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Signal Processing Group
TU Darmstadt
Electrical Engineering
at Technische Universität Darmstadt

Electrical Engineering and Information Technology (etit)

- **1882**: First Chair for Electrical Engineering worldwide and appointment of Professor Erasmus Kittler
- **1883**: First course of study in Electrical Engineering worldwide
- **2007**: Bachelor Degree (3 years) + Master Degree (2 years)
- **2018**: 1.969 students in etit (12.6 % female, 33.7 % international)
- **Guiding principle**: “quality and innovation by tradition”

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Albert Einstein (1919):
“In my opinion, you definitely ought to go to Darmstadt. They have a good polytechnic school there.”
Agenda

- Curriculum
  - Interdisciplinary Hands-On Research
  - Laboratories
- Competitions
  - Practical Remarks
Curriculum
Overview of Hands-On Opportunities

The diagram illustrates the progression of educational and research opportunities over five years. It highlights the technical complexity of problems, knowledge, skills, and independence of students. From left to right, the years are:

- **Year 1**: Engineering Introductory Project
- **Year 2**: Engineering Practicals
- **Year 3**: Bachelor’s Project, Pro-/Project Seminar
- **Year 4**: Bachelor’s Practical, DSP Practical, Advanced SP Seminars
- **Year 5**: Master’s Project, DSP Labs, CSS, RBL, Bio, Audio, SPG

This structure shows a gradual increase in complexity and depth as the students progress from foundational projects to advanced research projects.
Introduction to Electrical Engineering

- Engineering Introductory Project

  Topic 2018: Technical concept for intelligent road intersections using sensor systems and beamforming

- freshmen practice working independently in interdisciplinary teams
- first exposure to signal processing problems
- limited prior knowledge is assumed
- choice of topic is essential
Curriculum
Year 2

Basic Courses on Signal Processing

- Deterministic Signals and Systems
- Fundamentals of Signal Processing

+ practical experiments with real-world data in the lectures
+ inclusion of student assistants (UTAs) as a means of integration

⚠️ basic knowledge of signal processing is still missing at this point
Curriculum
Year 3

Larger Research Projects

▶ Communication and Sensor Systems Laboratory (CSS)
▶ Proseminar
▶ Project Seminar
▶ Bachelor’s Thesis Project

+ outstanding Bachelors thesis projects can lead to conference publications
+ develop skills in Matlab, Latex and BibTeX
⚠ workload of Research Associate (RA) can be high in relation to the outcome
⚠ acquiring real data and working with it must be well planned
Curriculum

Year 4

Advanced Engineering Projects

- Digital Signal Processing Practical
- Advanced Seminars in Signal Processing

+ apply concepts learned in the DSP courses using real-world data
+ deepen the knowledge in signal processing
+ students can collect their own measurements

⚠️ time can be too short for students to gain a deep insight

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Curriculum
Year 5

Final Project

- Final Year Thesis Project (Master)

+ students are ready to undertake larger projects and work independently
+ cooperation with selected industry and research partners provides hands-on experience
+ recruitment of RAs
- Master’s students often stop at the height of their productivity
Agenda

▶ Curriculum

▶ **Interdisciplinary Hands-On Research**

▶ Laboratories

▶ Competitions

▶ Practical Remarks
Research cooperation between signal processing and psychology

Topic:
Investigate the synchronization of physiological signals in emotional situations

+ databases, once established, can be reused by other students or researchers
+ the interdisciplinary nature of the project requires explaining fundamental concepts without using equations
+ excellent results could be obtained and publications were produced
+ it takes time for students from all research fields to speak the same language
+ detailed documentation is essential in interdisciplinary research
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Laboratories
Signal Processing Group (SPG) Lab

- basic audio signal processing lab
- biomedical sensor lab
- synthetic aperture sonar lab
- radar lab
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+ students can collect their own measurements
+ students can carry out research jointly with RAs
+ even patented technologies have been developed in these labs
⚠️ keeping the lab up-to-date, providing GUIs and help to students is time consuming
Laboratories
Advanced Real-Time Audio Processing Lab

Advanced Real-Time Audio Processing Lab

- development of algorithms for hearing devices
- focus on feedback cancellation and beamforming
Bioinspired Communication Systems Lab

- statistical signal processing research in the context of biomolecular systems
- students can generate their own data by performing single-cell experiments
Receive Beamforming Lab

- student experiment in the field of multi-antenna receive beamforming
- main challenge: find the best trade-off between performance and complexity
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Competitions
Case Study Competition by Rohde & Schwarz

- several hundred students from Germany and Singapore take part
- final competition in Munich using modern measurement equipment
- winning team receives a prize and money for teaching purposes

Winning team from Darmstadt at the ceremony in Munich (2012)
Competitions
IEEE Signal Processing Cup

- several hundred students from all over the world take part
- final competition here at ICASSP
- winning team receives a grand prize and travel grant to ICASSP

Winning team from Darmstadt at their final presentation in Brisbane (2015)
Agenda

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- Interdisciplinary Hands-On Research
- Laboratories
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- Practical Remarks
Practical Remarks
for Successful Design Projects

▶ Interculturality:
  • give special emphasis to integrating students from other cultures
  • honest and direct communication is very important
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for Successful Design Projects

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▶ Mentorship:
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▶ Evaluation:
  • constantly try to improve courses, labs, and seminars through evaluations based on detailed questionnaires
Thank you for your attention!