saxony (Sächsisches Hochschulfreiheitsgesetz - SächsHSFG) of 15 January 2013 (SächsGVBl. p. 3), last amended by article 11 of the Act of 29 April 2015 (SächsGVBl. pp. 349, 354), the Technische Universität Dresden enacts the following Study Regulations as a statute.

Contents

Please note: This is an English translation of the German original. **Only the German version is legally binding.**

§ 1

Area of applicability

These Study Regulations define the objective, the contents, the structure and the order of events during studies for the consecutive Master programme Nanoelectronic Systems at the Technische Universität Dresden on the basis of the provisions of the applicable Law on Higher Education in the Free State of Saxony (*Sächsisches Hochschulfreiheitsgesetz*) and the Examination Regulations.

§ 2

Aims of the programme

(1) The graduates of the Master programme Nanoelectronic Systems acquire methods, techniques and tools for the design and the manufacture of nanoelectronic systems and also for the application of these systems in selected applications areas and can reliably deploy this knowledge. Students will be enabled to analyse tasks in these areas and thence to develop effective solutions. They identify the interactions and interdependencies between these key issues and can take account of them when finding solutions. Graduates are familiar with the latest research and developments in these areas and are positively involved in the process.

(2) Thanks to their broad technical knowledge and their familiarity with the international research communities in the areas design, manufacture and application of nanoelectronic systems, which they acquired during their studies with an international orientation, graduates are fit to solve a variety of complex tasks in the design, manufacture and application of nanoelectronic systems in accordance with the chosen specialisation and after an adequate settling-in period in the industry. The students can work, in particular, in the information and semiconductors technology area.

§ 3

Admission requirements

(1) To be admitted to the programme, students must have earned a first job-qualifying university degree or a degree at a state-run or officially recognised university of cooperative education in Electrical Engineering, Information Systems Engineering, Computer Science, Physics or equivalent areas; it is mandatory that the degree is acknowledged in Germany.

(2) Moreover, students are expected to have particular technical knowledge in the fields of mathematics, electrical engineering and computer science.

(3) Fluency in English at level C1 of the Common European Framework of Reference for Languages (CEFR) is also a prerequisite. If English is not the native language of the applicant, s/he must proof his/her English proficiency by providing an internationally offered test (preferably IELTS: 6.5, TOEFL iBT:110 points).

§ 4

Beginning and duration of studies

(1) Students can commence studies in the winter semester.

(2) The standard period of study is 4 semesters during which students are required to accomplish face-to-face studies, self-study and the Master examination.

§ 5

Types of teaching and learning

(1) The academic material is organised in a modular structure. In the individual modules, the academic contents is communicated, consolidated and deepened in lectures, seminars, tutorials, lab courses, language classes, projects and also in self-study. In modules that are subject to several examination regulations synonyms are possible for assessments that are identical in content.

(2) Lectures introduce the subject area of the module.

(3) Exercises allow the application of the teaching content in selected sub-areas.

(4) Seminars allow students to gather information about a chosen topic under supervision based on technical literature or other material, to present and discuss in a group what they worked out and to present it in writing.

(5) Lab courses serve to apply theoretical knowledge and to acquire practical skills in potential professional fields. They serve to illustrate in experimentation the facts students have learned theoretically thus allowing them to make their own experience and practice their skills when handling devices, facilities and measuring instruments.

(6) Especially in the first two semesters of the study course, tutorials support students to learn solving subject-related and methodological problems independently.

(7) Excursions allow students to get an insight into different production and research facilities and to get to know subject-specific industry solutions and potential application areas.

(8) Language courses provide theoretical and practical knowledge and skills in one or more foreign languages. They develop communication skills and intercultural competence in an academic and professional context also in everyday situations.

(9) Students work on research projects in which they develop the capacity to work in a team and to work out their own solutions and implement them within a given time frame. Students also develop and exercise the ability to document the results obtained in an adequate form and to present them correctly using appropriate language.

(10) Through self-study students can work on, repeat and deepen the subject matter as they see it.

§ 6

Structure and organisation of the programme

(1) The programme has a modular structure. The courses are offered in three semesters. During the fourth semester, students work on their Master thesis and defend it. Part-time study is possible on the basis of the regulation on part-time study of the Technische Universität Dresden.

(2) The Master programme Nanoelectronic Systems offers the branch of study Nanoelectronics as well as the branch of study Nanosciene and Nanotechnology. Students have to choose one of the branches of study when applying. The student can choose a branch of study Nanoscience and Nanotechnology only when admitted to the Erasmus Mundus programme.

The programme in the branch of study Nanoelectronics comprises eight required mod- ules and required elective modules totalling 39 credits, which allow the student to focus on areas of particular interest.

The programme in the branch of study Nanoscience and Nanotechnology includes – in the first year – a compulsory year abroad at the KU Leuven (Belgium) within the frame of a joint studies programme, whose details are clarified in an agreement. The academic achievements that have to be acquired correspond to the achievements that have to be acquired within the Master programme Nanosciene and Nanotechnology of the KU Leuven (Belgium). In the second year, the programme comprises two required modules and required elective modules totalling 16 credits, which allow the student to focus on areas of particular interest.

(3) The module descriptions contain contents and qualification aims, the types of teaching and learning used, pre-exam achievements, usability, frequency, amount of work involved and duration of the various modules (Appendix 1).

(4) Classes are held in English.

(5) The appropriate distribution of the modules across the semesters, the observance of which allows the completion of studies within the standard period of study, the types and numbers of hours of the courses and also the number and fixed times of assessments and examinations are listed in the curriculum plan attached (Appendix 2) or in an individual curriculum plan that is confirmed by the faculty.

(6) The required elective modules offered and the curriculum plan can be modified by the Faculty Council on suggestion of the Academic Committee. The currently offered required elective modules shall be communicated by the faculty in the known manner as the semester starts. The modified curriculum plan is binding on those students to whom the faculty communicates it in the known manner as soon as studies begin. On application, the Examination Committee may decide on exceptions to sentence 3.

§ 7

Course contents

(1) The major focus of the Master programme Nanoelectronic Systems is on research.

(2) The programme comprises the topics semiconductor technology, circuit and system design.

(3) The topics covered by the required elective modules include materials and technologies for nanoelectronic systems, in particular storage technology, nanotechnology, optoelectronics and molecular electronics, design methods and techniques for the realisation of nanoelectronic systems, e.g. characterisation and modelling of electron devices, extended integrated circuit and system design and computer arithmetic, application fields for embedded nanoelectronic systems, in particular design, construction and use of software systems, modelling and simulation methods, business and economics issues, and also the German language and culture.

§ 8

Credit points

(1) ECTS credits document the average student workload and individual progress. One credit is equivalent to a workload of 30 hours. As a rule, students can earn 60 credit points per academic year, i.e. 30 credits per semester. The total workload of the programme is 120 credits and comprises the types of teaching and learning, the academic achievements and assessments and also the Master thesis and the defence the type and scope of which are all defined in the module descriptions (Appendix 1).

(2) The module descriptions (Appendix 1) indicate how many credits students can earn in one module. Students can earn credit points after having passed the module exam. § 26 of the examination regulations remains unaffected.

§ 9

Student advisory service

(1) The general student advisory service is the responsibility of the Central student advisory service of TU Dresden and answers all questions regarding programmes offered, terms of enrolment and general student affairs. The subject-related advisory service throughout studies is the responsibility of the Faculty Electrical Engineering and Information Technology. This subject-related advisory service helps students, in particular, tailor and plan their studies.

(2) As the third semester starts, students who have not yet earned an attestation by that time, are obliged to seek advisory service.

§ 10

Adaptation of module descriptions

(1) A simplified procedure is used to adapt module descriptions to changed conditions to ensure the organisational conditions for the programme. The fields „module name“, „contents and qualification goals“, „types of teaching“, „pre-exam achievements for earning credit points“ and also „credit points/ and grades“ cannot be modified.

(2) In the simplified procedure, the Faculty Council on suggestion of the Academic Committee decides upon the modification of the module description. The modifications shall be communicated by the Faculty in the known manner.

§ 11

Coming into force, public notice and transitional provisions

(1) These study regulations become effective as of 01 October 2014 and are publicly announced in the Official Notices of Technische Universität Dresden.

(2) They are valid for all students that are enrolled in the Master programme Nanoelectronic Systems from the winter semester 2014/15 on.

(3) For students enrolled before the winter semester 2014/15, the study regulations that were valid before these study regulations became effective continue being valid.

(4) These examination regulations are valid for all students that are enrolled in the Master programme Nanoelectronic Systems from the winter semester 2018/2019.

Issued on the basis of the decision of the faculty council of the Faculty of Electrical and Computer Engineering made on 17 September 2014 and the approval of the rectorial board of 1 December 2015.

Dresden, 11 July 2017

The Rector
of Technische Universität Dresden

Prof. Dr. Dr.-Ing. habil. Hans Müller-Steinhagen

Appendix 1
Module descriptions

Appendix 2
Curriculum plan

See separate document.

TECHNISCHE UNIVERSITÄT DRESDEN

Faculty Electrical Engineering and Information Technology

Appendix 1 and 2 of the study regulations of the consecutive Master's programme Nanoelectronic Systems

from 2014-03-19

Content

Appendix 1
Module descriptions

Required Modules

Module Number	Module Name	Lecturer in Charge
NES-12 ASW-14.1	Academic and Scientific Work	Studiendekan
Contents and Objectives	After completion of the module students have the key competencies for the academic and scientific work. They can deal critically with scientific texts or pass on their knowledge to others and monitor their learning process. This includes understanding the essential content of scientific texts, their integration into the current scientific context, the critical reflection of social, economic and cultural impact as well as their representation and presentation. To stimulate and to enable the development of knowledge among learners the students have acquired knowledge of the general academic teaching and can apply this.	
Modes of Teaching and Learning	The module consists of 3 hours per week lectures, tutorials, labs, or seminars and self study. The courses are choosen in the specified amount from the catalog "Wissenschaftliches Arbeiten (Scientific Work)". The catalog is given inclusive of the required examinations at the beginning of the semester faculty usually known.	
Prerequisites		
Usability	The module is a required module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module test is passed. The assessment consists of the prescribed examinations according to the catalog "Wissenschaftliches Arbeiten (Scientific Work)".	
Credit Points and Grades	4 credit points can be obtained by the module. The grade is derived from the unweighted mean of the grades of the individual examinations.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 120 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 10 01-14.1	Fundamentals of Estimation and Detection	Prof. Fettweis
Contents and Objectives	After completion of the module the students know the key approaches for parameter estimation and detection as well as the basics of linear estimation techniques and of memory-afflicted systems. They understand the different mathematical models and approaches that the current methods are based, and thus they are able to select and apply the appropriate procedures for various practical scenarios. Students can evaluate different estimators / detectors on the basis of quality criteria.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours per week tutorials and self-study.	
Prerequisites	Knowledge in system theory and basic knowledge in stochastic on bachelor level	
Usability	The module is a required module of the branch of study Nanoelectronic in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam in the amount of 120 minutes.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 10 03-14.1	Hardware/Software Codesign	Prof. Fettweis
Contents and Objectives	The module content includes: - Methods and different aspects of hardware and software implementation of embedded systems (including telecommunications). - Mutual influence of both designs (co-design) in order to optimize the circuit design, - New arallel processing concepts through massive structure reduction towards the "Nano Scale". Objectives: After completing this module, students have an overview of current hardware systems, specifically the various hardware platforms for software implementation of digital signal processing algorithms, and can evaluate these with respect to various criteria (eg, flexibility, power consumption). Students can derive from algorithms the hardware requirements in compliance with the requirements of flexibility for the hardware and software components. They know strategies to enhance performance and minimize power consumption and can apply them safely	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 1 hour per week tutorials and self-study.	
Prerequisites		
Usability	The module is a required module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems. The module creates the prerequisites for the module Hardware / Software Codesign Lab.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam in the amount of 120 minutes, if the number of registered students exceeds 16. With up to 16 registered students the written exam is replaceed by an oral exam as individual exam worth 20 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty.	
Credit Points and Grades	4 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 120 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-11 06 01-14.1	Lab Sessions	Prof. Fetzer
Contents and Objectives	This module provides the practical skills and abilities in the field of embedded system design and semiconductor manufacturing. Participants gain experience in teamwork and project work and deepen their skills in lecture and presentation techniques. After completing the module the students have a first state of knowledge on issues of embedded system design and have some experience with the most important process steps in semiconductor manufacturing.	
Modes of Teaching and Learning	The module consists of 1 hours per week lectures, 5 hours per week practical training and self-study.	
Prerequisites		
Usability	The module is a required module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of two lab protocols. A collection of exercises has to be solved as exam prerequisites.	
Credit Points and Grades	5 credit points can be obtained by the module. The module grade is the unweighted mean of the grades of the lab protocols.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 150 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-11 06 02-14.1	Principles of Dependable Systems	Prof. Fetzer
Contents and Objectives	After the completion of this module, students are able to design and to implement highly reliable and secure systems. Special skills they acquired for the design of distributed protocols for critical systems, due the variety of possible error and failure types in this area. Based on their theoretical knowledge, students can design effective solutions to practical scenarios.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours per week tutorials and self-study.	
Prerequisites	Participants should be familar with the basics of design, development and operation of computer-based systems (bachelor level).	
Usability	The module is a required module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam in the amount of 60 minutes, if the number of registered students exceeds 10. With up to 10 registered students the written exam is replaceed by an oral exam as individual exam worth 30 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty. A collection of exercises has to be solved as exam prerequisites.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 PW-14.1	Project Work	Studiendekan
Contents and Objectives	Contents: - Research, development, modeling, analysis, planning, design, system design, programming, - Implementation and coding, operation, maintenance, verification and testing, commissioning, Outcomes: The students have expertise in handling complex problems in modern engineering professional practice and to document and present their results. They have social skills of professional communication, project and product management.	
Modes of Teaching and Learning	The module consists of a project including self-study.	
Prerequisites		
Usability	The successful completion of the module is a prerequisite for the start of Master Thesis.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of the project report in the amount of 36 days and a presentation of 15 minutes duration..	
Credit Points and Grades	10 credit points can be obtained by the module. The module grade is the weighted mean of the grades of the two examinations, in which the grade of project report is weighted with 4/5 and the grade of the presentation is weighted with 1/5.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 300 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 08 02-14.1	Radio Frequency Integrated Circuits	Prof. Ellinger
Contents and Objectives	The module content includes: - High frequency integrated circuits for high speed wireless communications such as low noise amplifiers, power amplifiers, mixers, oscillators on basis of active and passive devices, as well as complete radio frontends and architectures, are lectured. - Advantages and challenges of aggressively scaled CMOS and BiCMOS, Moore than Moore (e.g. FinFET, SOI, strained silicon) and Beyond more Moore (silicon nano wire, CNT and organic) technologies are discussed from circuit design perspective. Qualification goals: After completion of the module the students obtain competences regarding - Methods for the design of analog high frequency integrated circuits. They know the basic circuits and architectures of the systems. - analysis and optimisation of these circuits, - complete design cycle for high frequency integrated circuits using the Cadance CAD system and are therefore prepared in this field for the requirements in industry and academia, - technical English	
Modes of Teaching and Learning	The module consists of 3 hours per week lectures, 1 hour per week tutorials, 2 hours per week practical training and self-study.	
Prerequisites	Basic knowledge in circuit design on bachelor level is required.	
Usability	The module is a required module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment is a written exam in the amount of 120 minutes. The exam can be taken in German or English.	
Credit Points and Grades	7 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 210 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 12 02-14.1	Semiconductor Technology	Prof. Bartha
Contents and Objectives	The module contains the technological basics for the fabrication of micro- and nano devices as well as the manufacturing concepts for integrated circuits. Students have the ability - to describe the operation of individual technologies for the production of micro- and nano-devices, - to work with basic principles for the production and miniaturization of components and circuits, - to add the individual technologies to complex process flows together and explain their interaction.	
Modes of Teaching and Learning	The module consists of 6 hours per week lectures, 1 hour per week practical training and self-study.	
Prerequisites		
Usability	The module is a required module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consist of a written exam in the amount of 120 minutes, if the number of registered students exceeds 20. With up to 20 registered students the witten exam will be replace by an oral exam as an individual exam worth 30 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty.	
Credit Points and Grades	11 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 300 hours.	
Duration	The module takes two semester.	

Required Elective Modules

Module Number	Module Name	Lecturer in Charge
NES-12 10 02-14.1	Communications	Prof. Fettweis
Contents and Objectives	The module content includes: Signal theory (sine waves, Dirac function, convolution, Fourier transform), linear time-invariant systems (transfer function, impulse response) bandpass signals (real and complex up and downward mixing of signals, equivalent lowpass signal), analog modulation (modulation, demodulation, properties of AM , PM, FM), analog-digital conversion (sampling, signal reconstruction, quantization, sub- and over sampling), digital modulation schemes (modulation methods, matched-filter receiver, bit error probability). Outcomes: After completing this module, students master the basic principles and practical application of communications. The students will be able to understand the basic signal processing in communications systems and to describe them mathematically. They are familiar with the transmission in base band and band-pass area and know the basic analog and digital modulation methods. They understand for simple analog and digital transmission scenarios the impact of noise on the transmission quality.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 1 hour per week tutorials and self-study.	
Prerequisites	It is assumed the knowledge of systems theory for analog and digital systems, algebra, calculus, complex analysis, partial differential equations and probability theory at the bachelor level.	
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam in the amount of 120 minutes.	
Credit Points and Grades	3 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 90 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-11 02 03-14.1	Computer Arithmetic	Prof. Spallek
Contents and Objectives	Contents / Topics - design of binary adder circuits (rippling, block parallel, hierarchical) - carry-save and signed-digit number representations - multi-operand addition, generalized counters - multiplication - division by digit recurrence and by numerical approximation - square rooting - CORDIC algorithms - general function evaluation Qualifications / Competences - ability to describe the implementation of arithmetic operations and their associated complexities in space and time - ability to construct custom arithmetic circuits according to set design goals	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours per week tutorials and self-study.	
Prerequisites		
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of an oral exam worth 45 minutes.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 12 04-14.1	Electromechanical Networks	Prof. Fischer
Contents and Objectives	The students - are skilled with the basic methodological and practical knowledge to analyse and to design effectively the dynamic behavior of coupled electromechanical, magnetic and fluidic systems using a circuit representation of the different subsystems including their interactions based on network theory, - master the function and modelling of electromechanical transducers, - can simulate the behavior of electromechanical systems with existing circuit simulation software such as Spice.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 1 hour per week tutorials and self-study.	
Prerequisites	Basic knowledge on bachelor level of electrical circuits, sophomore level mathematics (calculus and elementary linear algebra).	
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of written exam in the amount of 120 minutes.	
Credit Points and Grades	4 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 120 hours.	
Duration	The module takes one semester.	
Accompanied Literature	Lenk, A., Ballas, R.G., Werthschützky, R., Pfeifer, G.: Electromechanical Systems in Microtechnology and Mechatronics - Electrical, Mechanical and Acoustic Networks, their Interactions and Applications, 1st Edition., 2011, ISBN: 978-3-642-10805-1	

Module Number	Module Name	Lecturer in Charge
NES-30 GLC-14.1	German Language and Culture	Carlos Ampié Loría
Contents and Objectives	Content of the module: German lessons with regional and cultural topics Objective: Knowledge about German everyday language (written and spoken) on A1-Level of the CEFR	
Modes of Teaching and Learning	The module consists of 4 hours per week language courses and self-study.	
Prerequisites		
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam with the amount of 90 minutes.	
Credit Points and Grades	4 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 120 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 10 04-14.1	Hardware/Software Codesign Lab	Dr. Matus
Contents and Objectives	Content of the module: Approaches to accelerate digital signal processing algorithms Outcomes: The students know the ASIP design methodology (Application Specific Instruction Processor). They can independently implement algorithms and are able to participate with their own contributions to discussions about the complexity, memory usage, layout of data in the memory architecture and possible improvements.	
Modes of Teaching and Learning	The module consists of 1 hour per week tutorials, 2 hours per week practical training and self-study.	
Prerequisites	Knowledge in Hardware/Software Codesign, as e.g. are taught in the module Hardware/Software Codesign, and basic knowledge in assembly language programming, Matlab and DSP architecture concepts on bachelor level.	
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a project report in the scope of 30 hours.	
Credit Points and Grades	4 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 120 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer of Charge
ET-12 12 07-14.1	Innovative Concepts for Active Nanoelectronic Devices	Prof. Dr.-Ing. T. Mikolajick
Contents and Objectives	Content of the module are: - Technology of nanoelectronic devices - Production of electronic components in nm-dimensions - Operation principles and modeling of nanoelectronic devices After completing this module, students are able - to design innovative concepts for active nanoelectronic devices, - to understand physical effects and transport mechanisms, - to develop analytical descriptions of physical mechanisms and electrical characteristics in nanostructured devices, - to identify the specific types of components existing at the present technology research or development stage, as well as to realize the corresponding materials science and electrical boundary conditions. The students can communicate in English.	
Modes of Teaching and Learning	4 hours per week lectures, 2 hours per week exercises, and self-study The language of instruction is at least partly English.	
Prerequisites	Prerequisite for the course is, e.g., the module Physics of Selected Devices (Physik ausgewählter Bauelemente)	
Usability	The module is a required elective module for the master's program Nanoelectronic Systems and a required elective module in the main study of the degree and master's program Elektrotechnik.	
Requirement for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of an oral exam as individual exam worth 15 minutes and a written exam in the amount of 90 minutes.	
Credit Points and Grades	7 credit points can be earned by the module. The module grade is the unweighted mean of the grades for the oral exam and the written exam.	
Frequency	The module is offered every winter semester.	
Work Load	The total effort is 210 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 08 04-14.1	Integrated Circuits for Broadband Optical Communications	Prof. Ellinger
Contents and Objectives	The module content includes: - Design of integrated circuits in aggressively scaled nanotechnologies, focusing on the broadband optical communications - Transimpedance amplifier, detector circuits, laser drivers, multiplexers, frequency dividers, oscillators, phase locked loops, synthesizers and data recovery circuits - Challenges (eg, high bandwidth, gain, noise and good large signal performances despite of lower voltages) and appropriate solutions for circuits in nanotechnology Qualication goals: Students obtain competences regarding - methods for the design of very fast integrated circuits and systems for optical communications, - the analysis and optimisation of these circuits, and - complete design cycle of circuits for optical communications using the Cadance CAD system.	
Modes of Teaching and Learning	The module consists of 3 hours per week lectures, 1 hour per week tutorials, 2 hours per week practical training and self-study.	
Prerequisites	Basic knowledge in analog circuit design on bachelor level is required.	
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam in the amount of 120 minutes. The exam can be written either in German or Englisch.	
Credit Points and Grades	7 credit points can be obtained by the module. The module grade is the grade of the written exam.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 210 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 10 06-14.1	Integrated Photonic Devices for Communications and Signal Processing	Jun.-Prof. Jamshidi
Contents and Objectives	After the completion of the module the students know theoretical background and technologies of various integrated photonic devices on silicon, with the emphasis on communications and signal processing. They can model, design, and simulate basic components including passive devices (waveguides, couplers, Gratings, Interferometers, resonators, filters) as well as high speed electro-optical modulators (Mach Zehnder and micro ring), electro-absorption modulators, high speed photo diodes, and lasers. They are able to analyze and synthesize these devices using different analytical and numerical methods. Students can communicate in English.	
Modes of Teaching and Learning	The module consists of 4 hours per week lectures and 2 hours per week practical training and self-study. The language of instruction is English at least partly.	
Prerequisites	Knowledge on bachelor Niveau of Electromagnetism and Semiconductors	
Usability	The module is a required elective module of the branch of study Nanoelectronics in the Master's program of Nanoelectronic Systems.	
Requirement for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of an assigned paper in scope of 30 hours and an oral exam as individual exam worth 30 minutes.	
Credit Points and Grades	7 credit points can be earned by the module. The module grade is the unweighted mean of the grades for the assigned paper and the oral exam.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 210 hours.	
Duration	The module takes one semester.	
Accompanied Literature	G. T. Reed, Silicon Photonics: The State of the Art (Wiley, 2008). A. Yariv and P. Yeh, Photonics, 6th ed (Oxford, 2007).	

Module Number	Module Name	Lecturer in Charge
NES-10 01 01-14.1	Investing in a Sustainable Future	Prof. E. Günther
Contents and Objectives	Contents of the module: - Basics and history of innovation and the implementation of innovation in organisations - Definition, assessment and concrete application within organizations of sustainable issues of organizational decisions - Different perspectives on entrepreneurial decisions Qualification objectives: Students taking this course achieve to include ecological and economical aspects of Corporate Social Responsibility in their decisions making and understand the basics of innovation management. Furthermore, they can work in interdisciplinary and intercultural teams, develop themselves solutions and present them in writing and which they present in written and oral form.	
Modes of Teaching and Learning	The module consists of 1 hours per week lectures, 2 hours per week seminars and self-study.	
Prerequisites		
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a project report in scope of 45 hours, a colloquium in the extent of 20 minutes and an oral exam as individual exam worth 20 minutes.	
Credit Points and Grades	4 credit points can be obtained by the module. The module grade is the weighted mean of the grades for the project (factor 2), the colloquium (factor 1) and the oral exam (factor 1).	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 120 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 08 01-14.1	Lab VLSI Processor Design	Prof. Schüffny
Contents and Objectives	Content of the module: - Basics, concepts and methods for designing complex digital VLSI-systems - Architectures for highly integrated digital processing systems, with emphasis on user-specific signal processing systems - Methods for the efficient transfer of architectural concepts in the highly integrated implementation of a digital system. - Specification and abstract modelling of the system, conversion into a Register-Transfer-Level (RTL) description, automated circuit synthesis and physical implementation (place & route, layout synthesis), delivering the data for the manufacture of the chip. - Verification of the design on all levels of abstraction (behaviour, implementation) via simulation (functional verification) - Proof of the equivalence of transformation steps via formal verification, i.e. by checking compliance with design rules (signoff-verification) Objectives: After completion of this module, the students will be able to carry out a complete implementation and verification of a VLSI-System (e. g. a processor with a complexity comparable to an 8051) using industrial design software (Synopsys, Cadence). They have experience of working together in a design team (division of tasks, definition of interfaces, sequence and timing).	
Modes of Teaching and Learning	The module consists of 4 hours per week tutorials and self-study.	
Prerequisites		
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a project report with in scope of 30 hours.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the grade of the project.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 12 01-14.1	Materials for Nanoelectronics and Vacuum Technology	Prof. Richter
Contents and Objectives	The module contains: The materials fundamentals for nanoelectronics and the fundamentals for vacuum technology. Objectives: The students have the ability from the knowledge of - the structure, the properties, the manufacture and the structure forming materials, and - the effects and the basic types of small structures the opportunities and challenges of nanoelectronic materials systems to derive. Students can - derive relationships of vacuum technology from the knowledge of the kinetic gas theory - justify suitable pump and pressure measuring methods for various pressure ranges.	
Modes of Teaching and Learning	The module consists of 4 hours per week lectures, 1 hour per week tutorials and self-study.	
Prerequisites		
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of two written exams in the amount of 90 minutes for each and a collection of practical protocols, if the number of registered students exceeds 20. With up to 20 registered students, the written exams will be replaced by an oral exam as an individual exam worth 30 minutes. The nature of the specific exams are announced at the end of the registration period as usually known from the faculty.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is weighted mean of the grades from the written exams weighted by 40 % each and the grade of the collection of lab protocols weighted by 20 %.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 12 03-14.1	Memory Technology	Prof. Mikolajick
Contents and Objectives	This module covers memory concepts in the market and in research respectively development stage: - Magnatic memories - Optival memories - Semiconductor memories (SRAM, DRAM, nonvolatile Memories (EPROM, EEPROM, Flash)) - Innovative semiconductor memories (e.g. ferroelectric, magnetoresistive, resisitive, organic, and single molecule memories) Qualification goals: After completion of the module the students have the comeptences to optimize and develop new generetions of existing memory concepts. Based on the physical effects they will also be able to devolpe new memory concepts. Furthermore the students are able to evaluate areas of application for the memory concept and are aware of their limitation.	
Modes of Teaching and Learning	The module consists of 4 hours per week lectures, 2 hours per week tutorials and self-study.	
Prerequisites	Requirements are necessary , which can be obtained in the first part of module Semiconductor Technology and in the module Materials for Nanoelectronics and Vacuum Technology for example.	
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems and a required elective module in the main study of the degree program Elektrotechnik.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of an oral exam as individual exam worth 25 minutes.	
Credit Points and Grades	7 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 210 hours.	
Duration	The module takes two semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 08 03-14.1	Modeling and Characterization of Electron Devices	Prof. Schröter
Contents and Objectives	The Module encompasses current scientific topics and trends in the area of characterization and modeling of micro- and nanoelectronic devices Objectives: After completing this module, students can solve real-and research-related tasks in the field of modeling and characterization of micro-and nanoelectronic devices independently (including design, documentation and discussion) as well as analyze and interpret test results. Furthermore, they will be capable of incorporating quickly and independently new topics based on research literature.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours per week tutorials, 2 hours per week practical training and self-study.	
Prerequisites	The following expertises on bachelor level are required: - Analysing and interpreting of realistic electrical characteristics of active microelectronic devices - Describing the behavior of active micro- and nanoelectronic devices employing equivalent circuits and physical (compact-)models Literature: M. Schröter, "Elektronische Bauelemente", Lecture script S.M.Sze,„Physics of Semiconductor Devices"	
Usability	The module is a required elective module of the specialization area Microelectronis in the master's programs Elektrotechnik and a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written project report in scope of 80 hours.	
Credit Points and Grades	8 credit points can be obtained by the module. The module grade is the grade of the report.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 240 hours.	
Duration	The module takes two semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 10 05-14.1	Modeling and Simulation of Telecommunication Systems	Prof. Lehnert
Contents and Objectives	The module compromises the concepts and tools of Discrete Event Simulation, including methods for generating arbitrarily distributed random variables and the time series analysis of simulation runs including accuracy measures. Outcomes: After completion of the module the students know the principles of performance analysis of communication networks and can handle essential procedures for modeling and performance evaluation. They will be able to select and apply appropriate methods of investigation by simulation for different problems. Students are familiar with the concept of queueing system models and can model real systems correctly. They have acquired basic knowledge of the simulator ns-3.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 1 hour per week tutorials and self-study.	
Prerequisites	Knowledge of systems theory on bachelor level and the fundamentals of communication networks (e. g. Proakis, Salehi: Communication Systems Engineering, Prentice Hall) are required.	
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consits of an oral exam as individual exam worth 30 minutes.	
Credit Points and Grades	4 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 120 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-13 14 02-14.1	Molecular Electronics	Prof. Cuniberti
Contents and Objectives	The students know the basics of molecular electronics with emphasis on: experimental methods, physical effects and theoretical tools, such as single molecule electronics, raster probe and break-junction techniques, transport mechanisms at the nanoscale, molecular components (diodes, transistors, sensors) and molecular architectures. The students know the most important experimental and theoretical methods of investigation of charge transport at the molecular scale.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours per week tutorials and self-study.	
Prerequisites		
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consits of a written exam in the amount of 90 minutes, if the number of registered students exceeds 10. With up to 10 registered students the written exam will be replaced by an oral exam as individual exam worth 20 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-13 14 03-14.1	Nanotechnology and Material Science	Prof. Cuniberti
Contents and Objectives	After completing the module the students know the basic physics of nanotechnology and the production and properties of nanostructured materials, including - quantum effects, mesoscopic systems, scaling laws - fabrication of clusters and nanotubes - band structure, density of states, electron transport in low-dimensional solids - theoretical foundations of scanning tunneling microscopy, atomic force microscopy, and optical near-field microscopy - nanostructuring via electron beam lithography, optical lithography, and scanning probe methods - Giant magnetoresistance, single electronic devices	
Modes of Teaching and Learning	The module consists of 4 hours per week lectures, 2 hours per week tutorials, 2 hours per week practical training and self-study.	
Prerequisites	The basics of physics, chemistry, and quantum mechanics	
Usability	The module is a required elective module of the branch of study nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam in the amount of 90 minutes, an oral exam as an individual exam worth 20 minutes and a graded lab course record, if the number of registered students exceeds 10. With up to 10 registered students the written exam is replaced by an oral exam as individual exam worth 20 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty.	
Credit Points and Grades	12 credit points can be obtained by the module. The module grade is the unweighted mean of the grades of the exams.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 360 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 12 05-14.1	Optoelectronics	Prof. Lakner
Contents and Objectives	Contents: Nano-Optics: - Optical phenomena on the length scale much lower than the diffraction limit of the wavelength λ, e.g. interaction between fluorescent atoms and molecules, optical interaction between molecules and surfaces, but also surface-reinforcing effects. - Usage of nano-optics for novel devices and applications (analysis and characterization). Opto-Electronic Devices and Systems: The principles and technical realization of optoelectronic devices and systems (such as light emitting diodes, laser diodes, compound semiconductors, organic semiconductors, micro-opto-electro-mechanical systems for modulation and deflection of light) and applications of these devices in projection systems, displays, modulators and optical storage. Outcomes: The students know the most important optical phenomena on length scales far below the diffraction limit (etc. bright and non-brihht recombination processes, electric field enhancement at interfaces and surfaces) and understand their application in optical devices and their use in applications. They know how optoelectronic components and systems are implemented and how they are used in applications (e.g. projection systems, displays).	
Modes of Teaching and Learning	The module consists of 4 hours per week lectures, 1 hour per week tutorials and self-study.	
Prerequisites	Basic knowledge about technical optic on bachelor level	
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of two oral exams as individual exams worth 20 minutes for each.	
Credit Points and Grades	7 credit points can be obtained by the module. The module grade is unweighted mean of the grades of the examinations.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 210 hours.	
Duration	The module takes one semester.	

Accompanied Literature	1. Bergmann, Schäfer, Niedrig (Hg): Lehrbuch der Experimentalphysik. Band III Optik. Walter de Gruyter Verlag Berlin, New York 2004 2. L. Novotny, B. Hecht: Principles of NanoOptics, Cambridge University Press (2006)

Module Number	Module Name	Lecturer in Charge
NES-11 06 05-14.1	Real-Time Systems	Prof. Härtig
Contents and Objectives	Upon completion of the module, students are able to classify, model, and evaluate real-time systems and they can concern oneself in depth with real-time systems. The module covers the basics of load and resource description, time, clocks and clock synchronization, timed vs. event-driven design and scheduling techniques. The students have advanced knowledge to topics such as real-time programming languages (synchronous and event-driven), real-time operating systems, real-time hardware, microcontrollers, caches, real-time communication in field bus systems and wide area networks, and general applications of real-time systems. With this broad knowledge the students have the holistic fundamentals on this subject.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 1 hour per week tutorials and self-study.	
Prerequisites	Basic knowledge on bachelor level in the areas of operating systems, computer architecture and software engineering	
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment is an oral exam as individual exam worth 30 minutes.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 12 06-14.1	Semiconductor Industry Challenges: Market Dynamics - Technology Innovations - Yield and Reliability Engineering	Prof. Dr. Ehrenfried Zschech
Contents and Objectives	After completion of this module, students understand key aspects of the semiconductor industry, both in terms of the market under the changing conditions for development and production as well as the context of the technological development. Besides the ability to operate manufacturing cost efficient, in the module is focused mainly due to the applied physical and engineering process in micro- and nanoelectronics and their theoretical foundations for increasing the yield in mass production and to ensure the required reliability of the products. The students understand the importance of business concepts in introducing of new products. They can show the relationships between components design, technology, materials and analysis for products and can assess the importance of the reliability of components for the quality management of products and line stability of micro-and nanoelectronics. Students are able to communicate in technical English.	
Modes of Teaching and Learning	The module consists of 3 hours per week lectures, one excursion within the scope of one week (blocked in the lecture-free period) and self-study. The language of instruction is English at least partially.	
Prerequisites	Knowledge in electrical engineering, materials science and physics for engineers and scientists at the bachelor level. The competences are assumed, which can be acquired in the module Semiconductor Technology.	
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirement for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consists of two examinations. Examination 1 is an assigned paper. Examination 2 is by more than 20 registered students a written exam in the amount of 90 minutes. With up to 20 registered students the written exam is replaceed by an oral exam as group exam worth 45 minutes. The nature of the specific exams are announced at the end of the registration period as usually known from the faculty.	
Credit Points and Grades	4 credit points can be earned by the module. The module grade is wighted mean of the grades of the examinations, where examination 1 is weighted with 1/3 and examination 2 is weighted with 2/3.	

Frequency	The module is offered every academic year beginning in the summer semester.
Work Load	The total effort is 120 hours.
Duration	The Module takes one semester

Module Number	Module Name	Lecturer in Charge
NES-11 06 03-14.1	Software Fault-Tolerance	Prof. Fetzer
Contents and Objectives	After the completion of this module, graduates of this module are able to develop and to use mechanisms and systems designs, that address on often than the average as software errors occurring system failures in distributed systems at run time. They have the necessary expertise on the subject of forgiveness and use their expertise to discuss and evaluate current scientific work in this area. The students to have the necessary practical skills with which they can analyze and correct errors in specific application scenarios. They are in a position to use the acquired skills of this module in new, unknown scenarios and apply them to develop effective practical solutions.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours per week tutorials and self-study.	
Prerequisites	Participants should be familar with the basics of design, development and operation of computer-based systems. (bachelor level)	
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consist of a written exam in the amont of 60 minutes, if the number of registered students exceeds 10. With up to 10 registered students the written exam is replace by an oral exam as individual exam worth 30 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty. A collection of exercises has to be solved as exam prerequisites.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 09 01-14.1	Stochastic Signals and Systems	Prof. Jorswieck
Contents and Objectives	After completion of the module the students master the description methods of stochastic signals as realizations of stochastic processes. They are in a position to calculate the behavior of deterministic and stochastic systems under the condition that the systems handle stochastic processes.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours of tutorials per week, and self-study.	
Prerequisites	Basics of the theory of deterministic systems and basic knowledge of probability calculus on bachelor level	
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment is a written exam in the amount of 90 minutes.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-11 06 06-14.1	Systems Engineering	Prof. Fetzer
Contents and Objectives	After completing this module, students are familar with the basics of design, development and operation of computer-based systems. They have an overview of structures of such systems, which usually consist of several hardware components and several layers of software. The students have the necessary knowledge, especially to non-functional aspects of systems, such as reliability and availability, and control mechanisms for providing these non-functional aspects. The students should be able to understand fundamental relationships of the subject and they can use this knowledge during their further studies.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours per week tutorials and self-study.	
Prerequisites	Basic knowledge in the areas of system architecture, modularization and structuring of complex systems (on bachelor level).	
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consist of a written exam in the amont of 60 minutes, if the number of registered students exceeds 10. With up to 10 registered students the written exam is replace by an oral exam as individual exam worth 30 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty. A collection of exercises has to be solved as exam prerequisites.	
Credit Points and Grades	5 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 150 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-12 08 05-14.1	Theory of Nonlinear Networks	Prof. Tetzlaff
Contents and Objectives	After completing this module, students know and apply the basic properties of nonlinear networks and can use important mathematical tools for analysis of networks. Furthermore, the students have knowledge of the structure, properties and applications of Cellular Nonlinear Networks, as well as of memristive networks. They are able to transfer this knowledge also to other nonlinear network structures.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 1 hour per week tutorials and self-study.	
Prerequisites	knowledge of higher mathematics, system theory and circuit design on bachelor level	
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consist of a written exam in the amount of 90 minutes.	
Credit Points and Grades	4 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 120 hours.	
Duration	The module takes one semester.	

Module Number	Module Name	Lecturer in Charge
NES-11 06 07-14.1	Ubiquitous Information Systems	Prof. Schill
Contents and Objectives	After completing this module, students will be able to classify middleware architectures and platforms for the construction of distributed applications and information systems. This includes the area of mobile communication and mobile processing and the processing in distributed environments. Students can classify and develop concepts and architectures for distributed and ubiquitous application and information systems, select appropriate solutions and evaluate modern technological developments in the art.	
Modes of Teaching and Learning	The module consists of 4 hours per week lectures, 2 hour per week tutorials and self-study.	
Prerequisites	Basic knowledge in the areas of computer networks and operating systems.	
Usability	The module is a required elective module in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. The module assessment consist of a written exam in the amont of 120 minutes, if the number of registered students exceeds 10. With up to 10 registered students the written exam is replace by an oral exam as individual exam worth 30 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty.	
Credit Points and Grades	9 credit points can be obtained by the module. The module grade is the grade of the examination.	
Frequency	The module will be offered every winter semester.	
Work Load	The total effort is 270 hours.	
Duration	The module takes one semester.	
Accompanied Literature	Tanenbaum, A.S.: Computer Networks.	

Module Number	Module Name	Lecturer in Charge
NES-11 06 04-14.1	Wireless Sensor Networks	Prof. Schill
Contents and Objectives	After completion of this module, students are familiar with the fields of ubiquitous computing and wireless sensor and can discuss competent topics such as applications for wireless sensor networks and thier main components. They are aware of the typical aspects of such sensor networks such as energy comsumption, communication, network-level processing and self organisation. They are able to understand and design algorithms for link layer management and media access control in wireless sensor networks. Because a wireless sensor network is a distributed network, the students also master aspects like time synchronization, topology control, and data aggregation. They are familiar with the routing techniques and the request distribution. They can consider und discuss the issues and problems in the field of wireless sensor networks comprehensively.	
Modes of Teaching and Learning	The module consists of 2 hours per week lectures, 2 hours per week tutorials and self-study.	
Prerequisites	Basic knowledge of computer architecture, distributed systems, mobile communication, and software engineering at the bachelor level	
Usability	The module is a required elective module of the branch of study Nanoelectronics in the master's program Nanoelectronic Systems.	
Requirements for Acquiring Credit Points	The credit points are awarded when the module assessment is passed. This consists of an individual presentation and of a written axam in the amount of 90 minutes, if the number of registered students exceeds 20. With up to 10 registered students the witten exam will be replaced by an oral exam as individual exam worth 30 minutes. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty.	
Credit Points and Grades	6 credit points can be obtained by the module. The module grade is the unweighted mean of the grades of the examinations.	
Frequency	The module will be offered every summer semester.	
Work Load	The total effort is 180 hours.	
Duration	The module takes one semester.	

Appendix 2 Curriculum plans

A-2.1. Curriculum plan for full-time students in the branch of study Nanoelectronic

with type and number of SWS (= class hours per week per semester) and the necessary assessments, the type, hours and organisation of which are described in the module descriptions

A-2.1.1 Summary with required modules

module no.	module name	1st semester V/U/Se/Sp/P	2nd semester V/U/Se/Sp/P	3rd semester V/U/Se/Sp/P	4th semester V/U/Se/Sp/P	CP
NES-11 06 01-14.1	Lab Sessions	0/1/0/0/5 2xPL				5
NES-11 06 02-14.1	Principles of Dependable Systems	2/2/0/0/0 PVL PL				6
NES-12 10 01-14.1	Fundamentals of Estimation and Detection	2/2/0/0/0 PL				6
NES-12 12 02-14.1	Semiconductor Technology	4/0/0/0/0	2/0/0/0/1 PL			10
NES-12 08 02-14.1	Radio Frequency Integrated Circuits		3/1/0/0/2 PL			7
NES-12 10 03-14.1	Hardware/Software Codesign		2/1/0/0/0 PL			4
NES-12 ASW-14.1	Academic and Scientific Work			*/*/*/*/* *		4
NES-12 PW-14.1	Project Work			project PL		10
	required elective modules, see following pages	6 CP	16 CP	16 CP		38
					master thesis	29
					defence	1
		30	**30**	**30**	**30**	**120**

V lecture
Ü tutorial
Se seminar
Sp language course
P lab course

PL assessment(s)
PVL pre-exam achievement(s)
CP credit points
* in acc. with student's choice

A-2.1.2 Required elective modules

module no.	module name	1st semester V/U/Se/Sp/P	2nd semester V/U/Se/Sp/P	3rd semester V/U/Se/Sp/P	CP
NES-30 GLC-14.1	German Language and Culture	0/0/0/4/0 PL			4
NES-12 12 01-14.1	Materials for Nanoelectronics and Vacuum Technology	4/0/0/0/1 3xPL			6
NES-11 06 06-14.1	Systems Engineering	2/2/0/0/0 PVL PL			5
NES-12 09 01-14.1	Stochastic Signals and Systems	2/2/0/0/0 PL			6
NES-12 10 02-14.1	Communications		2/1/0/0/0 PL		3
NES-12 10 06-14.1	Integrated Photonic Devices for Communications and Signal Processing		4/0/0/0/2 2xPL		7
NES-10 01 01-14.1	Investing in a Sustainable Future		1/0/2/0/0 3xPL		4
NES-12 08 01-14.1	Lab VLSI Processor Design		0/2/0/0/2 PL		6
NES-13 14 01-14.1	Nanotechnology and Materials Science		4/2/0/0/2 3xPL		12
NES-11 06 03-14.1	Software-Fault Tolerance		2/2/0/0/0 PVL PL		6
NES-11 06 04-14.1	Wireless Sensor Networks		2/2/0/0/0 2xPL		6
NES-12 12 03-14.1	Memory Technology		2/1/0/0/0	2/1/0/0/0 PL	7
NES-12 08 03-14.1	Modelling and Characterisation of Electron Devices		2/2/0/0/0	0/0/0/0/2 PL	8
NES-12 12 06-14.1	Semiconductor Industry Challenges: Market Dynamics - Technology Innovations - Yield and Reliability Engineering		1/0/0/0/0 PL	2/0/0/0/0 PL	4

module no.	module name	1st semester V/Ü/Se/Sp/P	2nd semester V/Ü/Se/Sp/P	3rd semester V/Ü/Se/Sp/P	CP
NES-11 02 03-14.1	Computer Arithmetic			2/2/0/0/0 PL	6
NES-12 12 04-14.1	Electromechanical Networks			2/1/0/0/0 PL	4
NES-12 10 04-14.1	Hardware/Software Codesign Lab			0/1/0/0/2 PL	4
ET-12 12 07	Innovative Concepts for Active Nanoelectronic Devices			4/2/0/0/0 2xPL	7
NES-12 08 04-14.1	Integrated Circuits for Broadband Optical Communications			3/1/0/0/2 PL	7
NES-12 10 05-14.1	Modelling and Simulation of Telecommunica-tion Systems			2/1/0/0/0 PL	4
NES-13 14 02-14.1	Molecular Electronics			2/2/0/0/0 PL	6
NES-12 12 05-14.1	Optoelectronics			4/1/0/0/0 2xPL	7
NES-11 06 05-14.1	Real-Time Systems			2/1/0/0/0 PL	6
NES-12 08 05-14.1	Theory of Nonlinear Networks			2/1/0/0/0 PL	4
NES-11 06 07-14.1	Ubiquitous Information Systems			4/2/0//00 PL	9

A-2.2 Curriculum plan for part-time students in the branch of study Nanoscience and Nanotechnology

with type and number of SWS (= class hours per week per semester) and the necessary assessments, the type, hours and organisation of which are described in the module descriptions

A-2.2.1 Summary with required modules

module no.	module name	1st semester V/Ü/Se/Sp/P	2nd semester V/Ü/Se/Sp/P	3rd semester V/Ü/Se/Sp/P	4th semester V/Ü/Se/Sp/P	CP
		°	°	°	°	60
NES-12 ASW	Academic and Scientific Work			*/*/*/*/* *		4
NES-12 PW	Project Work			project PL		10
	required elective modules, see following pages			16 CP		16
					master thesis	29
					defence	1
		30	**30**	**30**	**30**	**120**

V lecture
Ü tutorial
Se seminar
Sp language course
P lab course
PL assessment(s)
PVL pre-exam achievement(s)
CP credit points
° Academic achievements and assessments of the degree program Nanoscience and Nanotechnology at KU Leuven (Belgium) according to a cooperation agreement
* according to choice of student

A-2.2.2 Required elective modules

module no.	module name	1st semester V/U/Se7Sp/P	2nd semester V/U/Se/Sp/P	3rd semester V/U/Se/Sp/P	CP
NES-11 02 03-14.1	Computer Arithmetic			2/2/0/0/0 PL	6
NES-12 12 04-14.1	Electromechanical Networks			2/1/0/0/0 PL	4
NES-30 GLC-14.1	German Language and Culture			0/0/0/4/0 PL	4
NES-12 10 04-14.1	Hardware/Software Codesign Lab			0/1/0/0/2 PL	4
ET-12 12 07	Innovative Concepts for Active Nanoelectronic Devices			4/2/0/0/0 2xPL	7
NES-12 08 04-14.1	Integrated Circuits for Broadband Optical Communications			3/1/0/0/2 PL	7
NES-12 10 05-14.1	Modelling and Simulation of Telecommunica-tion Systems			2/1/0/0/0 PL	4
NES-13 14 02-14.1	Molecular Electronics			2/2/0/0/0 PL	6
NES-12 12 05-14.1	Optoelectronics			4/1/0/0/0 2xPL	7
NES-11 06 05-14.1	Real-Time Systems			2/1/0/0/0 PL	6
NES-12 08 05-14.1	Theory of Nonlinear Networks			2/1/0/0/0 PL	4
NES-11 06 07-14.1	Ubiquitous Information Systems			4/2/0/0/0 PL	9