### MUNICH UNIVERSITY OF APPLIED SCIENCES

#### IN FIGURES

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>18,400</td>
</tr>
<tr>
<td>Professors</td>
<td>463</td>
</tr>
<tr>
<td>Part-time lecturers</td>
<td>785</td>
</tr>
<tr>
<td>Administration staff</td>
<td>525</td>
</tr>
<tr>
<td>Research associates</td>
<td>143</td>
</tr>
<tr>
<td>PhD students</td>
<td>115</td>
</tr>
<tr>
<td>Degree programmes (Bachelor's and Master's)</td>
<td>85</td>
</tr>
<tr>
<td>Departments</td>
<td>14</td>
</tr>
<tr>
<td>Affiliated institutes</td>
<td>8</td>
</tr>
<tr>
<td>Research institutes</td>
<td>2</td>
</tr>
</tbody>
</table>
### UNIVERSITIES OF APPLIED SCIENCES

#### CHARACTERISTICS

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

- Automotive industry
- Biotechnology & life sciences
- Design & media
- Energy technology
- Finance
- Health/social sciences
- IT & communications
- Aerospace engineering
- Tourism
- Business services
THREE CAMPUSES

CAMPUS KARLSTRASSE
CAMPUS LOTHSTRASSE
CAMPUS PASING

MUAS
DEPARTMENT FK04- OVERVIEW

DEPARTMENT FK04 STRUCTURE IN FIGURES

<table>
<thead>
<tr>
<th>Count</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1350</td>
<td>Students</td>
</tr>
<tr>
<td>490</td>
<td>freshman/year</td>
</tr>
<tr>
<td>40</td>
<td>fulltime professors</td>
</tr>
<tr>
<td>30</td>
<td>other employees (lab and admin)</td>
</tr>
<tr>
<td>50</td>
<td>visiting lecturers (about 30 each semester)</td>
</tr>
<tr>
<td>36</td>
<td>laboratory facilities for teaching and research</td>
</tr>
<tr>
<td>3</td>
<td>Bachelor Programs</td>
</tr>
<tr>
<td>3</td>
<td>Master Programs</td>
</tr>
<tr>
<td>1</td>
<td>Research Institute</td>
</tr>
</tbody>
</table>
Bachelor- and Masterprograms

STRUCTURE

Master Electrical Engineering

Master of Science

10  Masterthesis
9   theoretical courses
8   theoretical courses

qualification test

Bachelor

Choice between AE, AT, KT, TI
7   courses + 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 EI

OUTSIDE HM

Bachelor EM

Bachelor RE

1. Hürde

Master Systems Engineering

Master of Systems Eng.

10  Masterthesis
9   theoretical courses
8   theoretical courses

qualification test

Bachelor

7   courses + 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 RE

7   courses + 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

OUTSIDE HM

Bachelor RE
We offer so called dual studies opportunities in cooperation with the consortium *university dual bavaria* and with numerous industrial partner companies.
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
STATISTIK BEGINNERS

„G8/G9-Berg“
kein Beginn
im SS 2013

„G8/G9-Berg“
kein Beginn
im SS 2013

Bachelor EI
Bachelor RE
Bachelor EM
Bachelor Summe
Master EL
Master SE
Master Summe

Beginners
seit „Berg“

(calender year (summer and winter semester))
LONG-TERM STUDENTS PROJECTS

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

- Shell Eco Marathon

- ProCK

- Formula Student driverless
Research and Development
<table>
<thead>
<tr>
<th>Laboratory Area</th>
<th>Sub-Laboratory Areas</th>
<th>Sub-Laboratory Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaging of Integrated Circuits</td>
<td>Microcomputer</td>
<td>Energy Systems</td>
</tr>
<tr>
<td>Realtime Operation Systems and Programming</td>
<td>Microcomputer Systems</td>
<td>Systems Engineering</td>
</tr>
<tr>
<td>Computer Networking</td>
<td>Microelectronics</td>
<td>Material Science</td>
</tr>
<tr>
<td>Digital Technologies</td>
<td>Microwave Techniques</td>
<td>Communication Engineering</td>
</tr>
<tr>
<td>Electrical Engines and Machinery</td>
<td>Multimedia Applications</td>
<td>Communication Transmission</td>
</tr>
<tr>
<td>Electrical Measurement Technology</td>
<td>Pattern Recognition &amp; Artificial Intelligence</td>
<td>Computer-Kicker</td>
</tr>
<tr>
<td>Electronics</td>
<td>Communication Satellites (Compact Range)</td>
<td>Robotics Laboratory</td>
</tr>
<tr>
<td>Fundamentals of Electric Engineering</td>
<td>Optical Communications</td>
<td>Workshop fine mechanics</td>
</tr>
<tr>
<td>High-Frequency Techniques</td>
<td>Computer Applications</td>
<td></td>
</tr>
<tr>
<td>High Voltage Engineering</td>
<td>Control Theory and Technology</td>
<td></td>
</tr>
<tr>
<td>Power Electronics</td>
<td>Analog Circuit Technology</td>
<td></td>
</tr>
<tr>
<td>Mechatronics</td>
<td>Analog Signal Processing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Software Development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solar Techniques und</td>
<td></td>
</tr>
</tbody>
</table>
**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
Applied Research: High frequency components

**Project MoMiFI**: Miniaturization of high frequency modules for mobile phones.

Project partners: RF360, a Qualcomm/TDK Joint Venture, ASM, Christian Koenen GmbH

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
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

Prof. Dr. H. Palm
Applied Research: Energy Efficient Class-D Amplifiers for ELA

**Topic:** Energy-efficient 100V system amplifier for ELectroacoustic 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

Josef Klugbauer, Prof. Dr. C. Münker
**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)

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

**Google Summer of Code 2018:**
- Link pyFDA and myHDL (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: 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 (ReVISEDBat)

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 – 2020/09
- 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
Applied Research: Universal connection of automotive traction batteries for stationary applications (UnABESA)

Second-Life applications for traction batteries

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 – 2020/06
- Staff at HM: two research fellows, student workers

Supported by:

Prof. Dr. S. Schramm, Prof. Dr. 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

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Prof. Dr. 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: 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
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)

Prof. Dr. S. Hecker
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-pinch 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
Frequency Selective Plate [FSP] for Multiplex Use of a Parabolic Antenna for TV and Internet

- Direct order from Eutelsat S. A. (Paris) worldwide third biggest provider of satellite communication services.
- HM has the leadership in conception, development and qualification.
- Rollout of FSP actual in Greece, total volume 1 Million terminals (Europe, North Africa and Mead east).
- Patent: Inventor is HM, Owner is Eutelsat.

Follow up project starts in 2015, runtime 3 years.
- one PHD Student, several student assistants.
- Direct competition with European enterprises and universities.

Prof. Dr. G. Strauß
**Target:** Development of an antenna system for very high data rates between low orbit satellites

- Development for „SatCom on the Move“
- Space approval Mid 2015

**Cooperation with**

- Airbus (earlier EADS Astrium GmbH)
- Institute for Mobil and Satellite Communication IMST GmbH
- Technical University of Munich TUM, Institute for light weight construction
- Deutsches Zentrum für Luft- und Raumfahrt DLR

Prof. Dr. G. Strauß
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

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Prof. Dr. T. Michael
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“

Institute for Sustainable Energy Systems

System layer
Integration layer
Component layer

Generation
Conversion
Transmission
Storage
Consumption

Horizontal penetration
Vertical penetration
Research Institute „Sustainable Energy Systems“

- Prof. Stephanie Uhrig, FK04 since 2017 „Power Engineering“
- Prof. Simon Schramm, FK04 since 2014 „Renewables and Grid Integration“
- Prof. Herbert Palm, FK04 since 2008 „Systems Engineering“
- Prof. Christoph Hackl, FK04 since 2018 „Mechatronic and Renewable Energy Systeme“
- Prof. Oliver Bohlen, FK04 since 2014 „Electric Energy Storage Systems“
...some impressions of our labs
...and more...
...and even more...

Pattern Recognition & Artificial Intelligence

Systems Engineering

Digital Signal Processing
...the end

Comm. Satellites
Compact Range

Control Technology

Analog Circuit Technology