Masters (MSc)

Medical Engineering

University of Stuttgart
Germany

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.

- The program is offered at the Universities of Stuttgart and Tübingen.

Structure, contents and objectives of Medical Engineering

1st term	2nd term	3rd term	4th term
Advanced Modules Engineering Design (6 ECTS)	**Advanced Modules** Information Technology, Optics and Imaging (6 ECTS)		
Advanced Modules Biomaterials and Materials Engineering (6 ECTS)			
Advanced Modules Biomechanics and Bionics (6 ECTS)	**Key competencies** (subject-related) (3 ECTS)	**Industrial / clinical-technical internship** (12 ECTS)	
	Key competencies (interdisciplinary) (3 ECTS)	**Term paper** (12 ECTS)	
Specialization Subject 1 (18 ECTS including practical training)			
Specialization Subject 2 (18 ECTS including practical training)			**Master's thesis** (30 ECTS)
Total: 30 ECTS	Total: 30 ECTS	Total: 30 ECTS	Total: 30 ECTS

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	Key competencies (interdisciplinary) (3 ECTS)	**Term paper** (12 ECTS)	
Specialization Subject 1 (18 ECTS including practical training)			
Specialization Subject 2 (18 ECTS including practical training)			**Master's thesis** (30 ECTS)
Total: 30 ECTS	Total: 30 ECTS	Total: 30 ECTS	Total: 30 ECTS

Master Medical Engineering

All courses offered in English: 6 ECTS

Course Title	Term	ECTS	Institute
Medical Measurement Methods	winter	6	Institute of Medical Device Technology
Optical Signal Processing	summer	6	Display Technology
Lasers, Light Sources and Illumination Systems	winter	6	Institute of Applied Optics
Advanced Mathematics for Signal and Information Processing	winter	6	Network and System Technology
Deep Learning	summer	6	Network and System Technology
Optical Signal Processing	summer	6	Display 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

All courses offered 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

All courses offered 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
Theoretical and practical aspects in experimental research	summer	6	Continuum Biomechanics and Mechanobiology
Advanced Topics in Convex Optimization	Summer	6	Systems Theory and Automatic Control
Models and Test Methods in Biomedical Engineering-lectures and practice	summer	6	Institute of Biomedical Engineering
Biomedical Implant Engineering	winter	6	Institute of Biomedical Engineering

Master Medical Engineering

All courses offered in English: 3 ECTS

Course Title	Term	ECTS	Institute
Advanced Optical Design	on an irregular basis	3	Optik-Design und 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

All courses offered 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

Structure, contents and objectives of Medical Engineering

1st term	2nd term	3rd term	4th term
In -Depth Modules 1 Construction (6 ECTS)	**In-Depth Modules 2** Biomaterials and Materials (6 ECTS)	Research Work (15 ECTS)	Master`s Thesis Medical Engineering (30 ECTS)
In-Depth Modules 3 Biomechanics and Bionics Choose 3 Modules from 4 In-depth Module Groups			
In-Depth Modules 4 Information Technology, Optics, and Imaging (6 ECTS)	Key Qualification related to the subject (3 ECTS)		
	Key Qualification interdisciplinary (3 ECTS)		
Specialization Subject 1 (18 ECTS, including practical training)		Industry/ Clinical/ Technical Internship (15 ECTS)	
Specialization Subject 2 (18 ECTS, including practical training)			
Total 30 ECTS	Total 30 ECTS	Total 30 ECTS	Summe: 30 LP

Selected 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

Course Title	Term	Credits
Laboratory Techniques and Medical Device Approvals I + II	winter/ summer	6
Clinical Cases and Consequences for Medical Devices I + II	winter/ summer	6
Nanoanalytics / Interfaces I + II	winter/ summer	6
Implantology + Bioimaging	winter/ summer	6
Biomedical Technologies in Diagnostic and Therapy I + II	winter/ summer	6

Structure, contents and objectives of Medical Engineering

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In-Depth Modules 3 Biomechanics and Bionics — Choose 3 Modules from 4 In-depth Module Groups			
In-Depth Modules 4 Information Technology, Optics, and Imaging (6 ECTS)	**Key Qualification** related to the subject (3 ECTS)		
	Key Qualification interdisciplinary (3 ECTS)	**Industrial / Clinical-Technical Internschip** (15 ECTS)	
Specialization Subject 1 (18 ECTS, including practical training)			
Specialization Subject 2 (18 ECTS, including practical training)			
Total 30 ECTS	Total 30 ECTS	Total 30 ECTS	Summe: 30 LP

Structure, contents and objectives of Medical Engineering

All students must complete a mandatory **internship**. The internship has two purposes:

Firstly, it is used to examine the program`s learning outcomes, ensuring that the student has acquired all necessary knowledge to become a medical engineer professionally.

Secondly, the internship should also be considered as a first step to either an academic career or to working in industry, and can therefore be completed at an **industrial company**, a **hospital** or at an **academic institution** in Germany or abroad.

Industrial / clinical-technical internship

Industrial	Clinical-technical	Project-related
Section 1 • Experimental research • Measuring, testing and quality control • Assembly technology	**Section 1** • Experimental research • Measuring, testing and quality control • Project- and technical planning	Work on a project in the field of medical engineering at a medical technology company or at a medical care facility
Section 2 • Operations and maintenance • Engineering design and product development • Product management • Process development	**Section 2** • Operations and maintenance • Product management and logistics • Hygiene and sterile technologies • Education and training on medical devices • Clinic management	
1-4 weeks in at least three areas (see internship guideline)	1-4 weeks in at least three areas (see internship guideline)	1-4 weeks in at least three areas (see internship guideline)

Medical device companies in the region

Agglomeration of medical technology companies in 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.
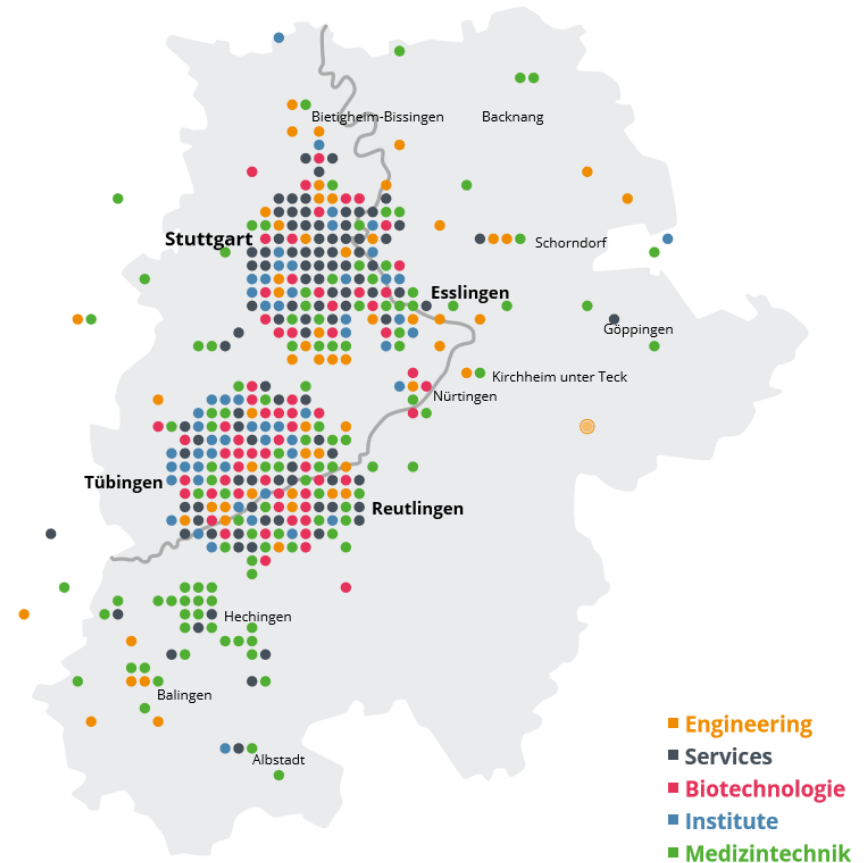
source: www.bioregio-stern.de

Legend:
- Engineering
- Services
- Biotechnologie
- Institute
- Medizintechnik

Professional fields and career prospects

- The Master's program in Medical Engineering offers **the skills** to **invent**, **develop** and **produce** medical technology in private companies, research institutes and healthcare.

- A broad set of professional skills enables graduates to work in functional areas such as technical development, sales or administrative project management.

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