



University of Stuttgart
Germany

Masters (MSc)

Medical Engineering

Exploring, Inventing
and Developing
Medical Technologies



Master`s program Medical Engineering

- This is a two year program (120 ECTS credits) mainly taught in German.
- A selection of courses is offered in English.
- Graduates are awarded the degree of Master of Science
- Exchange program with Eberhard Karl University of Tübingen

M.Sc. Medical Engineering Macrostructure

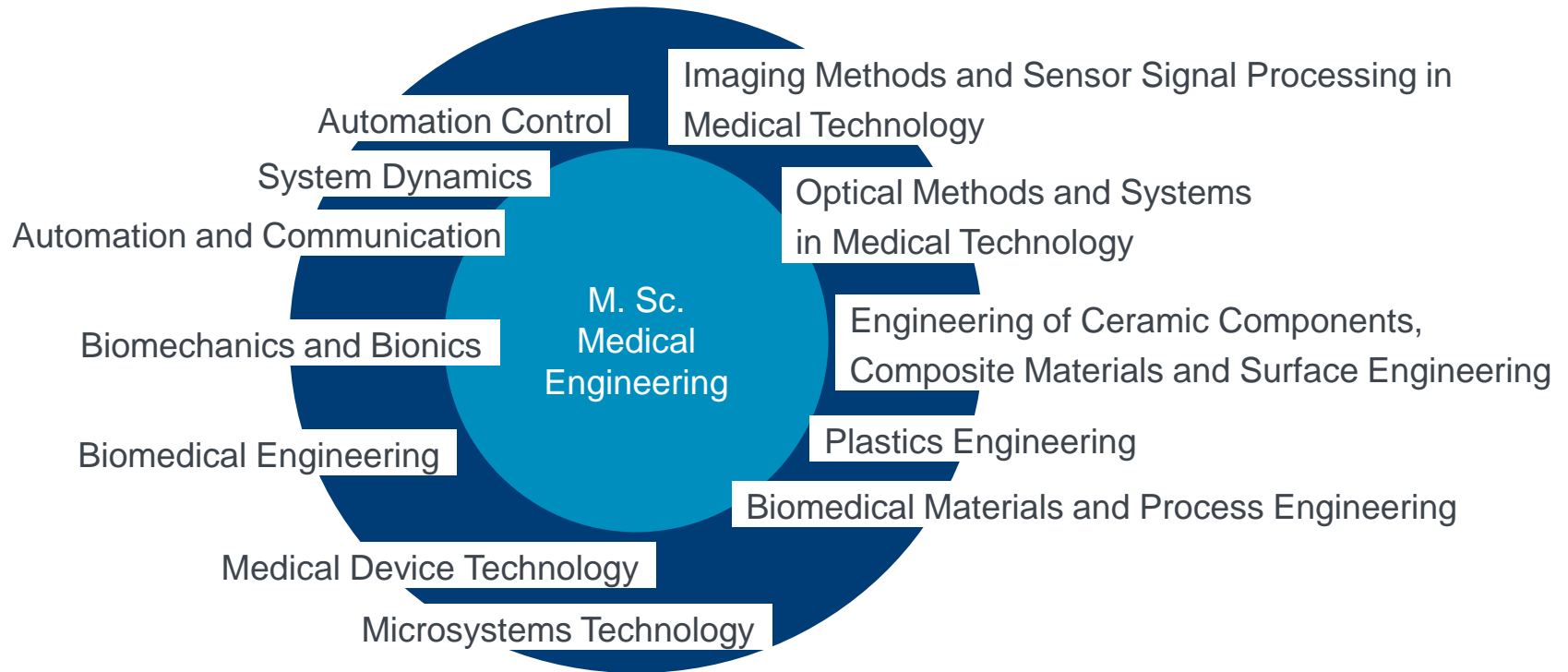
1st term	2nd term	3rd term	4th term
Advanced Modules 1 Engineering Design and Mechatronics (6 ECTS)	Advanced Modules 2 Biomaterials and Bioengineering (6 ECTS)	Industrial / clinical-technical internship (15 ECTS)	Master's Thesis Medical Engineering (30 ECTS)
Advanced Modules 3 Imaging, Measuring and Automation Technologies (6 ECTS)			
Advanced Modules 4 Advanced Engineering and Deep Learning (6 ECTS)	Key Qualification related to the subject (3 ECTS)	Industrial / clinical-technical internship (15 ECTS)	
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M.Sc. Medical Engineering

12 Specialization subjects



Specialization subject

Automation Control

Areas of study

- systems theory
- control of systems
- cyber-physical systems
- optimization



Practical course *Concepts of Control Technology*

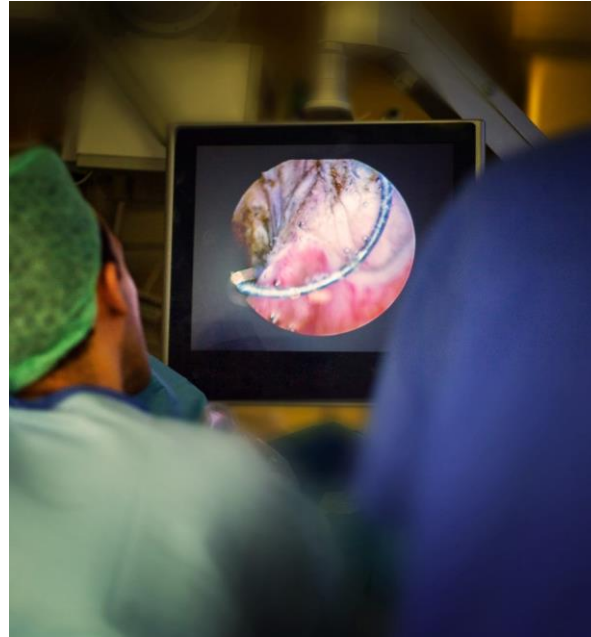
Image: Institute for Systems Theory and Automatic Control

Specialization subject

System Dynamics

Areas of study

- modeling
- simulation
- control and optimization of medical technology applications



Interoperative multisensory tissue differentiation

Image: Universitätsklinikum Tübingen

Specialization subject

Automation and Communication

Areas of study

- automation processes,
- communication and networking,
- software development,
- safety and reliability



Pill Dispenser

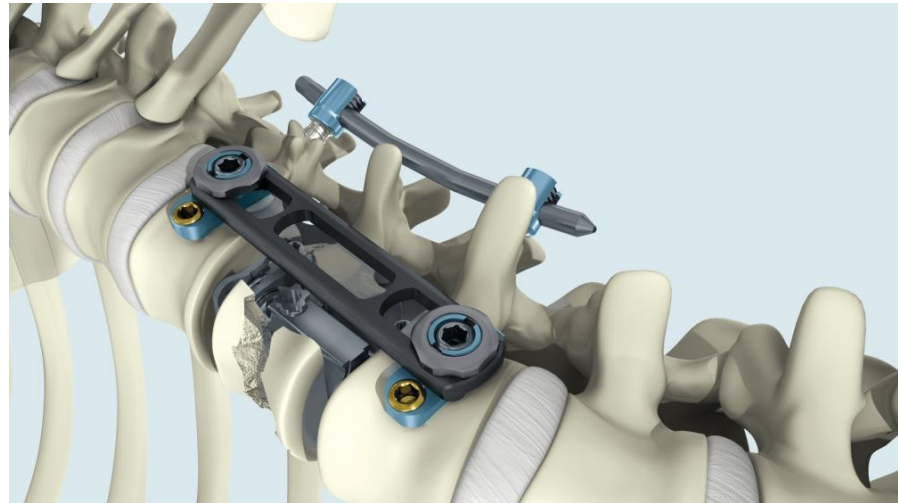
Image: Institute of Industrial Automation & Software Engineering

Specialization subject

Biomechanics and Bionics

Areas of study

- computer models,
- data science,
- continuum biomechanics,
- biorobotics and bionics



Fracture Management

Image: Institute for Modelling and Simulation of Biomechanical Systems

Specialization subject

Biomedical Engineering

Areas of study

- minimally invasive implants
- tissue engineering
- physiological signal acquisition
- medical imaging
- numerical and in-vitro models
- biofluid dynamics



Practices in the polymer laboratory

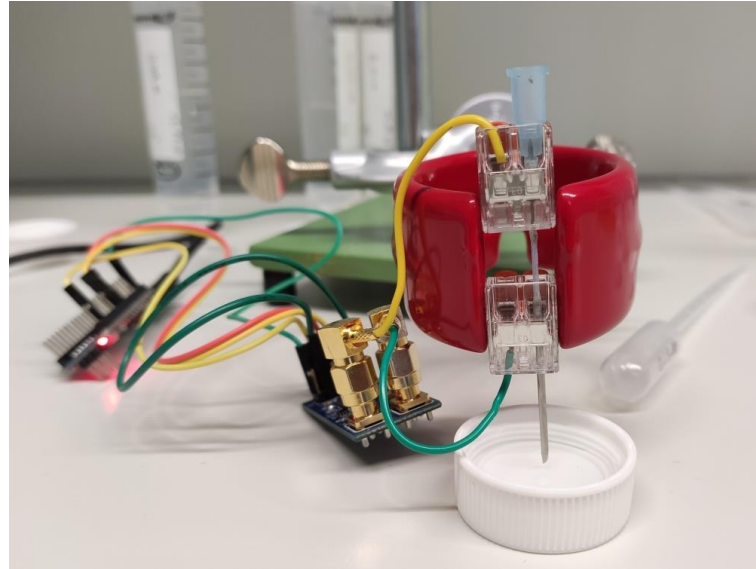
Image: Institute for Biomedical Engineering

Specialization subject

Medical Device Technology

Areas of study

- actuators
- Sensors
- electronics
- design



Electrical impedance measurement

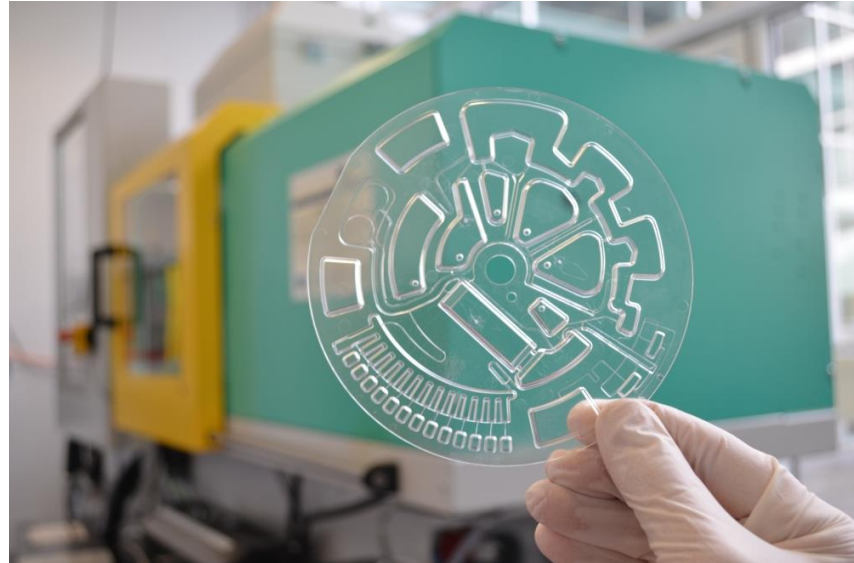
Image: Institute of Medical Device Technology

Specialization subject

Microsystems Technology

Areas of study

- microtechnology
- micromechanics
- microfluidics
- bioelectronics
- microoptics
- data processing



Microfluidics application

Image: Hahn-Schickard-Gesellschaft für angewandte Forschung

Specialization subject

Imaging Methods and Sensor Signal Processing in Medical Technology

Areas of study

- medical imaging systems
- signal processing
- artificial intelligence
- machine learning



Positron Emission Tomography (PET) images

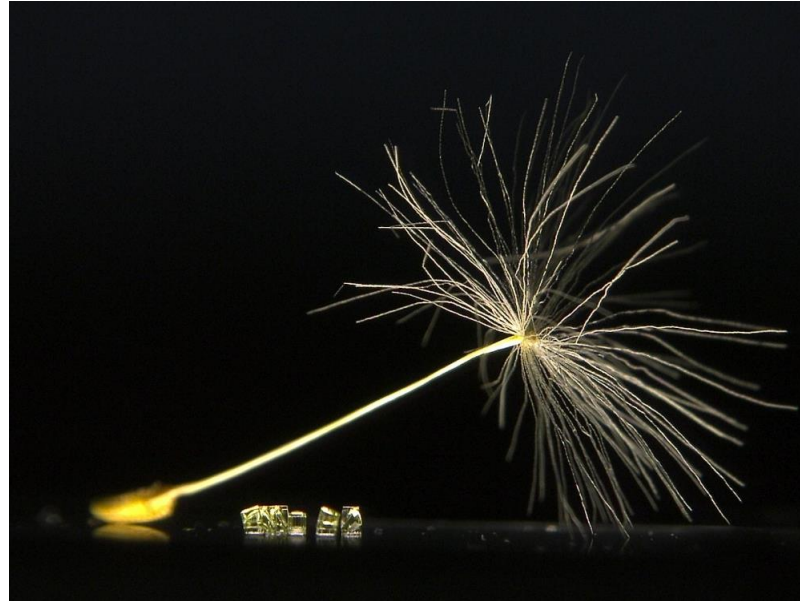
Image: University of Stuttgart, Max Kovalenko

Specialization subject

Optical Methods and Systems in Medical Technology

Areas of study

- optical systems
- manufacturing processes for optics
- optical design and simulation
- optical metrology



3D-printed Micro-Optics

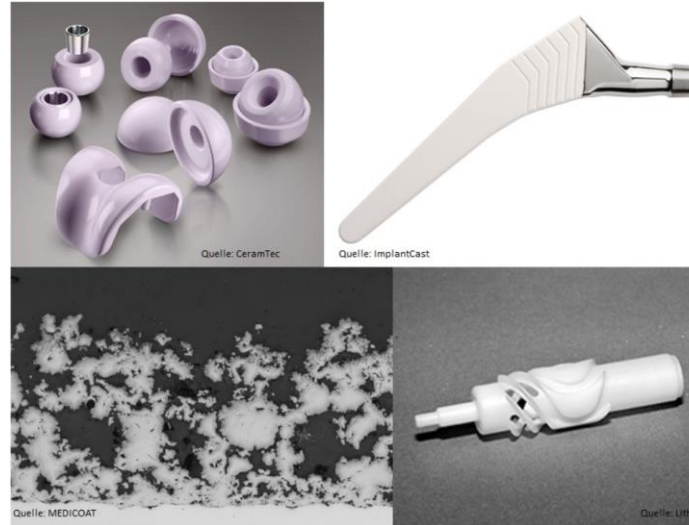
Image: Institute of Applied Optics

Specialization subject

Engineering of Ceramic Components, Composite Materials and Surfaces

Areas of study

- coatings
- fiber composites
- solid ceramic components



Coating for implants and medical products

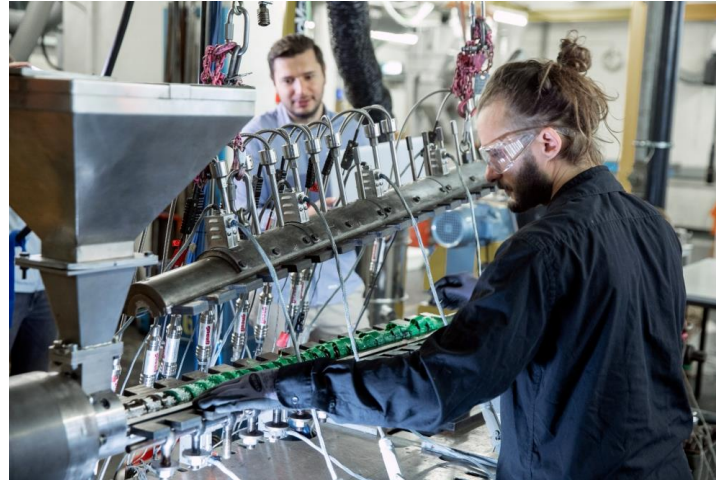
Image: Institute for Manufacturing Technologies of Ceramic Components and Composites

Specialization subject

Plastics Engineering

Areas of study

- materials and biomaterials
- production engineering
- plastic products



Twin-screw extruder for processing thermoplastics

Image: Institute of Plastics Engineering

Specialization subject

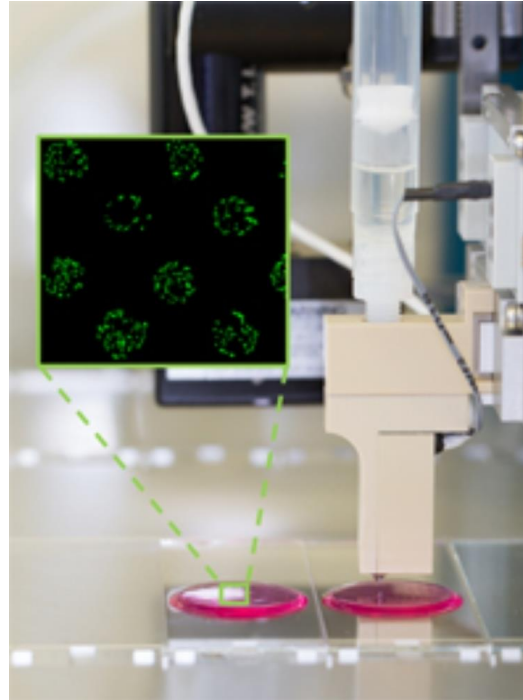
Biomedical Materials and Process Engineering

Areas of study

- additive manufacturing,
- medical textiles,
- regenerative medicine,
- artificial membranes,
- biomimetic and biobased surfaces

3D printing of hydrogels

Image: IGVP



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Advanced Modules provide scientific and engineering foundations for four fields of knowledge, which are relevant to medical engineering.

From three of these groups, students must take one subject.

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Advanced Modules can be replaced with modules from the Biomedical Technologies Master`s program at the University of Tübingen as part of a student exchange program.

Advanced Modules: Engineering Design

Exchange program



ECT	Term	ECTS
Clinical Cases and Consequences for Medical Devices	winter/ summer	6
Clinical Cases and Consequences for Medical Devices	winter/ summer	6
NanoBioAnalytics and -Physics	winter/ summer	6

Master Medical Engineering

List of lectures in English: 6 ECTS

Course Title	Term	ECTS	Institute
Models and Test Methods in Biomedical Engineering	summer	6	Biomedical Engineering
Biomedical Implant Engineering	winter	6	Biomedical Engineering
Computational Modeling of Flow in Organs and Medical Devices	summer	6	Biomedical Engineering
Applied Computational Fluid Dynamics 1	summer	6	Reactive Flows
Micro Technology and Microsystems Technology	summer	6	Micro Integration

Master Medical Engineering

List of lectures in English: 6 ECTS

Course Title	Term	ECTS	Institute
Optimal Control	winter	6	Computations in Control
Convex Optimization	winter	6	Computations in Control
Model Predictive Control	summer	6	Systems Theory and Automatic Control
Advanced Topics in Convex Optimization	summer	6	Systems Theory and Automatic Control
Biomechanics of Musculoskeletal Tissues	winter	6	Structural Mechanics and Dynamics in Aerospace Engineering
Lasers, Light Sources and Illumination Systems	winter	6	Applied Optics

M.Sc. Medical Engineering

List of lectures in English: 6 ECTS

Course Title	Term	ECTS	Institute
Medical Measurement Methods	winter	6	Medical Device Technology
Optical Signal Processing	summer	6	Display Technology
Optical Signal Processing	summer	6	Display Technology
Advanced Mathematics for Signal and Information Processing	winter	6	Network and System Technology
Deep Learning	summer	6	Network and System Technology
Detection and Pattern Recognition	summer	6	Network and System Technology
Statistical and Adaptive Signal Processing	winter	6	Network and System Technology

Master Medical Engineering

List of lectures in English: 6 ECTS

Course Title	Term	ECTS	Institute
Flat Systems	winter	6	System Dynamics
Dynamic Filtering	winter	6	System Dynamics
Introduction to Systems Biology	winter + summer	6	Systems Theory and Automatic Control
Communications II	winter	6	Telecommunications
Digital Video Communications	winter	6	Telecommunications
Model Predictive Control	summer	6	Systems Theory and Automatic Control
Nonlinear Control	summer	6	Systems Theory and Automatic Control
Robust Control	on an irregular basis	6	Mathematical Systems Theory

Master Medical Engineering

List of lectures in English: 3 ECTS

Course Title	Term	ECTS	Institute
Advanced Optical Design	on an irregular basis	3	Institute for Applied Optics Optical design and Simulation
Digital Image Processing	summer	3	Telecommunications
Neurovascular Implant Development	summer	3	Institute of Biomedical Engineering
Introduction to Neuromechanics	summer	3	Continuum Biomechanics and Mechanobiology
Introduction to Adaptive Control	winter	3	Systems Theory and Automatic Control
Models and Test Methods in Biomedical Engineering-lectures	summer	3	Institute of Biomedical Engineering
Matrix Computations in Signal Processing and Machine Learning	winter	3	Network and System Technology

Master Medical Engineering

List of lectures in English: 3 ECTS

Course Title	Term	ECTS	Institute
Project Management	winter	3	Institute of Biomedical Engineering
Risk management and statistics in medical technologies	summer	3	Institute of Biomedical Engineering

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mandatory internship

- examines the program's learning outcomes
- first step to either an academic career or to working in industry
- at an **company**, a **hospital** or at an **academic institution** in Germany or abroad

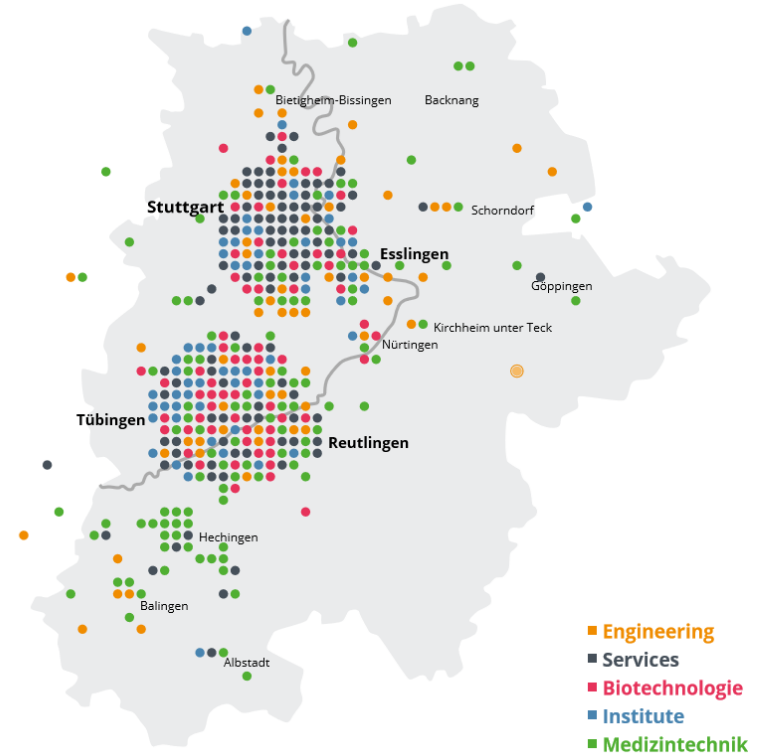
Industrial / clinical-technical internship

Industrial	Clinical-technical	Project-related
<p>Section 1</p> <ul style="list-style-type: none"> • Experimental research • Measuring, testing and quality control • Assembly technology 	<p>Section 1</p> <ul style="list-style-type: none"> • Experimental research • Measuring, testing and quality control • Project- and technical planning 	
<p>Section 2</p> <ul style="list-style-type: none"> • Operations and maintenance • Engineering design and product development • Product management • Process development 	<p>Section 2</p> <ul style="list-style-type: none"> • Operations and maintenance • Product management and logistics • Hygiene and sterile technologies • Education and training on medical devices • Clinic management 	<p>Work on a project in the field of medical engineering at a medical technology company or at a medical care facility</p>
<p>1-4 weeks in at least three areas (see internship guideline)</p>	<p>1-4 weeks in at least three areas (see internship guideline)</p>	<p>1-4 weeks in at least three areas (see internship guideline)</p>

Medical device companies in the region

Agglomeration of medical technology companies the region around the cities of Stuttgart, Tuttlingen, Reutlingen and Hechingen.

A total of over 12,000 people are employed in 140 medical technology companies in the region.



source: www.bioregio-stern.de

Professional fields and career prospects

Examples of professional fields are:

- construction of medical electronic devices and sensor systems
- development of optical systems and imaging techniques
- application-oriented research and development of medical information technologies
- development and implementation of automation and software solutions
- biomedical research in institutes, companies and clinics, regulatory affairs