THE DEPARTMENT OF ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY

FK04
MUNICH UNIVERSITY OF APPLIED SCIENCES IN FIGURES

18,486 Students
476 Professors
784 Part-time lecturers
541 Administration staff
134 Research associates
117 PhD students
84 Degree programmes (BA & MA)
14 Departments
11 Affiliated institutes
4 Research institutes
Location Info

- Automotive industry
- Biotechnology
- & life sciences
- Design & media
- Energy technology
- Finance
- Health/social sciences
- IT & communications
- Aerospace engineering
- Tourism
- Business services
### UNIVERSITIES OF APPLIED SCIENCES

#### CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><strong>DEGREES</strong></td>
<td>Bachelor, Master, PhD (cooperation w/ research universities)</td>
</tr>
<tr>
<td><strong>MAIN STUDY FOCUS</strong></td>
<td>practice and application</td>
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<tr>
<td><strong>RESEARCH FOCUS</strong></td>
<td>application-oriented research</td>
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<tr>
<td><strong>CLASS SIZE</strong></td>
<td>small</td>
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<tr>
<td><strong>INTERNSHIP</strong></td>
<td>Compulsory Internship Semester</td>
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<tr>
<td><strong>REQUIREMENT FOR PROFESSORS?</strong></td>
<td>Min. 5 years industry / professional background</td>
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Research

In figures

4 Research Institutes
5 Major fields
11 Affiliated institutes
95 Research projects (publicly funded)
117 Ph.D. students
134 Research associates
12.4 million Euro third party funds
Campuses

CAMPUS KARLSTRASSE

CAMPUS LOTHSTRASSE

CAMPUS PASING
Campus Lothstraße
Central administration and services

- CAREER Center
- E-Learning Center
- Science Support Center
- Center for Continuing Education
- Library

- IT Services
- General Chemistry Laboratories
- Strascheg Center for Entrepreneurship
- 9 departments
Campus Lothstraße
Departments

- Mechanical, Automotive and Aeronautical Engineering
- Electrical Engineering and Information Technology
- Building Services Engineering, Paper and Packaging Technology, Print and Media Technology
- Applied Sciences and Mechatronics
- Computer Science and Mathematics
- Engineering and Management
DEPARTMENT FK04 – OVERVIEW

STRUCTURE IN FIGURES

1,275 Students
450 freshman/year
40 fulltime professors
30 other employees (lab and admin)
50 visiting lecturers (about 30 each semester)
36 laboratory facilities teaching/research
3 Bachelor Programs
3 Master Programs
2 Research Institute
BACHELOR- AND MASTER PROGRAMS

STRUCTURE

Bachelor EI
- Choice between AE, AT, KT, TI
- 7 courses (main studies) + bachelor thesis
- 6 courses (basic studies)
- 5 industrial training period
- 4 courses (basic studies)
- 3 courses (basic studies)
- 2 courses (basic studies)
- 1 courses (basic studies)

Bachelor RE
- 7 courses (main studies) + bachelor thesis
- 6 courses (main studies)
- 5 industrial training period
- 4 courses (basic studies)
- 3 courses (basic studies)
- 2 courses (basic studies)
- 1 courses (basic studies)

Bachelor EM
- 7 courses (main studies) + bachelor thesis
- 6 courses (main studies)
- 5 industrial training period
- 4 courses (basic studies)
- 3 courses (basic studies)
- 2 courses (basic studies)
- 1 courses (basic studies)

Master Electrical Engineering
- Masterthesis
- 10 theoretical courses
- 9 theoretical courses
- 8 theoretical courses

Master Systems Engineering
- Masterthesis
- 10 theoretical courses
- 9 theoretical courses
- 8 theoretical courses

Master of Science
- qualification test

OUTSIDE HM
HM DUAL
STUDY PROGRAM

We offer so called dual studies opportunities in cooperation with the consortium *university dual bavaria* and with numerous industrial partner companies.
HM DUAL
STUDY PROGRAM

- There are two basic types:
  - studies and vocational training in combination
    - Duration 4.5 years
    - Dual degree: Bachelor degree and certificate from Chamber of Commerce and Industry
  - studies with intensive industrial internship periods
    - Bachelor: duration 3.5 years
    - Master: duration 1.5 years
    - Student is during his studies funded by and bounded by contract to industrial partner
    - Bachelor – Master degree
LONG-TERM STUDENTS PROJECTS

- Formula Student Electric
  - https://www.munichmotorsport.de

- Shell Eco Marathon

- ProCK

- Formula Student driverless
RESEARCH
MAJOR FIELDS

- Automotive
- Digitalisation
- Energy Efficiency
- Production & Materials
- Socio-economic Innovations
LIST OF LABORATORIES (FOR TEACHING AND/OR RESEARCH)

- Packaging of Integrated Circuits
- Realtime Operation Systems and Programming
- Computer Networking
- Digital Technologies
- Electrical Engines and Machinery
- Electrical Measurement Technology
- Electronics
- Fundamentals of Electric Engineering
- High-Frequency Techniques
- High Voltage Engineering
- Power Electronics
- Mechatronics

- Microcomputer
- Microcomputer Systems
- Microelectronics
- Microwave Techniques
- Multimedia Applications
- Pattern Recognition & Artificial Intelligence
- Communication Satellites (Compact Range)
- Optical Communications
- Computer Applications
- Control Theory and Technology
- Analog Circuit Technology
- Analog Signal Processing
- Software Development
- Solar Techniques und Energy Systems
- Systems Engineering
- Material Science
- Communication Transmission
- Computer-Kicker
- Robotics Laboratory
- Workshop fine mechanics
APPLIED RESEARCH: Sensors

**Project SimuSens:** Development of a framework for the simulation of the thermomechanical stress in sensors.

Project Partner: tdk-electronics

Funded by the German Ministry of Research

Tasks of the UAS:

- Development of material models for solder and polymers
- Simulation of pressure sensors and microphones
- Verification of the simulations by measurements
- Development of low stress packages
Project MoMiFI: Miniaturization of high frequency modules for mobile phones.

Project partners: Qualcomm, ASM

Funded by the Bavarian Ministry of Economics

Tasks of the UAS-Munich:

- Development of copper pillar bumps as an replacement for solder bumps for micro-acoustic components
- Assembly of test modules, reliability testing, analysis and optimization of process and design
APPLIED RESEARCH: Energy Efficient Class-D Amplifiers for ELA

**Topic:** Energy-efficient 100V system amplifier for ELeetroacoustic infrAstructure (ELA)

- 100V system amplifier for ELA without line transformer
- Up to 400 W with 97% efficiency without fan or heat sink
- Module size only 9 cm x 5 cm x 1 cm
- High efficiency under all load conditions due to integrated variable supply voltage concept (patented)
- Switched-mode power supply using low-cost planar transformer
- Continuous self-test of the whole system
APPLIED RESEARCH: Digital Filter Design Tool pyFDA

**Topic:** User-friendly open-source tool for design, analysis and synthesis (VHDL and Verilog) of discrete-time fixpoint filters

**Application Areas:** Digital signal processing and FPGA design for R&D and education

**Open-Source:** Developed with Python and Qt-Widgets ([github.com/chipmuenk/pyfda](https://github.com/chipmuenk/pyfda))

**Modular architecture** for fast development of new filters and analysis modules

**Google Summer of Code 2018:**
- Link pyFDA and myHDL ([www.myhdl.org](http://www.myhdl.org)) for easy VHDL and Verilog code generation
- Implement more complex (a.o. systolic FIR) filters and synthesize them

Prof. Dr. C. Münker
APPLIED RESEARCH: E-Scooter

Partner: UAS-Munich, Auswall

Tasks of UAS Munich

- development of electronics for motor control
- development of innovative motor control algorithms
  - using new non-contact torque sensing (magnetostriction)
  - using heart-rate sensors to determine required motor torque (rehabilitation)
  - development of “Pedelec-Mode” for E-Scooter to avoid requirement for numberplates and to wear helmets for vehicles with motor support above 6km/h

Prof. Dr. S. Hecker
APPLIED RESEARCH: ASG and ANC using existing Electric Drives

Partner: UAS-Munich (FK03+04), BMW, MdynamiX AG
also supported by BMWi (ZIM)

Idea: Using existing electric drives (e.g. steering motor) in passenger cars as loudspeaker for

• Active Sound Generation (ASG) for electric cars
  • outside warning sounds for pedestrians (without additional outside loudspeaker)
  • company typical branding of motor sound

• Active Noise Cancellation (ANC) for combustion and electric cars
  • suppressing tonal noise (e.g. cavity noise from tires or combustion motor noise) inside the car without using microphones and loudspeakers
  • avoid expensive active and passive damper systems (e.g. active engine mounts)
APPLIED RESEARCH: Anti-Pinch Protection for Sliding Roofs

Partner: UAS-Munich, Webasto AG

Tasks of UAS Munich

- Development of adaptive algorithms for correction of Hall sensor errors
- Development of a multi-rate observer for exact motor speed estimation
- Development of observer based fault detection algorithms for anti-pincho system
- Development of robust motor speed controller for improved roof acoustics

Prof. Dr. S. Hecker
APPLIED RESEARCH: Multi purpose HiL-Testbench

Partner: UAS-Munich (FK 03+04), MdynamiX AG, TU Vienna

Idea: development of high performance hardware in the loop testbench for automotive components

Tasks
- Development of robust, model predictive, multi-input, multi-output control algorithms
- Allow HiL-tests for automotive components (e.g. steering system, engine mounts, active dampers) with bandwidths up to 40 Hz
- Real-time simulation of remaining vehicle dynamics and environment to allow driver in the loop testing
• „QuBa“ – Quad Band Antenna
• Frequency Selective Subreflector for Satellite Antennas

- Idea: Use of two antenna feeds with one reflector
- Boosting the available bandwidth
- Partner: Airbus
- 2018 – 2020
- One PHD Student
- Tasks:
  - Design concept
  - Full wave simulation
  - Measurement

Prof. Dr. G. Strauß
• „QuBeX“ – Quad Band Extend

- 2021 – 2023
- Investigation of diffraction effects
- Consideration of near field conditions
- One PHD Student
- Partner: Airbus
- New manufacturing method in cooperation with the Laboratory for Microsystems Engineering (Faculty 06)
Applied Research: E min

**Issue:** Optimization of In-house Communication for Minimizing the Power Consumption in Buildings

- Starting grant Hochschule München
  - Sensor network for wireless communication
  - Optimization of sensor network for minimum energy supply
  - Operation strategies for minimum electrical power
  - Operation strategies for minimum heating power
The Research Institute „Sustainable Energy Systems“ contributes significantly to a sustainable energy system and an efficient energy use by own research, consultation and teaching activities.
Research Institute "Sustainable Energy Systems"
Research Institute „Sustainable Energy Systems“

- Prof. Oliver Bohlen, FK04 „Elektrische Energiespeicher“
- Prof. Christoph Hackl, FK04 „Mechatronische und regenerative Energiesysteme“
- Prof. Herbert Palm, FK04 „Systems Engineering“
- Prof. Simon Schramm, FK04 „Regenerative Energien und Netzintegration“
- Prof. Stephanie Uhrig, FK04 „Elektrische Energietechnik“
- Florentina Alecu, Geschäftsführerin
Entering new technologies involves:
- Large amount of unknown solutions
- Lack of "proof-of-concept"

Extending the V-Model allows to manage related uncertainties

"Hyper Space Exploration" is a multi-criterial trade-off-analysis making use of:
- Design of (virtual) experiment
- Surrogate modelling
- Model-driven system optimization

Our applications:
- Sustainable energy systems
- Automotive top-level design (FEVs)
- Complex Controller Design
Applied Research: Fault-tolerant and efficient mechatronic and regenerative energy systems

- Large-scale WTS
  - Efficiency+Reliability
- Small-scale WTS
  - Reluctance SM
- Model predictive control for RES
  - Real-time applicability
- Airborne Wind Energy
  - Fault-tolerant control
- Geothermal energy
  - Fault-tolerant control
- Wave energy (SinnPower)
  - Efficiency+Reliability
- Electric vehicles (BMW)
  - Efficiency+Reliability
- Electrical power system
  - Three-phase four-wire system dynamics

Prof. Dr.-Ing. Christoph M. Hackl
Applied Research: Detection & Localization of mechanically induced damages in lithium ion batteries (ReVISEDBatt)

Research:
- Realistic mechanical stresses, such as shocks, vibrations and external forces
- Damages in cell and module components
- Effects on operational and aging behavior
- Detection methods

Objectives:
- Knowledge of damage mechanisms
- Development of novel early detection methods
- Online application in battery management systems

Project:
- Project period: 2017/09 – 2021/03
- Staff at HM: one research fellow, student workers

Supported by:
- Federal Ministry for Economic Affairs and Energy
- on the basis of a decision by the German Bundestag

Prof. Dr.-Ing. Bohlen
Applied Research: Universal connection of automotive traction batteries for stationary applications (UnABESA)

**Applications**
- Frequency regulation
- Peak shaving
- Decentralized storage

**Challenges**
- No standardized design
- Different battery properties
- Costs

**Research objectives**
- Universal architecture for different batteries and applications
- Highly efficient power electronics with innovative control
- Optimized power flow in heterogeneous battery systems

**Project:**
- Project period: 2017/06 – 2020/12
- Staff at HM: two research fellows, student workers

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**Supported by:**

- BMW
- Inductron Inductive Electronic Components GmbH
- ISES

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Prof. Dr.-Ing. S. Schramm, Prof. Dr.-Ing. Bohlen
Applied Research: Private Grid Coupling

Hard Facts
- Mains parallel
- Galvanic isolated
- Surplus energy transferred
- Depending on energy production and consumption

Customer Value
- PV plant is more profitable
- Economic benefits for producer and receiver
- More people get access to renewable energy
- Contribution to a successful energy revolution

Prof. Dr.-Ing S. Schramm
**Applied Research: Analysis of complex energy systems**

**Goal:** Development of a process for automated and data-based analysis of complex energy systems and identification of (essential) consumers.

**Research Interests:**
- Which parameters influence energy consumption in complex energy systems?
- How can this data be captured and utilized?
- In which resolution and measuring accuracy are these data needed?
- Which methods of data analysis (big data, machine learning, NILM) can be applied to the data?
- How can consumers (types) be recognized?
- How can changing structures be recognized during operation?
Applied Research: Capability Analysis for Reliable and reproducible Diagnosis on Electrical Machines (CarpeDiem)

Research objectives
- Development of reproducible method for failure diagnosis on rotating machines
- Use of non-intrusive frequency response measurement and analysis (FRA)

Applications
- Different types of rotating machines
- Detection of different failure modes like broken rods or shorts within windings
- Condition assessment

Challenges
- Influencing factors unclear
- Classification of machine types
- Modeling of frequency response highly challenging

Project:
- Period: 2020/04 – 2022/03
- Staff at HM: one research fellow

Open rod on damping winding: Influence of rotor position on frequency response