MASTER'S PROGRAMMES
EE, S&C (AND EMSYS)

MAARTEN KORSTEN
CONTENT

- Faculty of Electrical Engineering, Mathematics & Computer Science
- Research (Centres)
- Master’s programmes
EEMCS FACULTY
INFORMATION TECHNOLOGY

- Electrical Engineering
- Mathematics
- Computer Science
RESEARCH INSTITUTES

- CTIT  Institute for ICT Research in Context
  - Including Robotics & Mechatronics

- MIRA  Biomedical Technology

- MESA  Nanotechnology

- ITC  Institute for Geo-Information Science and Earth Observation

- IGS  Institute for Innovation and Governance Studies
MASTER’S PROGRAMMES EEMCS

Disciplinary
- Electrical Engineering
- Applied Mathematics
- Computer Science

Interdisciplinary
- Embedded Systems
- Systems & Control
- Human Media Interaction
- Internet Science & Technology
- Business Information Technology
# RESEARCH IN THE ELECTRICAL ENGINEERING GROUPS

<table>
<thead>
<tr>
<th><strong>Biomedical</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Biomedical Signals &amp; Systems</td>
<td>MIRA</td>
</tr>
<tr>
<td>Biomedical and Environmental Sensor systems</td>
<td>MESA/MIRA</td>
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<table>
<thead>
<tr>
<th><strong>IC-design and Computer Architecture</strong></th>
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<tbody>
<tr>
<td>Computer Architectures for Embedded Systems</td>
<td>CTIT</td>
</tr>
<tr>
<td>Integrated Circuit Design</td>
<td>CTIT</td>
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<table>
<thead>
<tr>
<th><strong>Measurement, Control and Mechatronics</strong></th>
<th></th>
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<tbody>
<tr>
<td>Robotics and Mechatronics</td>
<td>CTIT</td>
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<table>
<thead>
<tr>
<th><strong>Telecommunication</strong></th>
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<tbody>
<tr>
<td>Design and Analysis of Communication Systems</td>
<td>CTIT</td>
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<tr>
<td>Telecommunication Engineering</td>
<td>CTIT</td>
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<table>
<thead>
<tr>
<th><strong>Micro and nanosystems</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical and Environmental Sensor systems</td>
<td>MESA/MIRA</td>
</tr>
<tr>
<td>Nano-electronics</td>
<td>MESA</td>
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<tr>
<td>Semiconductor Components</td>
<td>MESA</td>
</tr>
<tr>
<td>(Integrated) Optical Systems</td>
<td>MESA</td>
</tr>
<tr>
<td>Micro Sensors &amp; Systems</td>
<td>MESA</td>
</tr>
</tbody>
</table>
SELECTED RESEARCH TOPICS
BIOMEDICAL SIGNALS & SYSTEMS
SELECTED RESEARCH TOPICS
BIOMEDICAL AND ENVIRONMENTAL SENSORSYSTEMS

Nanofluidics

Biomedical Microdevices

Electrochemical sensors and sensor systems

Cells-on-chip
SELECTED RESEARCH TOPICS
ROBOTICS & MECHATRONICS

Topics

• Modeling
• Control
• Imaging
• Design
• Embedded Systems
SELECTED RESEARCH TOPICS
TELECOMMUNICATION ENGINEERING

Topics

- Electromagnetic Compatibility
- (Short Range) Radio
- Sensor networks
SELECTED RESEARCH TOPICS
INTEGRATED CIRCUIT DESIGN (NAUTA)

Central theme
• Integrated transceivers in CMOS technology
• For portable, fast and energy efficient communication systems

Topics
• Frequency synthesizers, radio frontends, RF beamforming and cognitive radio

RF Network Analysis Set Up (ICD laboratory)
PROGRAMME ELECTRICAL ENGINEERING

First year: courses
- 4 compulsory specialisation courses
  - Depending on your specialisation
- 1 non-technical course (Philosophy of Engineering)
- 7 elective courses
  - 5EC (European Credit) each

Second year: practical work
- Internship
- Master’s thesis

Specialisations
- Each research group has its own specialisation
### SPECIALISATIONS

<table>
<thead>
<tr>
<th>Specialisation</th>
<th>Chair</th>
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</thead>
<tbody>
<tr>
<td><strong>Biomedical</strong></td>
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<tr>
<td>Neurotechnology and Biomechatronics</td>
<td>BSS</td>
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<tr>
<td>Computer Vision and Biometrics</td>
<td>SCS</td>
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<tr>
<td><strong>IC-design and Computer Architecture</strong></td>
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<tr>
<td>Dependable Integrated Systems</td>
<td>CAES</td>
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<tr>
<td>Integrated Circuit Design</td>
<td>ICD</td>
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<tr>
<td><strong>Measurement, Control and Mechatronics</strong></td>
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<tr>
<td>Robotics and Mechatronics</td>
<td>RAM</td>
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<td><strong>Telecommunication</strong></td>
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<tr>
<td>Communication Networks</td>
<td>DACS</td>
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<tr>
<td>Telecommunication Engineering</td>
<td>TE</td>
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<tr>
<td><strong>Micro and nanosystems</strong></td>
<td></td>
</tr>
<tr>
<td>Lab-on-a-chip systems for Biomedical and Environmental Applications</td>
<td>BIOS</td>
</tr>
<tr>
<td>Nano-electronics</td>
<td>NE</td>
</tr>
<tr>
<td>Devices for Integrated Circuits</td>
<td>SC</td>
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<tr>
<td>Integrated Optical Systems</td>
<td>OS (TNW)</td>
</tr>
<tr>
<td>Micro Sensors &amp; Systems</td>
<td>MSS</td>
</tr>
</tbody>
</table>
What is an Embedded System?

- **Signal Processing** in Hardware and / or Software for an application
- **Application**
  - mobile phone, audio / video processing, cars, robots, production machines
- **Software**
  - User interface
  - Data processing
  - Machine control
- **Hardware**
  - I/O
  - ASIC, DSP, FPGA
- **Strong demands**, e.g.
  - Real time
  - Maintainability
  - Costs
A modern car contains many embedded systems

- Motormanagement
- Cruise control
- ABS/Traction control
- Variable power steering
- Navigation
- Airco
- Airbag
- Intelligent parking system
- …
Application of Sensor networks

Chair Pervasive Systems

- Coral reef (Australia)
  - A sensor measures temperature, salinity, ...
    - Important events (e.g. raise of temp) are reported
    - Due to a position system the sensor knows its position
- Sensors communicate with each other in a wireless network
- Cause, and early detection, of coral bleaching possible

![Coral reef image]

![Coral bleaching image]
Production Cell Set-up
Chair Robotics and Mechatronics

The Boderc project focuses on distributed embedded real-time controllers of complex systems.

- Modelling
- Hardware
- Software

Boderc; Beyond the Ordinary: Design of Embedded Real-time Control
New generation of self-repairing multi-cores
Chair Computer Architecture for Embedded Systems

CMOS chip design by CAES, Recore, NXP, ATMEL
(> 1.2 M transistors)

software for real-time repair!

Xentium tile

SRAM tile
Positioning Master Embedded Systems

More information on the chairs: https://www.utwente.nl/en/eemcs/research/
# Programme setup

<table>
<thead>
<tr>
<th>First year</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Homologation (predefined for UT bachelor CS/EE, individual for others)</td>
<td>≤ 20</td>
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<tr>
<td>Compulsory</td>
<td>25</td>
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<tr>
<td>Elective courses</td>
<td>Remaining ECs to 60</td>
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<table>
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<tr>
<th>Second year</th>
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<tbody>
<tr>
<td>Internship</td>
<td>20</td>
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<tr>
<td>Final Project Preparation</td>
<td>10</td>
</tr>
<tr>
<td>Final project</td>
<td>30</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
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</table>
What is Systems & Control?

- Input
- System
- Output

- Input
- State
- System
- Output
Systems of systems

Input

System 1

System 2

System 3

Output
Example of a (feedback) control system
Systems and Control

Dynamic phenomena (systems) in interaction with their environment.

- Mathematical modeling.
  - Reflecting the main features.
  - Difference or differential equations, inequalities, algebraic equations, and logical constraints.
- Analysis and simulation of the mathematical model.
  - Prediction and estimation.
- Control
  - Choosing suitable inputs and constraints
  - Desired behavior
Core elements of the S&C programme

<table>
<thead>
<tr>
<th>Topic</th>
<th>Course</th>
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<tbody>
<tr>
<td>Modelling</td>
<td>Modelling &amp; Simulation</td>
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<tr>
<td>Control</td>
<td>Digital Control Engineering</td>
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<tr>
<td>Identification</td>
<td>System Identification &amp; Parameter Estimation</td>
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## SPECIALISATIONS

<table>
<thead>
<tr>
<th>Specialisation</th>
<th>Research group (chair)</th>
<th>Faculty</th>
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<tbody>
<tr>
<td>Control Theory</td>
<td>Hybrid Systems</td>
<td>EEMCS/Mathematics</td>
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<tr>
<td>Robotics &amp; Mechatronics</td>
<td>Mechanical Automation</td>
<td>EEMCS/Electrical Engineering</td>
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<tr>
<td></td>
<td>Biomechanical Engineering</td>
<td>Engineering Technology</td>
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<tr>
<td>Biomechatronics</td>
<td>Biomechanical Engineering</td>
<td>Engineering Technology</td>
</tr>
</tbody>
</table>
Robotics & Mechatronics

- Modelling
- Control
- Embedded control
- Imaging
- MEMS

Mechanical Automation

- Automation & Control
- Design of Mechanisms & Robotics
- Applied Laser Technology

Development of piezo hardmounts for precision equipment
Biomechatronics

- Surgical Robotics
- Tissue mechanics
- Neuro mechanics
- Movement mechanics
Development of an adaptive arm orthosis that compensates for the progression of Duchenne Muscular Dystrophy

- Weight compensation
- Actuation
- Intuitive control
SURGICAL ROBOTICS
SARTHAK MISRA

Pre-operative planning

MR/CT imaging
Finite element modeling

Ultrasound-based elasticity

Intra-operative control

Shape sensing
Continuum robots

Needle steering
Microrobotic systems

Procedure planning

Intuitive colonoscopy

UNIVERSITY OF TWENTE.
Control Theory

- Signal processing
  - Particle filtering
- Systems subject to constraints
- Hybrid systems
- Large-scale systems
- Dynamics and control of distributed parameter systems
Program Systems & Control (3TU)

<table>
<thead>
<tr>
<th>Year</th>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Year 1</td>
<td>Compulsory core courses</td>
<td>15 EC</td>
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<td></td>
<td>Integration project</td>
<td>5 EC</td>
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<tr>
<td></td>
<td>Non-technical course</td>
<td>5 EC</td>
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<td>Specialisation courses</td>
<td>35 EC</td>
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<tr>
<td>Year 2</td>
<td>Traineeship</td>
<td>20 EC</td>
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<tr>
<td></td>
<td>Final Project</td>
<td>40 EC</td>
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</table>
Differences between the programs

- Electrical Engineering: Electrical (signals) and Systems
- Systems & Control: Control and Mechatronics
- Embedded Systems: Computer Engineering
# ADMISSION FOR AT

<table>
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<tbody>
<tr>
<td>RAM, BSS</td>
<td>RAM, BSS</td>
<td>Computer Systems (EE5)</td>
<td>Systems &amp; Control (EE6)</td>
<td></td>
<td>RAM, BSS</td>
<td>Computer Systems (EE5)</td>
<td>Systems &amp; Control (EE6)</td>
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<tr>
<td>TE, ICD, CAES, SCS</td>
<td>TE, ICD, CAES, SCS</td>
<td>Computer Systems (EE5)</td>
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<td>Systems &amp; Control (EE6)</td>
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<tr>
<td>DACS</td>
<td>DACS</td>
<td>Computer Systems (EE5)</td>
<td>Systems &amp; Control (EE6)</td>
<td>Computer Networks (EE7)</td>
<td>DACS</td>
<td>Computer Systems (EE5)</td>
<td>Systems &amp; Control (EE6)</td>
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<tr>
<td>EMSYS</td>
<td>Module 2.1 (CS/EE) Computer Systems</td>
<td>Module 3.2 (CS/EE) Cyber Physical Systems</td>
<td>Module 2.3 (EE) Network Systems (with C++)</td>
<td>Two of these modules</td>
<td>EMSYS</td>
<td>Module 2.1 (CS/EE) Computer Systems</td>
<td>Module 3.2 (CS/EE) Cyber Physical Systems</td>
<td>Module 2.3 (EE) Network Systems (with C++)</td>
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</table>
Further information Systems & Control

https://www.utwente.nl/en/education/master/programmes/systems-control/

Peter Breedveld, program advisor

Maarten Korsten, coordinator

Jan Willem Polderman, program director
Further information Embedded Systems


Bert Molenkamp, program coordinator

Gerard Smit, programme director
Further information Electrical Engineering

https://www.utwente.nl/en/education/master/programmes/electrical-engineering/

Maarten Korsten, coordinator

Mark Bentum, program director