

Prof. Artur Erbe
Manuela Tetzlaff

Welcome and Information Meeting Master's Program Nanoelectronic Systems (NES)

Dresden, 11 October 2024

Initiated by Cool Silicon cluster

Cool Silicon: Leading-Edge Cluster with the goal of energy efficiency in the information and communications technology (ICT) sector

The graphic features the Cool Silicon cluster branding on the left, consisting of four blue teardrop-shaped icons with the text: **COOL silicon**, **COOL Computing**, **COOL Reader**, and **COOL Sensornet**. To the right, a blue map of Saxony is surrounded by a dense collection of logos for member companies and research institutions. These include: AMD (The future is fusion), elcon (Systemtechnik), adp (Informationstechnologien), ENAS, IIS, IKTS, IWS, IZFP, IPMS, IVI, CNT, IKS, AIS (Automation), digades (Forschung und Entwicklung), Institut für Bahntechnik GmbH, AvatR, beyerdynamic, DMOS, cideon, ennovatis (Energieeffiziente Systeme), blue wander communications, SIMLAB Technologies, GLOBALFOUNDRIES, HSEB, ZfP, Alcatel-Lucent, GBS ELEKTRONIK, HAP, RENESAS, EADS, IMA DRESDEN, namlab (nanoelectronic materials laboratory), IMMS, KSW microtec, RHE (MEMOPHYSIK), Agilent Technologies, KDS Radeberger (Präzisionstechnik und Halbleitertechnik), LFoundry, infineon, INNOTECH, EDC, ROTH & RAU, trace-tronic, nubix, P+E, SYSTEMA, PLASTIC LOGIC, aspect systems, HTW, SENTECH, SIGNALION, mps (Microelectronics Packaging Solutions), freedelity, voice INTER connect, and IMM.

SACHSEN-ANHALT

BRANDENBURG

Technology

- GLOBALFOUNDRIES

- Infineon

- X-FAB

Design

- Renesas

- DMOS GmbH

- Productivity Engineering GmbH

Silicon Saxony

- 3.650 companies with about 81.000 employees
- among them more than 350 companies with about 20.000 employees active in microelectronics
- 4 billion Euros revenue
- Training/Research:
 - 4 Universities,
 - 5 Universities of Applied Sciences,
 - 18 Fraunhofer-, 8 Leibniz-, 6 Max-Planck-, 2 Helmholtz Institutes, and 2 Helmholtz centres, 8 state-funded research institutions, a total of around 50 non-university research institutions.

POLEN

THÜRINGEN

- TechniSat
- National Instruments (former Signalion)

- ...

MIKROELEKTRONIK / IKT IN SACHSEN

TSCHECHISCHE REPUBLIK

BAYERN

Download Karte
Stand: Januar 2022

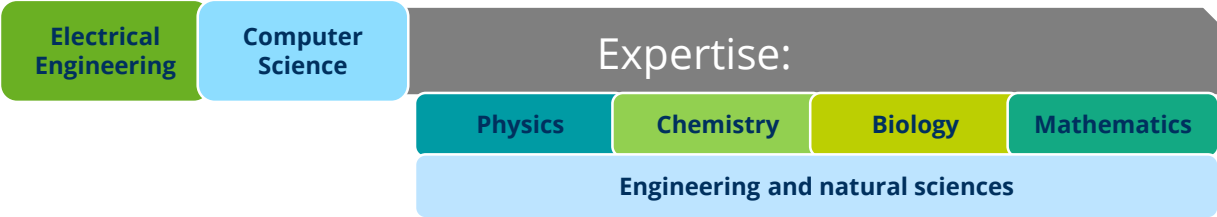
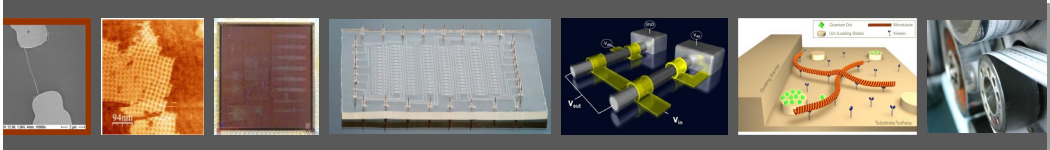


Nanoelectronics in research



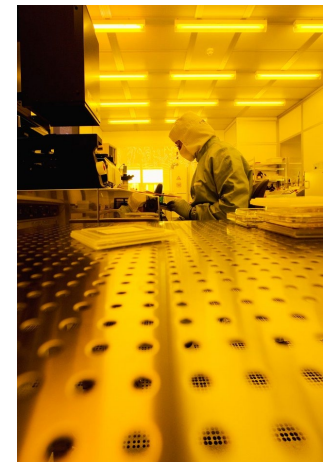
„Advancing Electronics“

- New perspectives for modern electronics
- Overcoming the CMOS bottlenecks with complementary technologies



Nanoelectronics at TU Dresden

- **Micro-, Opto- and Nanoelectronics** is one research focus of TU Dresden
- **Faculty of Electrical and Computer Engineering**
 - one of the oldest faculties for electrical engineering in Europe
 - one of the largest faculties for electrical engineering in Germany
 - Prof. Barkhausen was the founder of the first Low Power Technology Institute
- **Institute of Semiconductors and Microsystems (IHM)**
 - 411 m² Clean Room Laboratory (built 2006, extended 2013)
 - Chair of Nanoelectronics
- **NaMLab gGmbH (2009)**
- **Institute for Applied Physics** (Photo Physics, Semiconductor Physics)
- **Institute for Material Science**

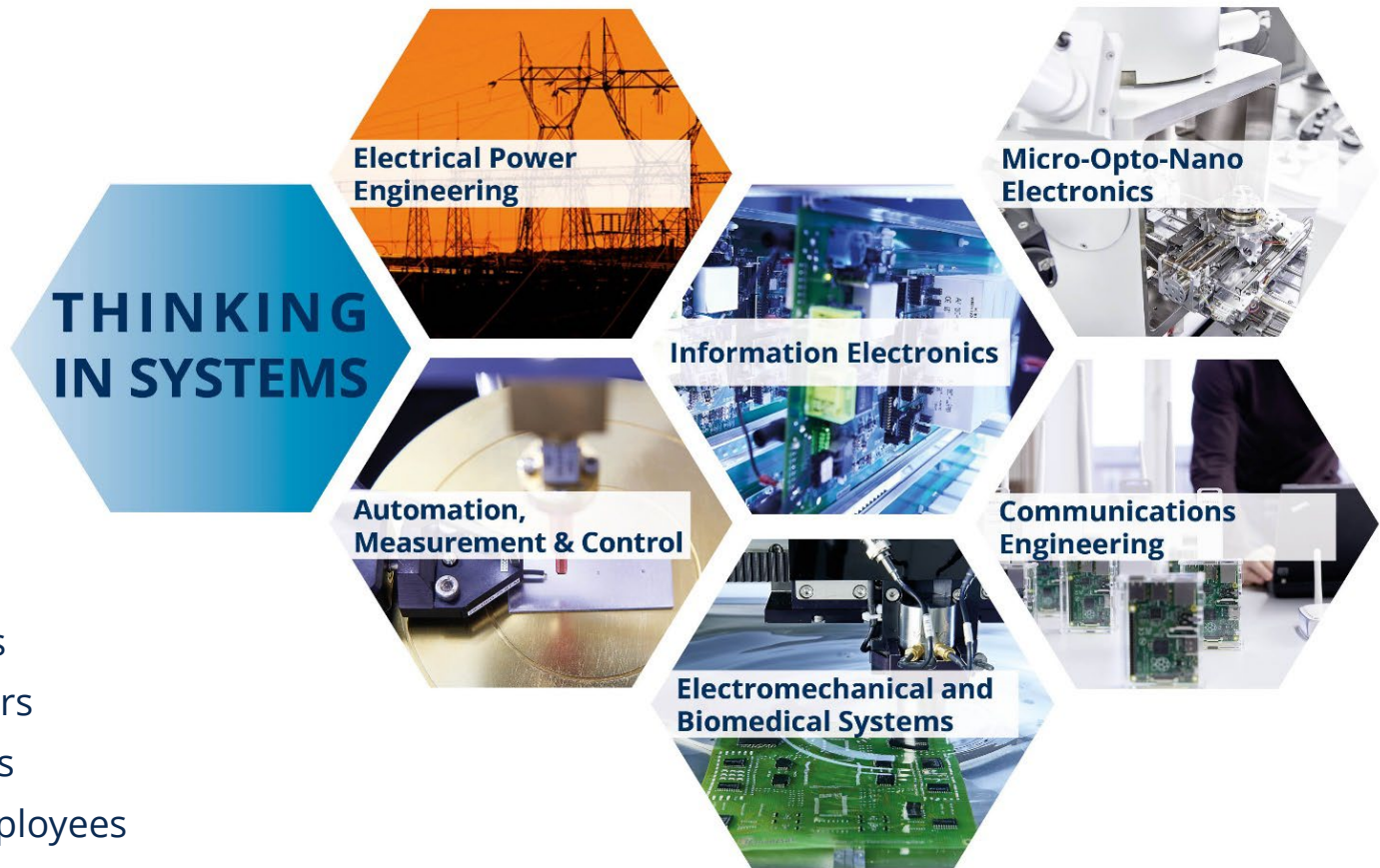


TU Dresden



- University of Excellence – Clusters of Excellence
- TU9 – German Universities of Technology
- **THE** overall ranking 2024 - TUD ranks 161st, placing it among the top 10% of all universities listed

Faculty of Electrical and Computer Engineering

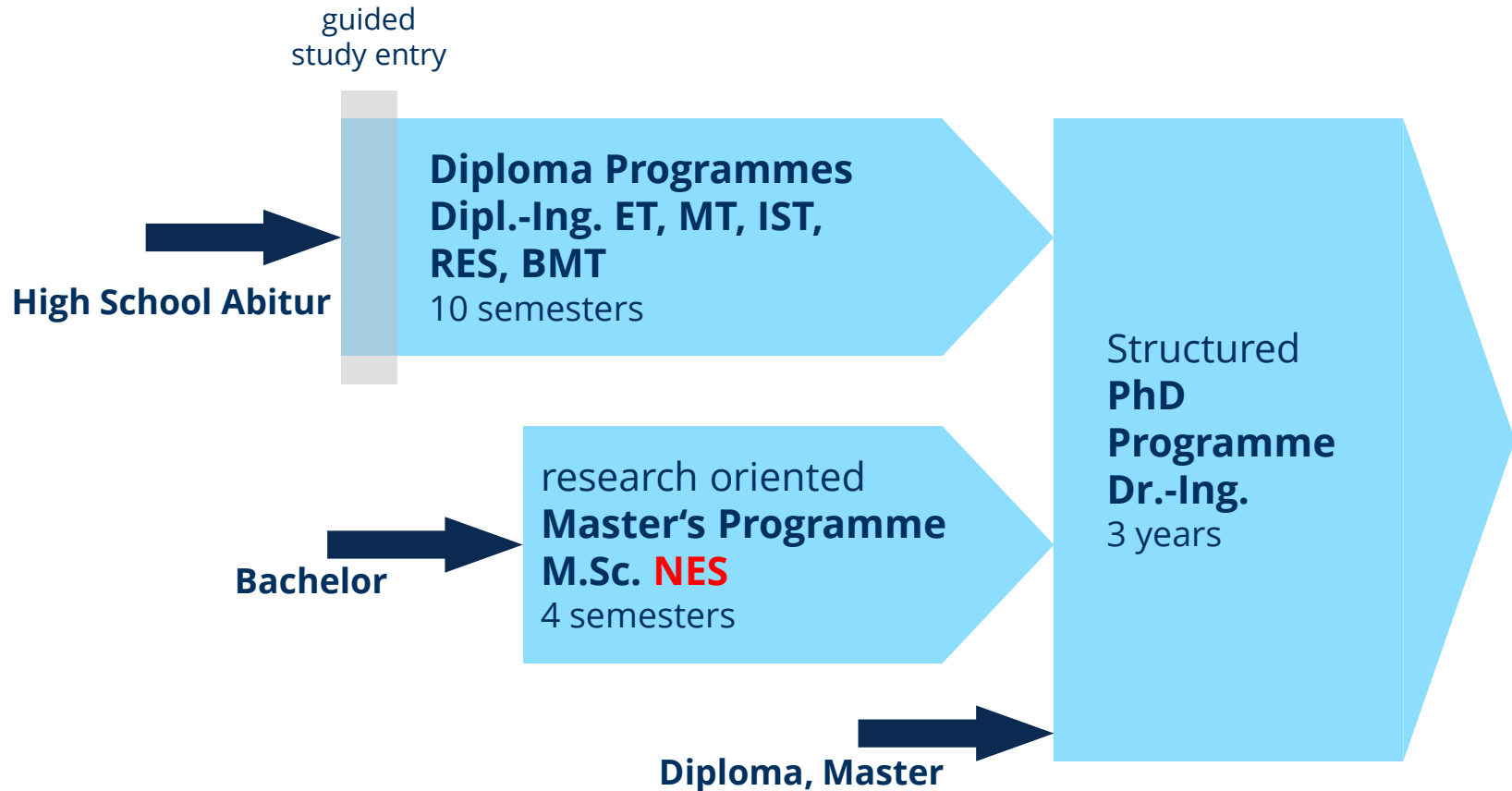


Faculty Facts

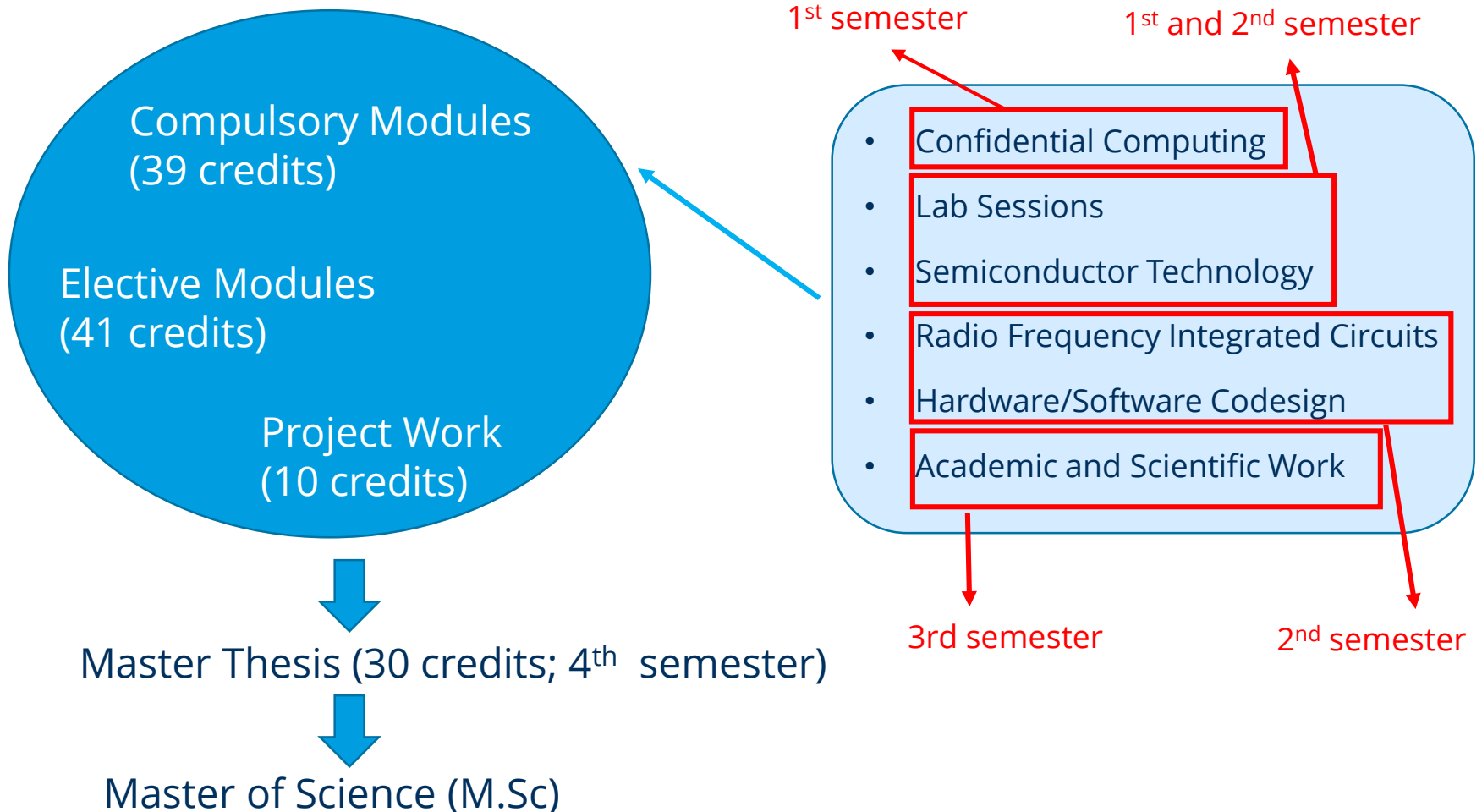
- 29 full professors
- 3 junior professors
- 350 PhD Students
- 460 scientific employees
- 1.800 Students
- approx. 39 million Euro third party funding every year

Faculty of Electrical and Computer Engineering

Scientific and research oriented education



Study flow chart of the NES programme



The Master's programme NES focuses on three key areas:

- Adaptive Laser Systems
- Antennas and Radar Systems
- Applied Joint Communications and Sensing Systems
- Communication Networks 3
- Communications
- Computational Laser Systems
- Foundations of Software Fault Tolerance
- Foundations Systems Engineering
- Fundamentals of Estimation and Detection
- Joint Communication and Sensing RF Hardware
- Joint Communications and Sensing Systems for 6G Networks
- Stochastic Signals
- Ubiquitous Systems
- Wireless Sensor Networks

Which key area are you most interested in?

- Adaptive Computing Systems for Robotics
- Deep Neural Network Hardware
- Design and Programming of Embedded Multicore Architectures
- Electromechanical Networks
- Foundation of Certified Programming Language and Compiler Design
- Hardware Modeling and Simulation
- Integrated Circuits for Broadband Optical Communications
- Integrated Photonic Devices for Communications and Signal Processing
- Introduction to Optical Non-classical Computing: Concepts
- Hardware Accelerators
- Neuromorphic VLSI Systems
- Physical Design
- VLSI Processor Design

- Innovative Concepts for Active Nanoelectronic Devices
- Materials for the 3D System Integration
- Memory Technology
- Molecular Electronics
- Nano&Optics
- Nanoscience
- Nanostructured Materials
- Optoelectronic Devices and Systems
- Plasma Technology
- Quantum Mechanics for Nanoelectronics

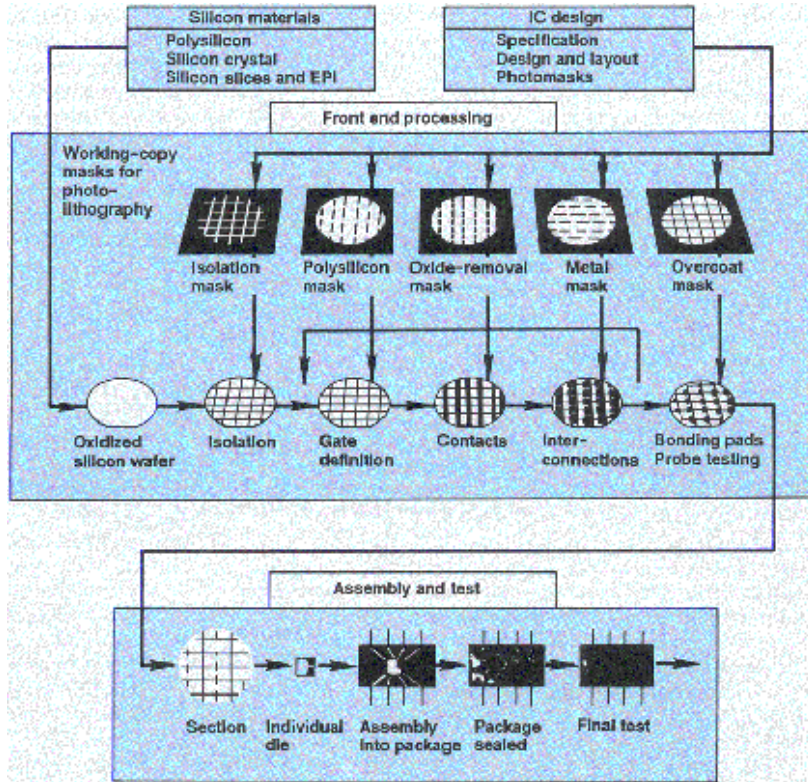
Application

Design

Technology

TECHNOLOGY

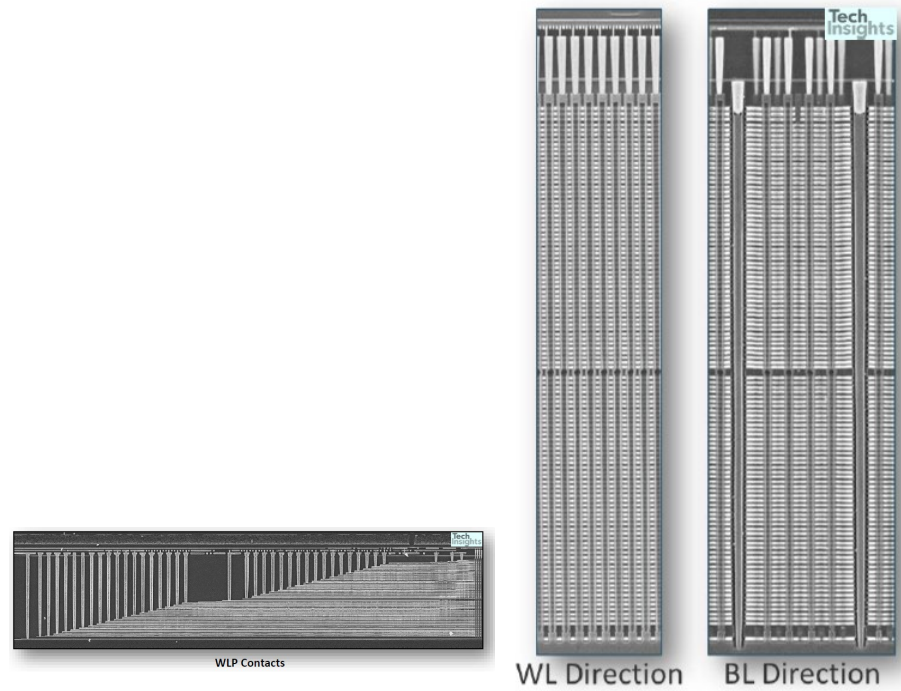
Typical process flow in semiconductor technology



Inside the cleanroom of TUD

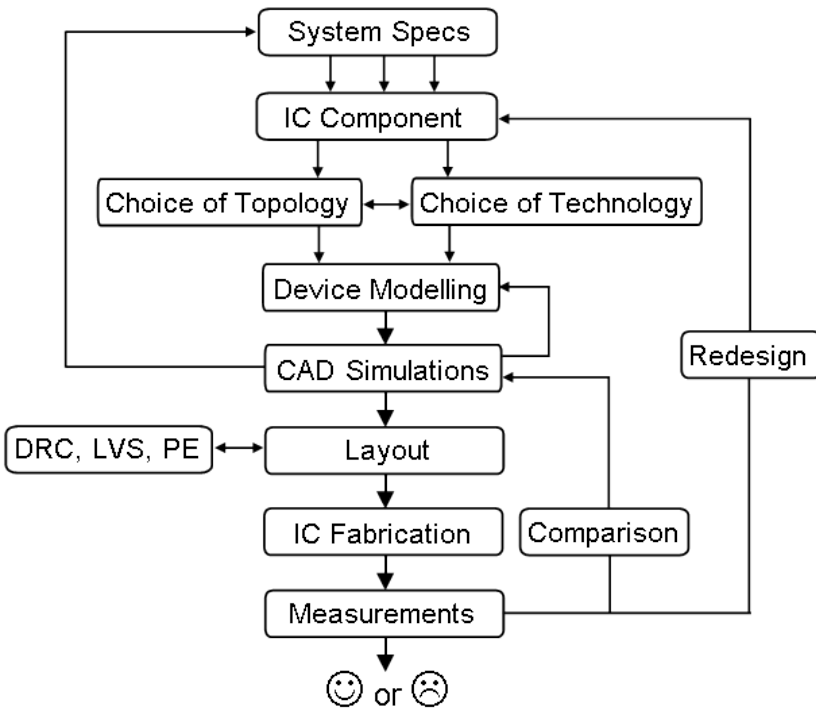


3D NAND cross section



DESIGN

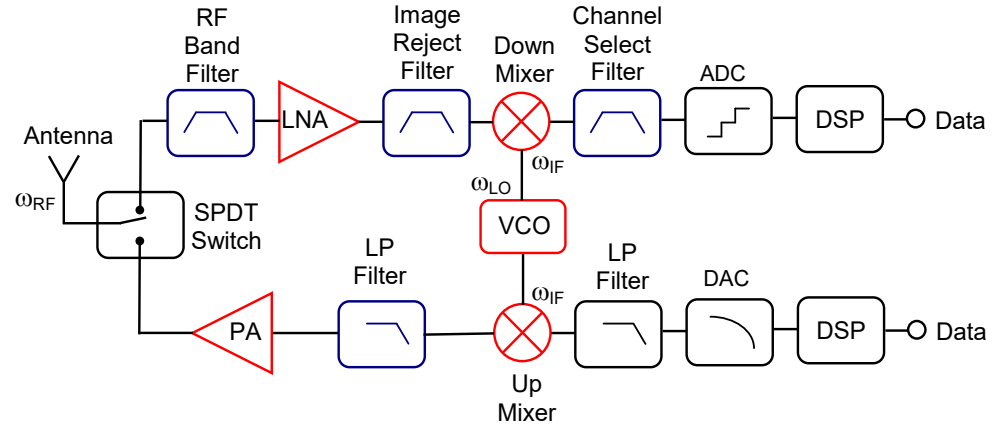
Procedure Chip Design



Example Theory

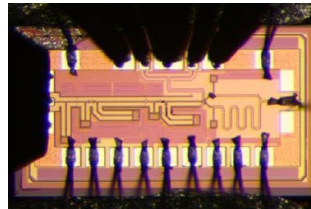
$$V_{out}/V_{in} = g_m R_L > 1$$

Example Transceiver Architectures for Wireless Communications

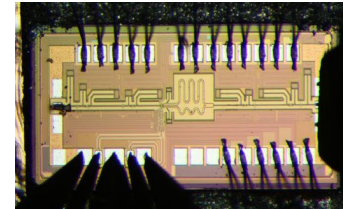


Example Chips for 6G communications, 200 GHz, 50 Gb/s wireless

Transmitter



Receiver

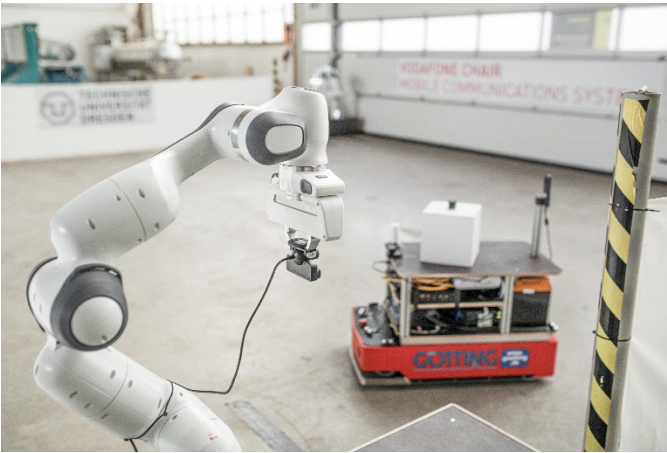


Bond-wire antennas

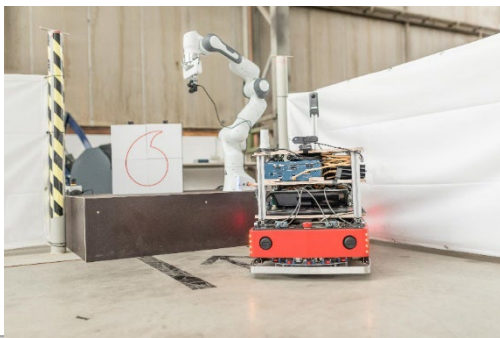
Fritsche, Stärke, Carta, Ellinger, A Low-Power SiGe BiCMOS 190 GHz Transceiver Chipset with Demonstrated Data Rates up to 50 Gbit/s using On-Chip Antennas, IEEE Trans. on Microwave Theory and Tech., March 2017, © IEEE

APPLICATION

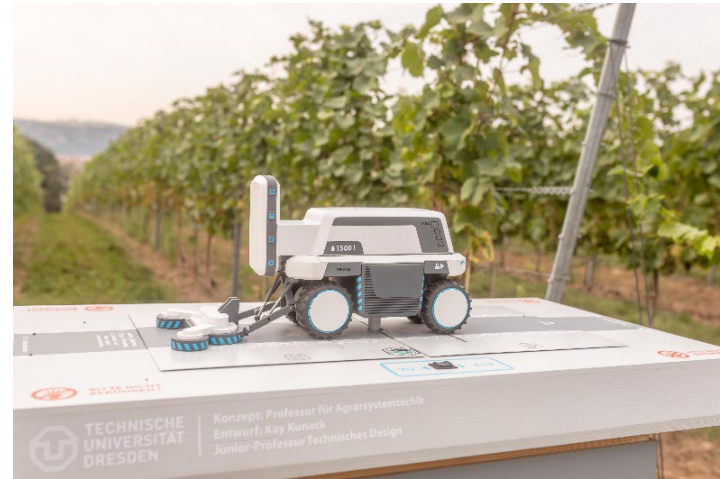
Automated Industry 4.0 scenario



Demo of automated robot arms and an AGV (automated guided vehicle). The AGV can be controlled remotely from anywhere in the world and connects two production lines, for example.



Mixed-Reality application in agriculture



The MR demo (Mixed Reality) shows a model of an autonomous fruit harvesting robot in a vineyard. Using an app, the model (later the "real" vehicle) can be scanned and then, by clicking on the video image in the app, provides information about individual components and, for example, maintenance instructions, which are then showed on the "real" video.

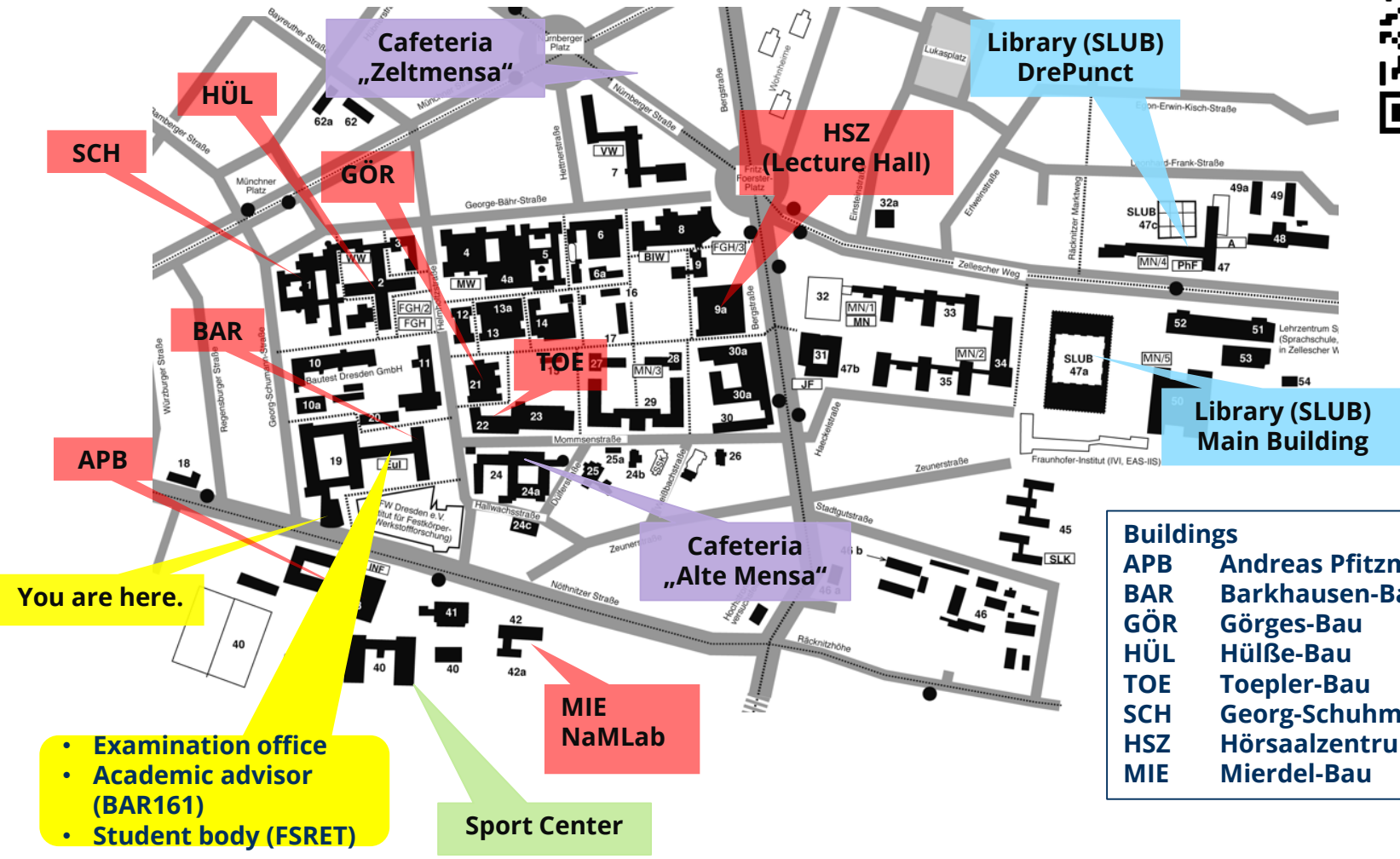
TU Dresden Vodafone Chair Mobile Communications Systems

Orientation on the campus of the TU Dresden



Barkhausen building

Main campus Südvorstadt



Buildings	
APB	Andreas Pfitzmann-Bau
BAR	Barkhausen-Bau
GÖR	Görges-Bau
HÜL	Hülße-Bau
TOE	Toepler-Bau
SCH	Georg-Schuhmann-Bau
HSZ	Hörsaalzentrum
MIE	Mierdel-Bau

The Campus Navigator is available for your Android or iOS smartphone. Search for "**Campus Navigator - TU Dresden**" in the official app stores.

Important dates of the academic year

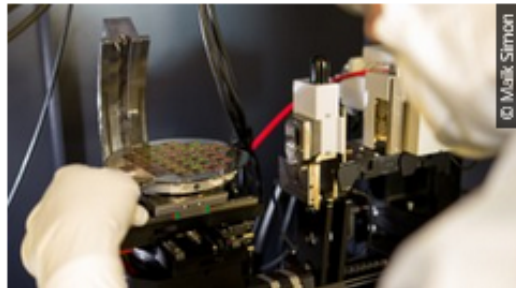
Winter semester 2024/25: 01.10.2024 until 31.03.2025

Courses and lectures: **Monday, 14.10.2024 until Saturday, 21.12.2024 and
Monday, 06.01.2025 until Saturday, 08.02.2025**

Lecture free periods and bank holidays:

- Reformation Day: Thursday, 31.10.2024
- Day of Prayer and Repentance: Wednesday, 20.11.2024
- Turn of the year: Sunday, 22.12.2024 until Sunday, 05.01.2025
- Lecture-free period: Monday, 10.02.2025 until Monday, 31.03.2025

Main exam period: Monday, 10.02.2025 until Saturday, 08.03.2025



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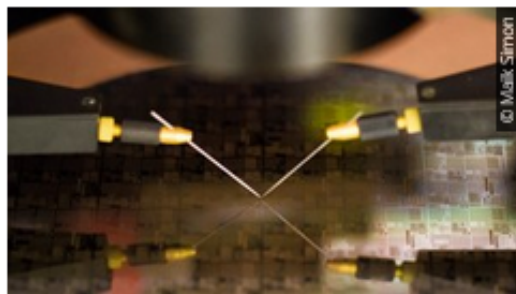
MASTER'S PROGRAMME NANOELECTRONIC SYSTEMS

The ongoing miniaturization in the microelectronics industry leads to systems that are now being referred to as nanoelectronic systems. Such systems offer a variety of applications, but their design and implementation is becoming increasingly complex.

The Master's programme Nanoelectronic Systems focuses on three key areas:

- Technologies for nanoelectronic systems
- Design of nanoelectronic systems
- Applications of nanoelectronic systems

⇓ **LEARN MORE**



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STUDENTS

Class Schedules

[1st semester timetable for winter semester 2024/25](#)
(as of 8th October, 2024)

[3rd semester timetable for winter semester 2024/25](#)
(as of 8th October, 2024)

[Curriculum plan compulsory modules for students who started in summer semester](#)

[List of modules that are currently in the 3rd semester timetable but can also be taken in 1st semester according to the recommendation of the lecturer](#)

Important Websites

[Modules and Study Guide](#)

[Living and Studying in Dresden](#)

[Exams](#)

[Project work / Master's theses](#)

Curriculum plans, modules descriptions,
links to course websites or OPAL, official
study documents

MODULES AND STUDY GUIDE

- [Compulsory Modules](#)
- [Elective Modules for Key Area Technology*](#)
- [Elective Modules for Key Area Design*](#)
- [Elective Modules for Key Area Applications*](#)
- [Nontechnical Elective Modules](#)
- [Overview Table of all Modules](#)
- [List of courses](#)

Compulsory Modules

Academic and Scientific Work (NES-12 ASW-14.1 // new study regulations: Eul-NES-C-ASW) ✓

Modulnummer	Modulname	1. Semester	2. Semester	3. Semester	4. Semester	LP
		V/Ü/P	V/Ü/P	V/Ü/P (M)	V/Ü/P	
Pflichtbereich						15
Eul-NES-C-ASW	Academic and Scientific Work	□	□	0/0/0 ¹ 3-SWS-Seminare PL	□	5
Eul-NES-C-PW	Project Work	□	□	0/0/0 ¹ 1-SWS-Projekte PL	□	10
Pflichtbereich der Studienrichtungen (1 aus 2 Studienrichtungen ist zum Studienbeginn zu wählen)						□
Studienrichtung Nanoelectronics						34
INF-NES-C-CONF	Confidential Computing	2/2/0 ¹ PL	□	□	□	6
INF-NES-C-LabS	Lab Sessions	0/0/4 ¹ PL	0/0/2 ¹ PL	□	□	7
Eul-NES-C-SCT	Semiconductor Technology	3/1/0	2/0/0 ¹ PL	□	□	8
Eul-NES-C-HwSwC	Hardware/Software Codesign	□	2/2/0 ¹ PL	□	□	5
Eul-NES-C-RFIC	Radio-Frequency Integrated Circuits	□	3/1/2 ¹ PL	□	□	8
Studienrichtung Nanoscience and Nanotechnology						60
An der KU Leuven (Belgien) zu erbringenden Leistungen		x/x/x ¹ PL ^{1a}	x/x/x ¹ PL ^{1a}	□	□	60
Wahlpflichtbereich der Studienrichtungen						□
Studienrichtung Nanoelectronics ² , gemäß Anlage 2-Teil 2		x/x/x ³ PL ^{3a}	x/x/x ³ PL ^{3a}	x/x/x ³ PL ^{3a}	□	41
Studienrichtung Nanoscience and Nanotechnology ⁴ , gemäß Anlage 2-Teil 3		□	□	x/x/x ³ PL ^{3a}	□	15
□		□	□	□	Abschlussarbeit ⁵ Kolloquium	29 ¹ 1
Leistungspunkte		30	30	31	29	120

1st semester:

Compulsory modules:

- Confidential Computing
- Lab Sessions (RoboLab)
- Semiconductor Technology 1

Elective modules:

- modules in the amount of about 16 ECTS

Module name	Semiconductor Technology
Module number	Eul-NES-C-SCT
Lecturer in charge	Prof. Dr. rer. nat. Stefan Mannsfeld stefan.mannsfeld@tu-dresden.de
Objectives	After completing the module, students are able to describe the operation of individual technologies for the production of micro- and nano-devices. They can work with basic principles for the production and miniaturization of components and circuits. Further, they can add the individual technologies to complex process flows together and explain their interaction.
Contents	The contents of the module are the technological basics for the fabrication of micro- and nano devices as well as the manufacturing concepts for integrated circuits.
Modes of teaching and learning	5 hours per week lectures, 1 hour per week exercises and self-study.
Prerequisites	Basic knowledge of the structure and function of electronic components at Bachelor's level is required.
Usability	The module is a required module in the branch of study Nanoelectronics in the Master's program Nanoelectronic Systems. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes. With up to 20 registered students the written exam will be replaced by a non-public oral exam as individual exam of 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	8 credit points can be earned by the module. The module grade is the unweighted mean of the grades of the assessments.
Frequency	The module is offered every academic year beginning in the winter semester.
Workload	The total effort is 240 hours.
Duration	The module takes two semesters.



STUDIES



STUDENTS



STUDY PROGRAMMES



NANOELECTRONIC SYSTEMS

**STUDENTS**

MODULES AND STUDY GUIDE

EXAMS


GENERAL INFORMATION


PROJECT WORKS / MASTER'S THESES

SCHOLARSHIPS

STUDENTS

Class Schedules

 **1st semester timetable for winter semester 2024/25**
(as of 8th October, 2024)

 **3rd semester timetable for winter semester 2024/25**
(as of 8th October, 2024)

Timetable 1st semester (winter term 2024/25)

Time/Day	Monday	Tuesday	Wednesday	Thursday	Friday				
1 DS 7:30 am - 9:00 am				E: Confidential Computing (for students enrolled as of winter semester 24/25) / parallel: Principles of Dependable Systems (for students enrolled before winter semester 24/25) Fetscher INF-NES-C-CONF Confidential Computing / NES-11.06.02-M.1 Principles of Dependable Systems APB/E023/U					
2 DS 9:20 am - 10:50 am	L: Quantum and Solid State Twardochleb PHY-NES-E-GMNE Quantum Mechanics / Nanoelectronics WME/0302/U	L: Semiconductor Technology 1 Mannsfeld Eul-NES-C-SCT Semiconductor Technology TOE/0226/H			Engineers Networks and Memristive Calculators RW				
3 DS 11:10 am - 12:40 pm	L: Systems Engineering Fetscher INF-NES-E-SE1 Foundations of Systems Engineering APB/E023/U				Engineering 1 of Systems Engineering 23/U				
4 DS 1:00 pm - 2:30 pm		Mannsfeld NES-12.12.02-19.1 / Eul-NES-C-SCT Semiconductor Technology TOE/0317/H	Kortke Eul-NES-E-StSig Stochastic Signals and Systems GÖR/0223/U	L: Plasma Technology Hauff Eul-NES-E-PlTs Plasma Technology WME/0302/U	P: RoboLab Knobloch NES-11.06.01-15.1 / INF-NES-C-15b-S Lab Sessions HÜLS/06/H				
5 DS 2:50 pm - 4:20 pm		E: Hardware Modelling and Simulation Göhringer NES-11.20 Hardware Modelling and Simulation APB/E006/U	L: Semiconductor Quantum Structures Wimmer/Helm/Dimakis PHY-NES-E-GMNE Quantum Mechanics for Nanoelectronics REC/0214/H	E: JOINT Communications and Sensing Systems for 6G Networks Dokhanchi Eul-NES-E-JCAS Joint Communications and Sensing Systems for 6G Networks NES/0219/H	L: Integrated Photonic Devices Jamchidi Eul-NES-E-IPD Integrated Photonic Devices for Communications and Signal Processing BAR/0215/H	L: Plasma Technology Hauff Eul-NES-E-PlTs Plasma Technology WME/0302/U	L: Integrated Photonic Devices Jamchidi Eul-NES-E-IPD Integrated Photonic Devices for Communications and Signal Processing BAR/0215/U	E: Distributed Systems Springer NES-11.06.07-M.1 Ubiquitous Systems APB/E023/U	E: Plasma Technology Hauff Eul-NES-E-PlTs Plasma Technology BAR/0215/U
6 DS 4:40 pm - 6:10 pm	L: Hardware Modelling and Simulation Göhringer INF-NES-E-HMS Hardware Modelling and Simulation MER/0026/H	L: Joint Communications and Sensing Systems for 6G Networks Dokhanchi Eul-NES-E-JCAS Joint Communications and Sensing Systems for 6G Networks GÖR/0223/U	L: Fundamentals of Estimation and Detection (compulsory for students enrolled before winter semester 24/25, elective for students enrolled as of winter semester 24/25) Rave NES-12.10.01-M.1 / Eul-NES-E-FED Fundamentals of Estimation and Detection TOE/0317/H	L: Fundamentals of Estimation and Detection (compulsory for students enrolled before winter semester 24/25, elective for students enrolled as of winter semester 24/25) Rave NES-12.10.01-M.1 / Eul-NES-E-FED Fundamentals of Estimation and Detection TOE/0317/H					


lecture, practical course,...

lecturer

module

room

Curriculum – elective modules

- Catalogue of 40 elective modules (is updated every semester!)
- You have to select elective modules with at least **41 credit points**
- You can choose modules of the catalogue by your own choice.
The classification of modules (Application, Technology, Design) is a guideline for you only.
- If possible, register for the module on  (OPAL) or the course website - links can be found on website *Modules and Study Guide*

Required steps if you want to take an exam:

- 1. Register for the module on SELMA (online platform for class and exam management)**
- 2. Register for the exam.**

The registration period for the exams is announced by the examination office. Usually, the registration period in the winter semester is in January.

Solving problems

- Visit the website of the program
<https://tu-dresden.de/ing/elektrotechnik/studium/studieren-an-der-fakultaet/master-nes>

- Ask fellow students or your mentor

- Contact the academic advisor (study course, general problems,...)

Manuela Tetzlaff, BAR 161, phone: +49 351 463 37363

email: master-nes@mailbox.tu-dresden.de

Tuesday: 01:30 pm – 03:00 pm

You can come by at any time. If I am not in the office, please try again or contact me by phone or e-mail.

- Contact the examination office (questions about exams, (de-)registration, grades, ...)

Denise Hartfiel, BAR 177a, phone: +49 351 463 42280

Office hours:

Tue 01:00 – 03:00 pm

Counseling service by phone or by appointment:

Thu 09:00 – 11:00 am

Please send your emails to the examination office only via ticket system!

- Contact the **International Office** (questions about enrollment, visa, leave of absence, ...)

Email: studium.international@mailbox.tu-dresden.de

Academic Affairs Committee



Prof. Thomas Mikolajick
(Dean of Studies)



Prof. Gerhard Fettweis



Prof. Kambiz Jamshidi

Student representatives:

- Jayanta Chowdhury
- Ahmed Belal Safi
- Shradha Sandesh Komatwar

Studies Co-ordinator:

- Prof. Mikolajick
- Ayush Dileep

Examination Committee:

- Prof. Mikolajick
- Prof. Fettweis
- Harshita Sriramu
- Lara John

Studying in Germany

- 15 weeks lectures, tutorials and lab courses, 4 weeks exams afterwards
- Learning during the exam weeks only is not enough!
 - attend all classes every week, participate actively and start working on problems during the semester
 - treat your study like a 40hour, full-time-job

Workload for each module is given in the module description

- Rule of thumb: 1 credit point is earned through 30 hours of work!
- Example: 180 hours (6 CP) for „Confidential Computing“

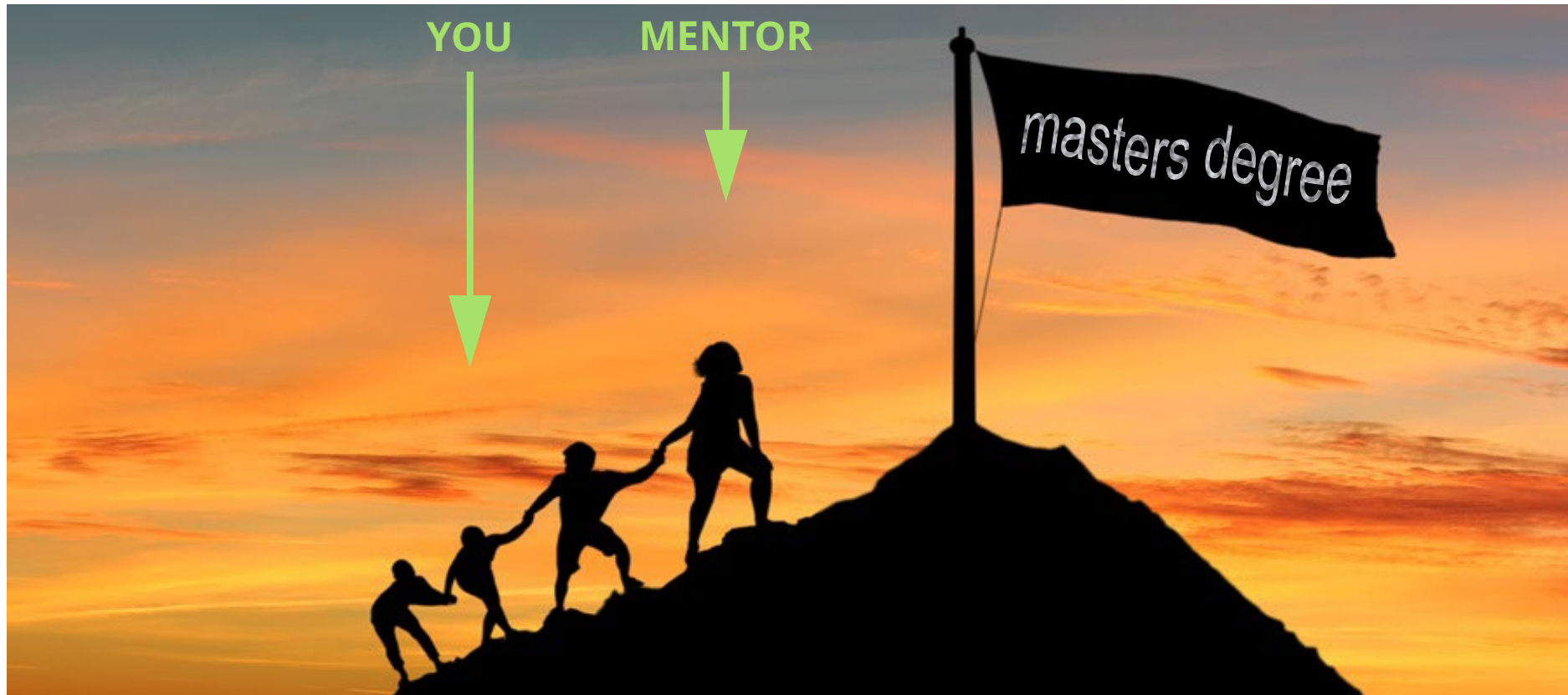
Lectures (2 hours x 15 weeks)	30
Tutorials (2 hours x 15 weeks)	30
Preparation for exam (38 hours)	38
Exam (2 hours)	2

- Rework transcript after lecture
- Read transcript before next lecture
- Solve exercises
- Discuss issues with fellow students
- Studying related books
- etc.

Check regularly your TU Dresden email account to ensure that you do not miss any important information!

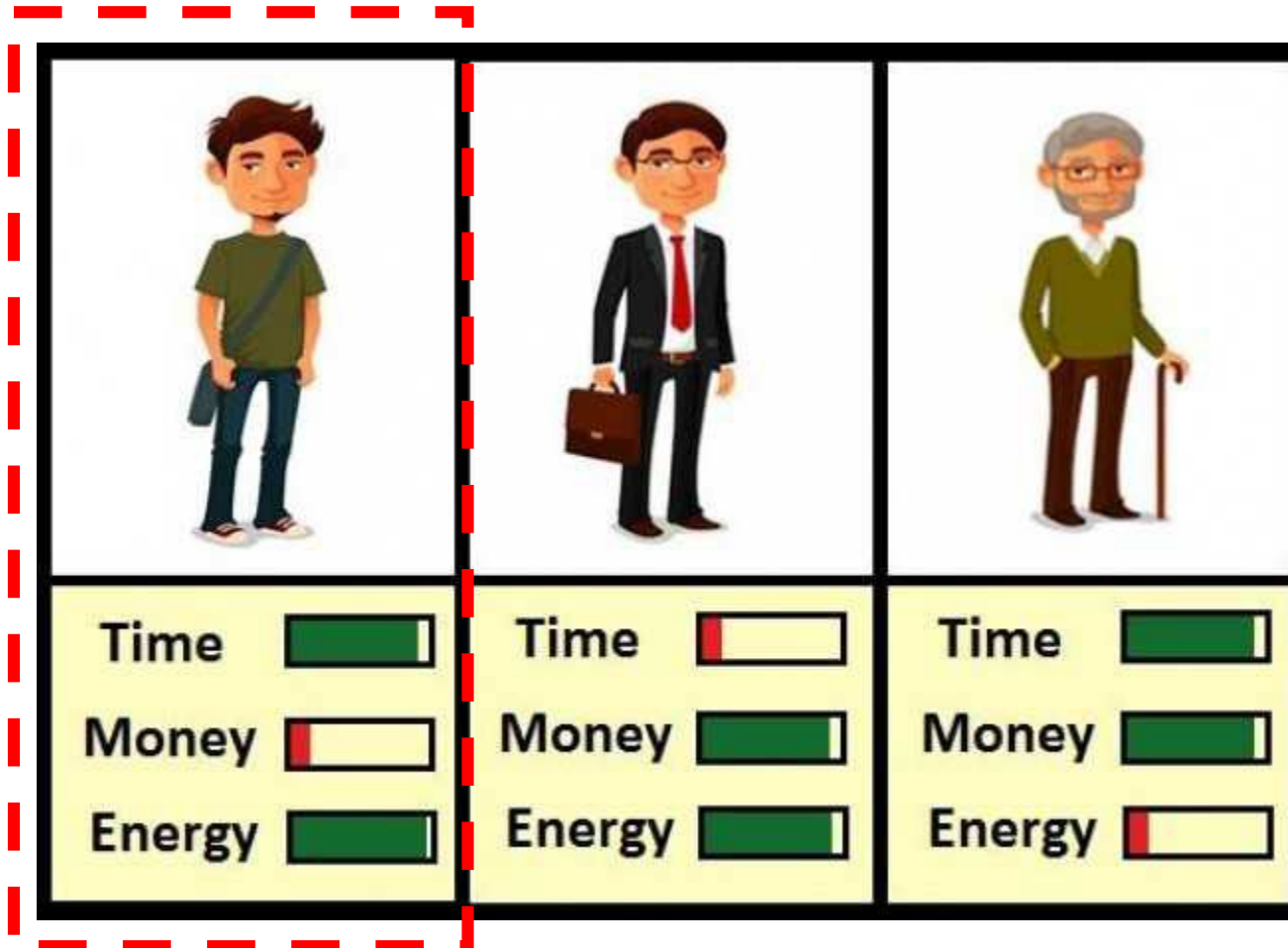
Most deadlines are very strict, do not miss a deadline!

NES student mentoring program



Have a good start!

YOU



Herzlich Willkommen!

Welcome!

Questions?