EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Module Description
Master of Science in Biomedical Technologies

(01_10_2023)

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1. Qualification goals of the master course

The Biomedical Technologies master's program responds to the evergrowing need for qualified specialists within biomedical and technical field. The aim of the Master's course is to qualify for a research-related professional activity in the field of biomedical technologies. Students will acquire broad knowledge in the field of biomedical technologies, including specific knowledge in the fields of bioimaging, nanotechnology and implantology. The graduates of the master's program have trained analytical thinking and judgment as well as practical research skills and knowledge. The graduates have comprehensive theoretical and practical knowledge in many questions of medical technology.

As a graduate of the master's program, you will be able to work independently on scientifically complex issues (planning, implementation and evaluation), to analyze the validity of different methods and to apply existing knowledge and to transfer it to a new situation. As a master's graduate, you have knowledge that normally builds on the bachelor's level (see qualification goals of the B.Sc. medical technology) and that significantly deepens or expands it. They are able to define and interpret the specifics, limitations, terminologies and doctrines of their field of study. This can be done both application- or research-oriented. They have a broad, detailed and critical understanding of the latest knowledge in one or more special areas (bioimaging, nanotechnology or implantology). They are able to apply your knowledge and understanding as well as their problem-solving skills in new and unfamiliar situations, e.g. in a new working group. For example, during their studies the students are obliged to do at least two six-week internships directly related to their chosen area of specialization. They can independently acquire new knowledge and skills and are able to carry out independent research or application-oriented projects (e.g. the master's thesis) independently and/or autonomously. What is particularly noteworthy about the master's degree is that as a graduate you are able to analyze problems in the biomedical-technical field in an interdisciplinary manner. The teaching of "soft skills" such as communication, presentation techniques and project management (Medtech Innovation module), which are an integral part of many modules, also plays an important role. In addition to deepening their technical and methodological skills, the students also develop their social and communication skills so that they are able to apply different working and communication styles.
For example, this content can be found in the following modules:
Teamwork and Presentation Techniques – Medtech Innovation
Consideration of social and ecological aspects – Ethical Technology Assessment and Sustainable Development
Communication & Presentation Techniques – Clinical Cases.
In addition to the written master's thesis, an oral presentation is also planned in front of the experts and experts, in which the graduates must represent the results of their research. The research results have to be presented in English in writing and orally.
These qualification goals of the Biomedical Technologies master's program are specified at the level of the modules (see specific learning goals in the module handbook)

Qualification Goals
With reference to the “SPIRiT” teaching concept, the Medical Faculty of Tübingen pursues practical and research-oriented teaching in its courses with regard to the desired acquisition of skills by the students.

In particular, future graduates of the M.Sc. Biomedical Technologies has the following competencies:

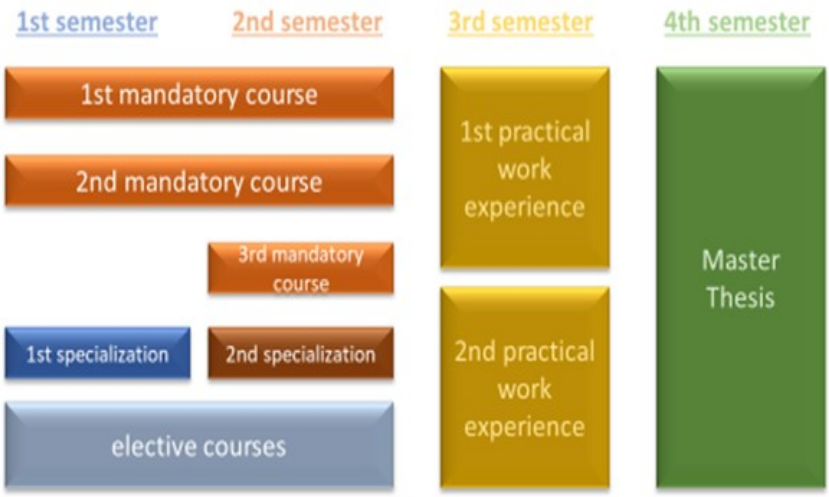
- They are able to apply knowledge in the field of biomedical technologies and their methods in practice, to question them critically and also to transfer them to related disciplines (basic knowledge and research skills)
- They have the competence to do literature research independently and to collect information in the area mentioned. They have the ability to interpret of research results and to develop solutions.
- They have problem-solving skills with regard to the current technical and digital challenges
- They are able to apply the knowledge about the current state of research they have acquired in new situations or to practical problems in unfamiliar contexts and to exchange information on a subject-related basis (knowledge transfer, practice-oriented problem-solving skills)
- They are able to work in interdisciplinary teams and communicate problems between medical and technical specialists (interdisciplinary communication competence). They can also describe the technical problems in an understandable way (e.g. patients).
- They have the skills to deal with technical problems and to meet complex challenges in order to successfully carry out projects in the field of biomedical technologies independently
- They can reflect on your own actions in the framework ethical principles

Special professional qualification goals are the following:

- They are able to evaluate methods and basic knowledge in the field of biomedical technologies and to develop new projects based on them
- They have in-depth knowledge in the specialization areas and extensive knowledge of the methods applied
- They are able to expand their methodological knowledge independently and to incorporate the relevant knowledge into new projects

2. Curriculum

2.1 Overview by Study Progress



2.2 Overview by Study Modules

The program for *Biomedical Technologies* with Specialization in Implantology, Nanoanalytics/Interfaces and Bioimaging consists of the following modules:

Module No.	Module Name	ECTS
	Mandatory courses	
AM1	***Biomedical Technologies in Diagnostic and Therapy I and II***	6
AM2	***Laboratory Techniques and Medical Device Approvals I and II***	6
AM3	***Clinical cases and Consequences for Medical Devices***	6
	Specialization areas (2 out of 3 specializations Implantology, Bioimaging and Nanoanalytics/Interfaces including for each specialization Lecture, Seminar and Labwork (15 ECTS in total) have to be chosen). ***Practical work experiences and master thesis can also be completed in industry or abroad and have to be performed within the selected specialization areas.***	
AS4	***Bioimaging***	15
AS4.1	***Bioimaging – Lecture and Seminar***	6
AS4.2	***Bioimaging – Labwork***	9
AS5	***Bioimaging – Practical work experience***	15
AS6	***Nanoanalytics/Interfaces I***	15
AS6.1	***Nanoanalytics/Interfaces I – Lecture and Seminar***	6
AS6.2	***Nanoanalytics/Interfaces I – Labwork***	9
AS7	***Implantology***	15
AS7.1	***Implantology – Lecture and Seminar***	6
AS7.2	***Implantology – Labwork***	9
AS8	***Implantology – Practical work experience***	15
AS9	***Nanoanalytics/Interfaces II***	15
AS9.1	***Nanoanalytics/Interfaces II – Lecture and Seminar***	6
AS9.2	***Nanoanalytics/Interfaces II – Labwork***	9
AS10	***Nanoanalytics/Interfaces – Practical work experience***	15
	Elective courses (Lectures and Seminars comprising 12 ECTS in total have to be chosen: either from another specialization area, from the Master program Medical Radiation Sciences or from the Master program Medical engineering at the University of Stuttgart.)	

AS4.1	***Bioimaging – Lecture and Seminar***	6
AS6.1	***Nanoanalytics/Interfaces I – Lecture and Seminar***	6
AS7.1	***Implantology – Lecture and Seminar***	6
AS9.1	***Nanoanalytics/Interfaces II – Lecture and Seminar***	6
AE11	***Aktorik in der Gerätetechnik***	6
AE12	***Technologien der medizinischen Bildgebung und Labordiagnostik***	3
AE13	***Interface-Design***	6
AE14	***Grundlagen der Keramik und Verbundwerkstoffe***	6
AE15	***Nanotechnologie I – Chemie und Physik der Nanomaterialien***	3
AE16	***Nanotechnologie II – Technische Prozesse und Anwendungen***	3
AE17	***Optische Systeme in der Medizintechnik***	6
BM5.1	***Physik und Technologie der medizinischen Strahlenanwendung – Vorlesung***	3
BM8	***Biostatistik/Biostatistics***	6
BM12.1	***Nuklearmedizin, diagnostische und interventionelle Radiologie, Strahlentherapie – Vorlesung***	3
BM 15	***NanoBioPhysics and scanning probe microscopy***	3
BM17	***Ethical and Social Aspects of Biomedical Technolgoies***	3
BM 18	***MEDTEC Innovation***	9
BM 21	**MRI-applications for neuroscientific and clinical research**	3
E 16	**Medical Technology Aspects of Cardiovascular Medicine**	3
BM 14	***Python***	6
AMT12	***Master Thesis***	30

3. Module Descriptions

<table>
<tr><td>module number:
AM1</td><td colspan="3">title of the module:
Biomedical Technologies in Diagnostic and Therapy I and II</td><td>nature of the module:
compulsory</td></tr>
<tr><td>credit points</td><td colspan="4">6 CP</td></tr>
<tr><td>work load
- contact hours (SWS)
- self study</td><td colspan="4">Total: 180 h
contact hours: 60 h (2 SWS per semester)
self study (preparation for exams included): 120 h</td></tr>
<tr><td>duration of the module</td><td colspan="4">2 semesters</td></tr>
<tr><td>time schedule (winter/summer term)</td><td colspan="4">The module is offered once per year starting with lecture I in the winter term.</td></tr>
<tr><td>language (English/German)</td><td colspan="4">English</td></tr>
<tr><td>maximum/minimum number of participants</td><td colspan="4">Minimum: 5</td></tr>
<tr><td>module structure /teaching methods</td><td colspan="4">lecture (4 SWS)</td></tr>
<tr><td>contents</td><td colspan="4"><u>Thematic focus:</u>
Heart-lung machine, artifical respiration, anaesthetic technique, computer-assisted surgery, electromedical technique, electronic implants, rehabilitation technology, biocompatible prosthesis, biomedical laser applications</td></tr>
<tr><td>objectives</td><td colspan="4">The course provides important and up-to-date knowledge of different biomedical technologies.
After completion of this module, students will be able to understand the state-of-the-art technologies, modern methodologies and open questions in selected fields of biomedical technologies.</td></tr>
<tr><td rowspan="3">Requirements for credit points / exams and grading scheme (where appropriate, weighting)</td><td>course</td><td>exam</td><td>Grading scheme</td><td>weighting</td></tr>
<tr><td>Biomedical Technologies in Diagnostic and Therapy I</td><td>Written exam</td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>Biomedical Technologies in Diagnostic and Therapy II</td><td>Written exam</td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>applicability</td><td colspan="4">M.Sc. in Biomedical Technologies (mandatory course) and M.Sc. in Medizinische Strahlenwissenschaften/Medical Radiation Sciences (elective course)</td></tr>
<tr><td>recommended semester</td><td colspan="4">1st and 2nd semester</td></tr>
<tr><td>participation requirements</td><td colspan="4">B.Sc. degree</td></tr>
<tr><td>person responsible for the module</td><td colspan="4">Schenk, Martin, PD Dr.
Martin.schenk@med.uni-tuebingen.de</td></tr>
<tr><td>literature / teaching materials</td><td colspan="4">Texts and books will be announced at the beginning of term.</td></tr>
</table>

<table>
<tr><td>module number:
AM2</td><td colspan="3">title of the module:
Laboratory Techniques and Medical Device Approvals I and II</td><td>nature of the module:
compulsory</td></tr>
<tr><td>credit points</td><td colspan="4">6 CP</td></tr>
<tr><td>work load
- contact hours (SWS)
- self study</td><td colspan="4">Total: 180 h
contact hours: 60 h (2 SWS per semester)
self study (preparation for exams included): 120 h</td></tr>
<tr><td>duration of the module</td><td colspan="4">2 Semesters</td></tr>
<tr><td>time schedule (winter/summer term)</td><td colspan="4">The module is offered once per year starting with lecture I in the winter term.</td></tr>
<tr><td>language (English/German)</td><td colspan="4">English</td></tr>
<tr><td>maximum/minimum number of participants</td><td colspan="4">Minimum: 5</td></tr>
<tr><td>module structure /teaching methods</td><td colspan="4">lecture (4 SWS)</td></tr>
<tr><td>contents</td><td colspan="4"><u>Thematic focus:</u>
- Molecular biology, cell culture, DNA, RNA and protein isolation, molecular interactions, surface refinement, opt. spectroscopy, microsystems engineering, lab-on-a-chip, live cell imaging, FACS, electron microscopy
- research methodologies, experimental design
- regulatory affairs and patents</td></tr>
<tr><td>objectives</td><td colspan="4">The course provides important and up-to-date knowledge of different laboratory techniques and medical device approvals in biomedical technologies.
After completion of this module, students will be able to understand the state-of-the-art technologies, modern methodologies and open questions in selected fields of regulatory affairs.</td></tr>
<tr><td rowspan="3">Requirements for credit points / exams and grading scheme (where appropriate, weighting)</td><td>course</td><td>exam</td><td>Grading scheme</td><td>weighting</td></tr>
<tr><td>Laboratory Techniques and Medical Device Approvals I</td><td>Written exam</td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>Laboratory Techniques and Medical Device Approvals II</td><td>Written exam</td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>applicability</td><td colspan="4">M.Sc. in Biomedical Technologies (mandatory course) and M.Sc. in Medizinische Strahlenwissenschaften/Medical Radiation Sciences (elective course)</td></tr>
<tr><td>recommended semester</td><td colspan="4">1st and 2nd semester</td></tr>
<tr><td>participation requirements</td><td colspan="4">B.Sc. degree</td></tr>
<tr><td>person responsible for the module</td><td colspan="4">Schenke-Layland, Katja, Prof. Dr.
katja.schenke-layland@med.uni-tuebingen.de</td></tr>
</table>

literature / teaching materials	Texts and books will be announced at the beginning of term.

module number: AM3	**title of the module:** *Clinical cases and Consequences for Medical Devices*			**nature of the module:** compulsory
credit points	6 CP			
work load **- contact hours (SWS)** **- self study**	Total: 180 h contact hours: 60 h (2 SWS per semester) self study (preparation for exams included): 120 h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year starting with lecture I in the winter term.			
language (English/German)	English			
maximum/minimum number of participants	Minimum: 5			
module structure /teaching methods	lecture (4 SWS)			
contents	<u>Thematic focus:</u> One important clinical case (patient) / lecture - necessary therapy, e.g. necessary medical device - consequences for the medical device			
objectives	The course provides important and up-to-date knowledge of different clinical cases, the medical indications and the application of medical devices. After completion of this module, students will be able to understand the most important clinical cases and evaluate the consequences, limitations and chances for medical devices.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Clinical Cases and Consequences for Medical Devices I and II	Written exam	1-5	6 ECTS
applicability	M.Sc. in Biomedical Technologies (mandatory course) and M.Sc. in Medizinische Strahlenwissenschaften/Medical Radiation Sciences (elective course)			
recommended semester	2nd semester			
participation requirements	B.Sc. degree			
person responsible for the module	Gharabaghi, Alireza, Prof. Dr. med.			
literature / teaching materials	Texts and books will be announced at the beginning of term. There is no general script.			

<table>
<tr><th>module number:
AS4.1</th><th colspan="3">title of the module:
Bioimaging – Lecture and Seminar</th><th>nature of the module:
specialization</th></tr>
<tr><td>credit points</td><td colspan="4">6 CP</td></tr>
<tr><td>work load
- contact hours (SWS)
- self study</td><td colspan="4">Total: 180 h
contact hours: 56 h
self study (preparation for exams included): 124 h</td></tr>
<tr><td>duration of the module</td><td colspan="4">1 semester</td></tr>
<tr><td>time schedule (winter/summer term)</td><td colspan="4">The module is offered once per year in the first half of the winter term as block course</td></tr>
<tr><td>language (English/German)</td><td colspan="4">English</td></tr>
<tr><td>maximum/minimum number of participants</td><td colspan="4">Seminar: max.: 20</td></tr>
<tr><td>module structure /teaching methods</td><td colspan="4">lecture and seminar (4 SWS)</td></tr>
<tr><td>contents</td><td colspan="4"><u>Thematic focus:</u>
- Image Correction
- Functional MRI
- Hyperpolarized MRI
- Principles of Combined PET/MR Imaging
- Basics of Image Reconstruction
- Imaging and Metabolomics (MRI, NMR)
- Advanced Tracer development and production
- MR Angiography
- Research in Radiochemistry
- Pharmacological Modelling</td></tr>
<tr><td>objectives</td><td colspan="4">Students
- get functional and methodical based competences
- get theoretical knowledge about setup of experiments concerning special topics in Neurology, oncology, immunology and other diseases
- learn about preparation of patients and rodents before the measurements, setup of measurements for certain needs and topics
- gain insights into the image analysis tools in preclinical and clinical implementation</td></tr>
<tr><td rowspan="3">Requirements for credit points / exams and grading scheme (where appropriate, weighting)</td><td>course</td><td>exam</td><td>Grading scheme</td><td>weighting</td></tr>
<tr><td>Lecture</td><td>Written/oral exam</td><td>70-100%, <70% failed</td><td>3 ECTS</td></tr>
<tr><td>Seminar</td><td>Oral presentation (30 min presentation + 15 min discussion)</td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>applicability</td><td colspan="4">M.Sc. in Biomedical Technologies (specialization and elective course) and M.Sc. in Medizinische Strahlenwissenschaften/Medical Radiation Sciences (elective course) and elective course for students of M.Sc. Medical Engineering Univ. of Stuttgart), required for modules AS4.2 and AS5</td></tr>
</table>

recommended semester	1st semester
participation requirements	B.Sc. degree
person responsible for the module	Calaminus, Carsten, Dr. rer. nat. Carsten.calaminus@med.uni-tuebingen.de
literature / teaching materials	Texts and books will be announced at the beginning of term.

module number: AS4.2	**title of the module:** *Bioimaging – Labwork*			**nature of the module:** specialization
credit points	9 CP			
work load **- contact hours (SWS)** **- self study**	Total: 270 h contact hours: 90 h self study (preparation for exams included): 180 h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year in the winter term as block course.			
language (English/German)	English			
maximum/minimum number of participants	Maximum: 16 Minimum: 3			
module structure /teaching methods	Practical Training and Seminar (6 SWS)			
contents	<u>Thematic focus:</u> - Clinical application of PET and MRI, PET/MR application, imaging of special diseases - Clinical application of CT and US, deeper insight into clinical topics - Physics and technologies used in the nuclear medicine - Image acquisition methods in preclinical imaging (MRI, OI, PET, SPECT/CT): design for special experiments in clinic and preclinical setup and scanning of rodents - Clinical and Preclinical Application and Drawbacks of different MRI sequences - Research in Radiochemistry - Advanced Tracer development and production			
objectives	Students - Gain functional and practical competences of the application of the imaging methods - are part of practical demonstrations in preclinical imaging including hands-on experiences - learn animal handling procedures in preclinical imaging according to the animal protection laws - Gain practical competences in detector physics - Learn the analysis of images in clinical and preclinical studies - Gain competences to work on the clinical setup of the scanners			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Labwork	4 Experimental protocols	1-5	9 ECTS
applicability	M.Sc. in Biomedical Technologies (specialization course), required for module AS5			
recommended semester	1st semester			
participation requirements	B.Sc. degree and successful completion of module AS4.1			

person responsible for the module	Calaminus, Carsten, Dr. rer. nat. Carsten.calaminus@med.uni-tuebingen.de
literature / teaching materials	Texts and books will be announced at the beginning of term.

module number: AS5	**title of the module:** *Bioimaging – Practical work experience*			**nature of the module:** specialization
credit points	15 CP			
work load **- contact hours (SWS)** **- self study**	Total: 450 h = 15 ECTS			
duration of the module	University Lab: min. 6 weeks and max. 6 months Industry: min. 3 months and max. 6 months			
time schedule (winter/summer term)	The module is offered once per year in the winter term as block course			
language (English/German)	english			
maximum/minimum number of participants	Maximum: 8 Minimum: 1			
module structure /teaching methods	Practical Training			
contents	The Labwork contains a special topic which the student has to work on in theory and practice under the supervision of a scientist or medical doctor.			
objectives	The aim of the labwork is that the student develops his research skills to an independent level. After the student has learned the skills for setting up experiments and analysing the data the student should work on his own under the supervision of the scientist/medical doctor in charge. Based on this research the student should finish his/her project and write a protocol as well as give a talk. The idea of the labwork is to give the student the best preparation he/she can get for his/her master´s thesis as well as to provide the student a deeper insight into the bioimaging field.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Practical Training	Written report about the internship (10-15 pages, Arial 12, single-spaced)	1-5	15 ECTS
applicability	M.Sc. in Biomedical Technologies (specialization course), recommended for master´s thesis in bioimaging			
recommended semester	3rd semester			
participation requirements	B.Sc. degree, passed semester 1 and 2, and successful completion of module AS4.1 and AS4.2			
person responsible for the module	Calaminus, Carsten, Dr. rer. nat. Carsten.calaminus@med.uni-tuebingen.de			
literature / teaching materials				

<table>
<tr><th>module number:
AS6.1</th><th colspan="3">title of the module:
Nanoanalytics/Interfaces I – Lecture and Seminar</th><th>nature of the module:
specialization</th></tr>
<tr><td>credit points</td><td colspan="4">6 CP</td></tr>
<tr><td>work load
- contact hours (SWS)
- self study</td><td colspan="4">Total: 180 h
contact hours: 60 h
self study (preparation for exams included): 120 h</td></tr>
<tr><td>duration of the module</td><td colspan="4">1 semester</td></tr>
<tr><td>time schedule (winter/summer term)</td><td colspan="4">The module is offered once per year in the winter term</td></tr>
<tr><td>language (English/German)</td><td colspan="4">English</td></tr>
<tr><td>maximum/minimum number of participants</td><td colspan="4">Lecture: Maximum: 24; Minimum: 3
Seminar : Maximum: 8; Minimum: 3</td></tr>
<tr><td>module structure /teaching methods</td><td colspan="4">Nanoanalytics Lecture (2 SWS) and
Nanoanalytics Seminar (2 SWS)</td></tr>
<tr><td>contents</td><td colspan="4"><u>Thematic focus:</u>
- Introduction to statistical physics, soft matter and polymer physics, mechanics of cells and tissues, physics of the cytoskeleton, cellular forces, motor proteins, methods in nanobiophysics, high resolution microscopy techniques, micro- and nanofluidics, lab-on-a-chip technology
- Discussion of current research topics in the field of nanotechnology for medical applications</td></tr>
<tr><td>objectives</td><td colspan="4">Students
- are familiar with the basics of nanoanalytics and biophysics
- Independently study a scientific research topic and present it in the form of an oral seminar talk</td></tr>
<tr><td rowspan="3">Requirements for credit points / exams and grading scheme (where appropriate, weighting)</td><td>course</td><td>exam</td><td>Grading scheme</td><td>weighting</td></tr>
<tr><td>Nanoanalytics Lecture</td><td>Written/oral exam
Oral presentation (30 min presentation + 15 min discussion)</td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>Nanoanalytics Seminar</td><td></td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>applicability</td><td colspan="4">M.Sc. in Biomedical Technologies (specialization and elective course) and M.Sc. in Medizinische Strahlenwissenschaften/Medical Radiation Sciences (elective course) and elective course for students of M.Sc. Medical Engineering Univ. of Stuttgart. For elective courses only the lecture is applicable.</td></tr>
<tr><td>recommended semester</td><td colspan="4">1st semester</td></tr>
<tr><td>participation requirements</td><td colspan="4">B.Sc. degree</td></tr>
<tr><td>person responsible for the module</td><td colspan="4">Schäffer, Tilman, Prof., Dr. rer. nat.</td></tr>
<tr><td>teaching staff</td><td colspan="4">Rheinlaender, Johannes, PD, Dr. rer. nat.</td></tr>
<tr><td>literature / teaching</td><td colspan="4">Literature will be announced at the beginning of term.</td></tr>
</table>

materials	

module number: AS6.2 (Veranstaltungsnummer wird zugeteilt)	**title of the module:** *Nanoanalytics/Interfaces I – Labwork*	**nature of the module:** specialization

credit points	9 CP
work load **- contact hours (SWS)** **- self study**	Total: 270 h contact hours: 90 h self study (preparation for exams included): 180 h
duration of the module	1 semester
time schedule (winter/summer term)	The module is offered once per year in the winter term
language (English/German)	English
maximum/minimum number of participants	Maximum: 8 Minimum: 3
module structure /teaching methods	Practical Training (6 SWS)
contents	<u>Thematic focus:</u> Planning, execution, analysis and discussion of practical experiments: - optical lithography - light microscopy - electron microscopy - scanning probe microscopy - neurotransmitter detection - scattering techniques - protein crystallization
objectives	Students - are familiar with independent practical work with selected experimental methods in nanoanalytics / interfaces

Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Practical Training	4 Experimental protocols	1-5	9 ECTS

applicability	M.Sc. in Biomedical Technologies (specialization course), required for module AS10
recommended semester	1st semester
participation requirements	B.Sc. degree
person responsible for the module	Schäffer, Tilman, Prof., Dr. rer. nat.
teaching staff	Fleischer, Monika, Prof., Dr. rer. nat. Meyer, Jannik, Prof. Dr. rer. nat. Rheinlaender, Johannes, PD, Dr. rer. nat. Schäffer, Tilman, Prof., Dr. rer. nat. Schreiber, Frank, Prof., Dr. rer. nat.

literature / teaching materials	Literature will be announced at the beginning of term.

<table>
<tr><td>module number:
AS7.1</td><td colspan="3">title of the module:
Implantology – Lecture and Seminar</td><td>nature of the module:
specialization</td></tr>
<tr><td>credit points</td><td colspan="4">6 CP</td></tr>
<tr><td>work load
- contact hours (SWS)
- self study</td><td colspan="4">Total: 180 h
contact hours: 60 h
self study (preparation for exams included): 120 h</td></tr>
<tr><td>duration of the module</td><td colspan="4">1 semester</td></tr>
<tr><td>time schedule (winter/summer term)</td><td colspan="4">The module is offered once per year in the summer term as block course</td></tr>
<tr><td>language (English/German)</td><td colspan="4">English</td></tr>
<tr><td>maximum/minimum number of participants</td><td colspan="4">Lecture: max.: 50
Seminar: max.: 20</td></tr>
<tr><td>module structure /teaching methods</td><td colspan="4">lectures and seminars (4 SWS)</td></tr>
<tr><td>contents</td><td colspan="4"><u>Thematic focus:</u>
- Vital implants: Tissue engineering, cell biology, biomaterials, reactor technology
- Avital implants: Interface between tissue and man-made materials, signal acquisition and processing, biostability, biocompatibility, operational procedures, design and use in clinical trials</td></tr>
<tr><td>objectives</td><td colspan="4">Students
- Vital implants: Detailed knowledge of extracellular matrix components (focus on collagen and elastic fibres), properties of biomaterials, reading and review of current literature, presentation and documentation of own data
- Avital implants: An understanding of the coupling and interaction between technical implants and tissue, material and bio-compatibility, rejection, knowledge about the transmission of electrical signals and the passivation of surfaces and technical body parts of all kinds, principles of sensory and motor function</td></tr>
<tr><td rowspan="3">Requirements for credit points / exams and grading scheme (where appropriate, weighting)</td><td>course</td><td>exam</td><td>Grading scheme</td><td>weighting</td></tr>
<tr><td>Lecture</td><td>Written/oral exam</td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>Seminar</td><td>Oral presentation (30 min presentation + 15 min discussion)</td><td>1-5</td><td>3 ECTS</td></tr>
<tr><td>applicability</td><td colspan="4">M.Sc. in Biomedical Technologies (specialization and elective course) and M.Sc. in Medizinische Strahlenwissenschaften/Medical Radiation Sciences (elective course) and elective course for students of M.Sc. Medical Engineering Univ. of Stuttgart), required for modules AS7.2 and AS8</td></tr>
<tr><td>recommended semester</td><td colspan="4">2nd semester</td></tr>
<tr><td>participation requirements</td><td colspan="4">Successful completion of a Bachelor degree in Medical Technologies, or equivalent</td></tr>
</table>

person responsible for the module	Schenke-Layland, Katja, Prof., Dr. rer. nat. Katja.schenke-layland@med.uni-tuebingen.de
literature / teaching materials	Texts and books will be announced at the beginning of term.

module number: AS7.2 (Veranstaltungsnummer wird zugeteilt)	**title of the module:** *Implantology – Labwork*			**nature of the module:** specialization
credit points	9 CP			
work load **- contact hours (SWS)** **- self study**	Total: 270 h contact hours: 90 h self study (preparation for exams included): 180 h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year in the summer term			
language (English/German)	English			
maximum/minimum number of participants	Maximum: 16 Minimum: 3			
module structure /teaching methods	Practical Training			
contents	<u>Thematic focus:</u> - Vital implants: Tissue engineering, cell biology, biomaterials, reactor technology - Avital implants: Interface between tissue and man-made materials, signal acquisition and processing, biostability, biocompatibility, operational procedures, design and use in clinical trials			
objectives	Students - Vital implants: Cell and tissue culture techniques, properties of biomaterials, cell and tissue analysis for characterization, bioreactor technology, creating reports - Avital implants: Design and use of electronic implants (e.g. hearing implants, visual implants, brain stimulation) and endoprosthetic construction (e.g. femoral heads) for mechanics and movement, structural substitutes (breast implants, stents), surgical procedures			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Practical Training	4 Experimental protocols	1-5	9 ECTS
applicability	M.Sc. in Biomedical Technologies (specialization course), required for module AS8			
recommended semester	2nd semester			
participation requirements	Successful completion of a Bachelor degree in medical technologies, or equivalent and successful completion of module AS7.1			
person responsible for the module	Schenke-Layland, Katja, Prof., Dr. rer. nat. Katja.schenke-layland@med.uni-tuebingen.de			
literature / teaching materials	Texts and books will be announced at the beginning of term			

module number: AS8 (Veranstaltungsnummer wird zugeteilt)	**title of the module:** *Implantology – Practical work experience*			**nature of the module:** specialization
credit points	15 CP			
work load **- contact hours (SWS)** **- self study**	Total: 450 h			
duration of the module	University Lab: min. 6 weeks and max. 6 months Industry: min. 3 months and max. 6 months			
time schedule (winter/summer term)	The module is offered once per year in the summer and winter term as block course			
language (English/German)	english			
maximum/minimum number of participants	Maximum: 16 Minimum: 1			
module structure /teaching methods	Practical Training (10 SWS)			
contents	Vital implants: Tissue engineering, cell biology, biomaterials, reactor technology Avital implants: Interface between tissue and man-made materials, signal acquisition and processing, biostability, biocompatibility, operational procedures, design and use in clinical trials			
objectives	Vitale implants: Cell and tissue culture techniques, properties of biomaterials, cell and tissue analysis for characterization, bioreactor technology, creating reports Avital implants: Design and use of electronic implants (e.g. hearing implants, visual implants, brain stimulation) and endoprosthetic construction (e.g. femoral heads) for mechanics and movement, structural substitutes (breast implants, stents), surgical procedures			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Practical Training	Written report about the internship (10-15 pages, Arial 12, single-spaced)	1-5	15 ECTS
applicability	M.Sc. in Biomedical Technologies (specialization course), recommended for master´s thesis in implantology			
recommended semester	3rd semester			
participation requirements	Successful completion of a Bachelor degree in medical technologies, or equivalent, 2 passed specialization blocks and successful completion of module AS7.1 and AS7.2			
person responsible for the module	Schenke-Layland, Katja, Prof., Dr. rer. nat. Katja.schenke-layland@med.uni-tuebingen.de			
literature / teaching materials	Texts and books will be announced at the beginning of term			

<table>
<tr><td>module number:
AS9.1
(Veranstaltungsnummer wird zugeteilt)</td><td colspan="4">title of the module:
Nanoanalytics/Interfaces II – Lecture and Seminar</td><td>nature of the module:
specialization</td></tr>
<tr><td>credit points</td><td colspan="5">6 CP</td></tr>
<tr><td>work load
- contact hours (SWS)
- self study</td><td colspan="5">Total: 180 h
contact hours: 60 h
self-study (preparation for exams included): 120 h</td></tr>
<tr><td>duration of the module</td><td colspan="5">1 semester</td></tr>
<tr><td>time schedule (winter/summer term)</td><td colspan="5">The module is offered once per year in the summer term</td></tr>
<tr><td>language (English/German)</td><td colspan="5">english</td></tr>
<tr><td>maximum/minimum number of participants</td><td colspan="5">Lecture: Maximum: 24; Minimum: 3
Seminar: Maximum: 8; Minimum: 3</td></tr>
<tr><td>module structure /teaching methods</td><td colspan="5">Nanoanalytics Lecture (2 SWS) and
Nanoanalytics Seminar (2 SWS)</td></tr>
<tr><td>contents</td><td colspan="5"><u>Thematic focus:</u>
- Introduction to statistical physics, soft matter and polymer physics, mechanics of cells and tissues, physics of the cytoskeleton, cellular forces, motor proteins, methods in nanobiophysics, high resolution microscopy techniques, lab-on-a-chip technology
- Discussion of current research topics in the field of nanotechnology for medical applications</td></tr>
<tr><td>objectives</td><td colspan="5">Students
- are familiar with the fundamentals of nanoanalytics and biophysics
- study independently a scientific research topic and present it in the form of an oral seminar talk</td></tr>
<tr><td rowspan="2">Requirements for credit points / exams and grading scheme (where appropriate, weighting)</td><td>course</td><td colspan="2">exam</td><td>Grading scheme</td><td>weighting</td></tr>
<tr><td>Nanoanalytics Lecture

Nanoanalytics Seminar</td><td colspan="2">Written/oral exam

Oral presentation (30 min presentation + 15 min discussion)</td><td>1-5

1-5</td><td>3 ECTS

3 ECTS</td></tr>
<tr><td>applicability</td><td colspan="5">M.Sc. in Biomedical Technologies (specialization and elective course) and M.Sc. in Medizinische Strahlenwissenschaften/Medical Radiation Sciences (elective course) and elective course for students of M.Sc. Medical Engineering Univ. of Stuttgart), required for module AS10. For elective courses only the lecture is applicable.</td></tr>
<tr><td>recommended semester</td><td colspan="5">2nd semester</td></tr>
</table>

participation requirements	B.Sc. degree
person responsible for the module	Schäffer, Tilman, Prof., Dr. rer. nat.
teaching staff	Rheinlaender, Johannes, PD, Dr. rer. nat.
literature / teaching materials	Literature will be announced at the beginning of term.

module number: AS9.2 (Veranstaltungsnummer wird zugeteilt)	**title of the module:** *Nanoanalytics/Interfaces II – Labwork*			**nature of the module:** specialization
credit points	9 CP			
work load **- contact hours (SWS)** **- self study**	Total: 270 h contact hours: 90 h self study (preparation for exams included): 180 h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year in the summer term			
language (English/German)	English			
maximum/minimum number of participants	Maximum: 8 Minimum: 3			
module structure /teaching methods	Practical Training (6 SWS)			
contents	Thematic focus: Planning, execution, analysis and discussion of practical experiments: - optical lithography - light microscopy - electron microscopy - scanning probe microscopy - neurotransmitter detection			
objectives	Students - Independent practical familiarization with selected experimental methods in nanoanalytics / interfaces			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Practical Training	4 Experimental protocols	1-5	9 ECTS
applicability	M.Sc. in Biomedical Technologies (specialization course), required for module AS10			
recommended semester	2nd semester			
participation requirements	B.Sc. degree			
person responsible for the module	Schäffer, Tilman, Prof., Dr. rer. nat.			
teaching staff	Fleischer, Monika, Prof., Dr. rer. nat. Meyer, Jannik, Prof. Dr. rer. nat. Rheinlaender, Johannes, PD, Dr. rer. nat. Schäffer, Tilman, Prof., Dr. rer. nat. Schreiber, Frank, Prof., Dr. rer. nat.			
literature / teaching materials	Literature will be announced at the beginning of term.			

module number: AS10 (Veranstaltungsnummer wird zugeteilt)	**title of the module:** *Nanoanalytics/Interfaces – Practical work experience in Nanotechnology for Medical Applications*			**nature of the module:** specialization
credit points	15 CP			
work load **- contact hours (SWS)** **- self study**	Total: 450 h contact hours: 300 h self study (preparation for exams included): 150 h			
duration of the module	University Lab: min. 6 weeks and max. 6 months Industry: min. 3 months and max. 6 months			
time schedule (winter/summer term)	The module is offered once per year in the summer and winter term as block course.			
language (English/German)	English			
maximum/minimum number of participants	Maximum: 8 Minimum: 1			
module structure /teaching methods	Practical Training			
contents	The Labwork contains a special topic that the student has to work on in theory and practice under the supervision of a scientist or medical doctor.			
objectives	Independent practical familiarization with experimental methods in the planned area of the Master's thesis.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Practical Training	Written report about the internship (10-15 pages, Arial 12, single-spaced)	1-5	15 ECTS
applicability	M.Sc. in Biomedical Technologies (specialization course), recommended for master´s thesis in Nanoanalytics/Interfaces			
recommended semester	3rd semester			
participation requirements	B.Sc. degree, 2 passed specialization blocks and successful completion of either modules AS6.1 and AS6.2 or modules AS9.1 and AS9.2			
person responsible for the module	Schäffer, Tilman, Prof., Dr. rer. nat.			
teaching staff	Rheinlaender, Johannes, PD, Dr. rer. nat. Schäffer, Tilman, Prof., Dr. rer. nat.			
literature / teaching materials	Literature will be announced at the beginning of term.			

module number: AE11	**title of the module:** *Aktorik in der Gerätetechnik; Konstruktion, Berechnung und Anwendung mechatronischer Komponenten*	**nature of the module:** elective course
credit points	6 CP	
work load **- contact hours (SWS)** **- self study**	Total: 180 h contact hours: 42 h self study (preparation for exams included): 138 h	
duration of the module	2 semester	
time schedule (winter/summer term)	The module is offered each semester	
language (English/German)	German	
maximum/minimum number of participants	Maximum: 20	
module structure /teaching methods	Lecture, practical training,	
contents	Behandelt werden feinwerktechnische Antriebe unterschiedlicher Wirkprinzipe mit den Schwerpunkten: - Magnettechnik/-technologie (Werkstoffe, Verfahren, konstruktive Auslegung, Magnetisierung) - Elektromagnetische Antriebe (rotatorische und lineare Schritt-motoren; Berechnung, Gestaltung, Anwendung) - Elektrodynamische Antriebe (rotatorische und lineare Gleichstrom-kleinstmotoren; Berechnung, Gestaltung, Anwendung) - Piezoelektrische, magnetostriktive und andere unkonventionelle Aktorik (neue Werkstoffe in mechatronischen Komponenten, Berechnung, Gestaltung, Anwendung) - Beispiele zur Realisierung mechatronischer Lösungen in der Gerätetechnik. Beispielhafte Vertiefung in zugehörigen Übungen und Praktika (Spezialisierungsfachpraktika und APMB).	
objectives	Die Studierenden kennen die Grundlagen der Magnettechnik und -technologie (Werkstoffe, Verfahren, konstruktive Auslegung, Magnetisierung). Die Studierenden können elektromagnetische Antriebe (rotatorische und lineare Schrittmotoren) vereinfacht berechnen, gestalten und auslegen. Die Studierenden können elektrodynamische Antriebe (rotatorische und lineare Gleichstromkleinstmotoren) vereinfacht berechnen, gestalten und auslegen. Die Studierenden kennen piezoelektrische, magnetostriktive und andere unkonventionelle Aktorik.	

Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Oral exam (ca. 40 min)	1-5	6 ECTS

applicability	M.Sc. in Biomedical Technologies (elective course)
recommended semester	1st or 2nd semester
participation requirements	B.Sc. degree in Medical Technologies
person responsible for the module	Schinköthe, Wolfgang, Prof., Dr.-Ing.

literature / teaching materials	Literature will be distributed before start of lecture.

module number: AE 12	**title of the module:** *Technologien der medizinischen Bildgebung und Labordiagnostik*			**nature of the module:** elective course
credit points	3 CP			
work load **- contact hours (SWS)** **- self study**	Total: 90 h contact hours: 28 h self study (preparation for exams included): 62 h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year in the summer term			
language (English/German)	German			
maximum/minimum number of participants	Maximum: 20			
module structure /teaching methods	Lecture			
contents	Bildgebende Diagnostik - Röntgen - Computertomographie - Magnetresonanztomographie - Positronenemissionstomographie - Labordiagnostik - Klinische Chemie - Immunologie - Molekulare Diagnostik (DNA Analyse) Informationstechnologie in der Medizintechnik			
objectives	- Kenntnis bildgebender und labormedizinischer Diagnoseverfahren und deren klinischer Bedeutung und Einsatzfelder. - Grundverständnis der zugrundeliegenden physikalischen und biomolekularen Messprinzipien. - Einblick in die Entwicklung und Herstellung medizintechnischer Geräte und die damit verbundenen technologischen Herausforderungen. - Verständnis grundlegender Zusammenhänge im Gesundheitswesen in Bezug auf Arbeitsabläufe, Kostenentwicklung und Behandlungsqualität.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Oral exam (ca. 30 min)	1-5	3
applicability	M.Sc. in Biomedical Technologies (elective course)			
recommended semester	1st or 2nd semester			
participation requirements	B.Sc. degree in Medical Technologies			
person responsible for the module	Yang, Bin, Prof., Dr.-Ing.			
literature / teaching materials	Literature will be distributed before start of lecture.			

module number: AE 13	**title of the module:** *Interface-Design*			**nature of the module:** elective course
credit points	6 CP			
work load **- contact hours (SWS)** **- self study**	Total: 180 h contact hours: 42 h self study (preparation for exams included): 138 h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year in the summer term			
language (English/German)	German			
maximum/minimum number of participants	Maximum: 20			
module structure /teaching methods	Lecture, practical training, seminar			
contents	Darstellung des interdisziplinären Interfacedesígn als Vertiefung zum Technischen Design mit Fokussierung auf alle relevanten Mensch-Maschine- Interaktionen. Beschreibung aller notwendigen Begriffe und Grundlagen zur Interfacegestaltung. Ausführliche Vorstellung der Methoden zur Integration der Makro-, Mikro- und Informationsergonomie in den gegenwärtigen Entwicklungsprozess. Darauf aufbauend werden Werkzeuge, wie Usabiltiy-Tests und Workflow-Analyse, intensiv beschrieben und deren Bewertungen und Ergebnisse diskutiert. Es werden zahlreiche realisierte Beispiele aus der Praxis als Fallbeispiele vorgestellt und behandelt.			
objectives	Das Modul vermittelt Grundlagen und Vertiefungen zum Interfacedesign. Studierende besitzen nach dem Besuch des Moduls - das Wissen über die wesentlichen Grundlagen des Interfacedesigns als Bestandteil der methodischen Entwicklung und zur Vertiefung des Technischen Designs, - die Kenntnis über wesentliche InteraktionsprinziModulhandbuch pien zur Wahrnehmung, Kognition und Betätigung und Benutzung, - die Fähigkeit wichtige Methoden zur Gestaltung der Mensch-Maschine-Schnittstelle anzuwenden, Lösungen zu realisieren und zu präsentieren, - die Fertigkeiten zur Planung und Durchführung von Usability-Tests mit Probanden, - grundlegende Kenntnisse zu Kriterien und Bewertung von Anzeigern und Stellteilen über die XKompatibilitäten, - ein detailliertes Verständnis von Makro-, Mikround Informationsergonomie und deren Integration in die Planungs-, Konzept-, Entwurfs- und Ausarbeitungsphase, - die Fähigkeit zur Durchführung und Auswertung einer Workflow-Analyse als Querschnittsfunktion, - die Fähigkeit effiziente Bedienstrategien zu beurteilen, - das Wissen über Auswirkungen und zukünftige Trends der Interfacegestaltung.			
Requirements for credit points / exams and grading scheme (where appropriate,	course	exam	Grading scheme	weighting
	Lecture	Written exam (ca. 120 min)	1-5	6 ECTS

weighting)				
applicability	M.Sc. in Biomedical Technologies (elective course)			
recommended semester	1st or 2nd semester			
participation requirements	B.Sc. degree in Medical Technologies			
person responsible for the module	Maier, Thomas, Univ.-Prof., Dr.-Ing.			
teaching staff	Maier, Thomas, Univ.-Prof., Dr.-Ing. Schmid, Markus, Dr.-Ing.			
literature / teaching materials	Literature will be distributed before start of lecture.			

module number: AE 14	**title of the module:** *Grundlagen der Keramik und Verbundwerkstoffe*	**nature of the module:** elective course
credit points	6 CP	
work load **- contact hours (SWS)** **- self study**	Total: 180 h contact hours: 42 h self study (preparation for exams included): 138 h	
duration of the module	2 semester	
time schedule (winter/summer term)	The module is offered once per year in the winter term	
language (English/German)	German	
maximum/minimum number of participants	Maximum: 20	
module structure /teaching methods	Lecture	
contents	Dieses Modul hat die werkstoff- und fertigungstechnischen Grundlagen keramischer Materialien zum Inhalt. Darüber hinaus werden konstruktive Konzepte und die werkstoffspezifische Bruchmechanik berücksichtigt. Es werden keramische Materialien und deren Eigenschaften erläutert. Keramische werden gegen metallische Werkstoffe abgegrenzt. Anhand von ingenieurstechnischen Beispielen aus der industriellen Praxis werden die Einsatzgebiete und -grenzen von keramischen Werkstoffen aufgezeigt. Den Schwerpunkt bilden die Formgebungsverfahren von Massivkeramiken. Die theoretischen Inhalte werden durch Praktika vertieft und verdeutlicht. Stichpunkte: - Grundlagen von Festkörpern im Allgemeinen und der Keramik. - Einteilung der Keramik nach anwendungstechnischen und stofflichen Kriterien, Trennung in Oxid-/ Nichtoxidkeramiken und Struktur-/ Funktionskeramiken. - Abgrenzung Keramik zu Metallen. - Grundregeln der Strukturmechanik, Bauteilgestaltung und Bauteilprüfung. - Klassische Herstellungsverfahren vom Rohstoff bis zum keramischen Endprodukt. - Formgebungsverfahren, wie das Axialpressen, Heißpressen, Kalt-, Heißisostatpressen, Schlicker- , Spritz-, Foliengießen und Extrudieren keramischer Massen. - Füge- und Verbindungstechnik. - Sintertheorie und Ofentechnik. - Industrielle Anwendungen (Überblick und Fallbeispiele).	
objectives	Die Studenten können: - Merkmale und Eigenheiten keramischer Werkstoffe unterscheiden, beschreiben und beurteilen. - Belastungsfälle und Versagensmechanismen verstehen und analysieren. - werkstoffspezifische Unterschiede zwischen metallischen und keramischen Werkstoffen wiedergeben und erklären. - Technologien zur Verstärkung von Werkstoffen sowie die wirkenden Mechanismen benennen, vergleichen und erklären. - Verfahren und Prozesse zur Herstellung von massivkeramischen Werkstoffen benennen, erklären, bewerten, gegenüberstellen, auswählen und anwenden. - Herstellungsprozesse hinsichtlich der techn. und wirtschaftl.	

	Herausforderungen bewerten und anwendungsbezogen auswählen. - in Produktentwicklung und Konstruktion geeignete Verfahren und Stoffsysteme identifizieren, planen und auswählen. - Werkstoff- und Bauteilcharakterisierung erklären, bewerten, planen und anwenden.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Written exam (ca. 120 min)	1-5	6 ECTS
applicability	M.Sc. in Biomedical Technologies (elective course)			
recommended semester	1st or 2nd semester			
participation requirements	B.Sc. degree in Medical Technologies			
person responsible for the module	Gadow, Rainer, Univ.-Prof., Dr.Dr.h.c.			
teaching staff	Gadow, Rainer, Univ.-Prof., Dr.Dr.h.c.			
literature / teaching materials	Literature will be distributed before start of lecture.			

module number: AE 15	**title of the module:** *Nanotechnologie I - Chemie und Physik der Nanomaterialien*			**nature of the module:** elective course
credit points	3 CP			
work load **- contact hours (SWS)** **- self study**	Total: 90 h contact hours: 28 h self study (preparation for exams included): 62 h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered each semester			
language (English/German)	German			
maximum/minimum number of participants	Maximum: 20			
module structure /teaching methods	Lecture			
contents	Nanoskaligkeit natürlicher Materie. Definition der Nanotechnologien und Nanomaterialien. Aufbau und Struktur von Nanomaterialien. Dimensionalität von Nanomaterialien (3 D, 2 D, 1 D und 0 D). Methoden zur Analyse von Nanomaterialien und deren Anwendung. Synthese und Verarbeitung von Nanomaterialien. Top down versus bottom up. Synthese aus unterschiedlichen physikalischen Phasen (Gasphase und Flüssigphase). Mechanische, chemische, elektrische, optische, magnetische, biologische und toxikologische Eigenschaften von Nanomaterialien.			
objectives	Die Studierenden - verstehen die Nanoskaligkeit natürlicher Materie und können sie an Beispielen illustrieren. - können die Definition der Nanotechnologien und Nanomaterialien anwenden und die Potenziale und Risiken von Nanomaterialien diskutieren. - können den Aufbau und die Struktur von Nanomaterialien erklären. - können die Dimensionalität von Nanomaterialien (3 D, 2 D, 1 D und 0 D) bestimmen. - können Methoden zur Analyse von Nanomaterialien auswählen und die Vorgehensweise bei deren Anwendung skizzieren. - können unterschiedliche Verfahren zur Synthese aus unterschiedlichen physikalischen Phasen (Gasphase und Flüssigphase) von Nanomaterialien erläutern und deren grundlegende Prinzipien beschreiben. - verstehen die besonderen Attribute von top down- und bottom up-Verfahren zur Synthese und Verarbeitung von Nanomaterialien. - sind in der Lage besondere mechanische, chemische, elektrische, optische, magnetische, biologische und toxikologische Eigenschaften von Nanomaterialien zu bewerten.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Written exam (ca. 90 min)	1-5	3 ECTS
applicability	M.Sc. in Biomedical Technologies (elective course)			

recommended semester	1st or 2nd semester
participation requirements	B.Sc. degree in Medical Technologies
person responsible for the module	Tovar, Günter, Prof. Dr. Guenter.Tovar@igvp.uni-stuttgart.de
literature / teaching materials	Literature will be distributed before start of lecture.

module number: AE 16 (Veranstaltungsnummer wird zugeteilt)	**title of the module:** *Nanotechnologie II - Technische Prozesse und Anwendungen*			**nature of the module:** elective course
credit points	3 CP			
work load **- contact hours (SWS)** **- self study**	Total: 90 h contact hours: 28 h self study (preparation for exams included): 62 h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year in the winter term			
language (English/German)	German			
maximum/minimum number of participants	Maximum: 20			
module structure /teaching methods	Lecture			
contents	Technische Prozesse zur Synthese und Verarbeitung von Nanomaterialien unterschiedlicher Dimensionalität (3 D, 2 D, 1 D und 0 D) und aus unterschiedlichen physikalischen Phasen (gasförmig, flüssig, fest)			
objectives	Die Studierenden - verstehen technische Prozesse zur Synthese und Verarbeitung von Nanomaterialien unterschiedlicher Dimensionalität (3 D, 2 D, 1 D und 0 D) und aus unterschiedlichen physikalischen Phasen (gasförmig, flüssig, fest)und können Prozessketten illustrieren. - können Anwendungen von Nanomaterialien mit besonderen mechanischen, chemischen, Biochemischen, elektrischen, optischen, magnetischen, biologischen und medizinischen Eigenschaften verstehen und bewerten. - interpretieren die öffentliche Wahrnehmung von Nanotechnologien und Nanomaterialien und können reale Chancen und Risiken von Nanotechnologien und Nanomaterialien bewerten.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Written exam (ca. 90 min)	1-5	3 ECTS
applicability	M.Sc. in Biomedical Technologies (elective course)			
recommended semester	1st or 2nd semester			
participation requirements	B.Sc. degree in Medical Technologies			
person responsible for the module	Tovar, Günter, Apl. Prof., Dr. Guenter.Tovar@igvp.uni-stuttgart.de			
literature / teaching materials	Literature will be distributed before start of lecture.			

module number: AE 17	**title of the module:** *Optische Systeme in der Medizintechnik*			**nature of the module:** elective course
credit points	6 CP			
work load **- contact hours (SWS)** **- self study**	Total: 180h contact hours: 42h self study (preparation for exams included): 138h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year in the summer term			
language (English/German)	german			
maximum/minimum number of participants	Maximum: 20			
module structure /teaching methods	Lecture, practical training			
contents	Basic optical system design and optical system parameters. Basic architecture of optical systems used in medicine (microscope, surgical microscope, endoscope, ophthalmic systems) Modern microscopy methods (structured illumination, confocal, fluorescence). Optics of the human eye and ophthalmic systems. Lasers in medical diagnostics and therapy. Spectroscopic and hyperspectral methods and systems. 3-D optical metrology. Basic properties of detectors.			
objectives	The students know how to calculate basic optical quantities within simple optical systems The students are familiar with - the optical setup of microscopes, endoscopes, and ophthalmic systems - spectral systems and their application - the properties of the human eye - properties of laser beams - polarization The students have an overview - over state of the art microscopic methods in order to enhance resolution and/or contrast - laser systems and their application in medicine - important poroperties of optical detectors			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Written exam	1-5	6 ECTS
applicability	M.Sc. in Biomedical Technologies (elective course)			
recommended semester	1st or 2nd semester			
participation requirements	B.Sc. degree in Medical Technologies			

person responsible for the module	Herkommer, Alois, Univ.-Prof., Dr.
literature / teaching materials	Literature will be distributed before start of lecture. Additional recommended books: - Gross H.: Handbook of optical systems Vol. 1-4 - Hecht, E.: Optik (Optics) - Kühlke D.: Optik

<table>
<tr><td>Modulkennziffer:
BM5 .1</td><td colspan="3">Modultitel:
Physik und Technologie der medizinischen Strahlenanwendungen - Vorlesung</td><td>Art des Moduls:
Wahlfach</td></tr>
<tr><td>Leistungspunkte</td><td colspan="4">3 LP</td></tr>
<tr><td>Arbeitsaufwand*
- Kontaktzeit SWS
- Selbststudium</td><td colspan="4">Gesamt: 90 h
Kontaktzeit: 3 SWS (32 h)
Selbststudium: 58 Stunden</td></tr>
<tr><td>Moduldauer*</td><td colspan="4">1 Semester</td></tr>
<tr><td>Turnus*</td><td colspan="4">Das Modul wird in jedem Sommersemester angeboten</td></tr>
<tr><td>Unterrichtssprache</td><td colspan="4">Deutsch</td></tr>
<tr><td>Gruppengröße / beschränkte Teilnehmerzahl</td><td colspan="4">Vorlesung: max. 20 Teilnehmer</td></tr>
<tr><td>Lehrformen*</td><td colspan="4">Vorlesung (3 SWS)</td></tr>
<tr><td>Modulinhalt*</td><td colspan="4">Technische Umsetzung der Gesetzmäßigkeiten der Atom-, Kern- und Strahlenphysik in Gerätetechnik der radiologischen Diagnostik, Nuklear-medizin und Strahlentherapie:
- Beschleuniger für die Strahlentherapie und die Radionukliderzeugung
- Bestrahlungsfeld-Verifikationstechniken und Therapie-Bildprozeduren
- Gerätetechnik der Brachytherapie
- Gerätetechnik der Hyperthermie
- Geräte für die Bildgebung (Röntgendiagnostik, Szinitgrafie, bildgestützte Radiotherapie)
- Nukliderzeugung in Kernreaktor, Generatorsystemen und im Zyklotron
- Messverfahren und –protokolle für die Qualitätssicherung und den Strahlenschutz</td></tr>
<tr><td>Qualifikationsziele*</td><td colspan="4">- Die Studierenden verfügen nach erfolgreichem Abschluss des Moduls über das physikalisch-technische Basiswissen, das für die wissenschaftliche und klinische Arbeit in der medizinischen Strahlenforschung in der Onkologie erforderlich ist.
- Sie kennen Funktionsweise und Technik der gängigen in der Nuklearmedizin, Radiologie und Strahlentherapie eingesetzten Geräte.</td></tr>
<tr><td rowspan="2">Prüfungsform / Benotung (ggf. Gewichtung)*</td><td>Veranstaltung</td><td>Prüfungsform</td><td>Benotung</td><td>Leistungspunkte</td></tr>
<tr><td></td><td>Schriftliche Klausur</td><td></td><td>3 LP</td></tr>
<tr><td>Verwendbarkeit*</td><td colspan="4">Die Vorlesung dieses Moduls ist Teilmodul des Moduls BM5 im Masterstudiengang Medizinische Strahlenwissenschaften. Es kann nur die Vorlesung (3 SWS = 3 ECTS) belegt werden.</td></tr>
<tr><td>Empfohlenes Semester</td><td colspan="4">2. Fachsemester</td></tr>
<tr><td>Teilnahme-voraussetzungen*</td><td colspan="4">B.Sc. in Medizintechnik.</td></tr>
<tr><td>Modul-</td><td colspan="4">Thorwarth, Daniela, Prof. Dr.</td></tr>
</table>

verantwortlicher	Dohm, Oliver, Dr. rer. nat. Fehrenbacher, Dr. Georg
Literatur / Lernmaterialien	Wird zu Semesterbeginn bekannt gegeben.

module number: BM8	**Title of the module:** *Biostatistcs 1*	**Nature of the module:** Elective course
credit points	6	
work load **- contact hours (SWS)** **- self study**	Total: 180 h contact hours: 70 h self study (preparation for exams included): 110 hours	
duration of the module	1 Semester	
time schedule (winter/summer term)	Annual	
language (English/German)	German / English	
maximum/minimum number of participants	Lecture: no limit Tutorial: max. 28 participants	
module structure /teaching methods	Statistics 1: Lecture 1 (2 SWS), Tutorial (1 SWS) (elective, English)3 ECTS Anova: Lecture 1 (2 SWS), Tutorial (1 SWS) (elective, English) 3 ECTS Clinical Studies: Lecture 1 (2 SWS), Tutorial (1 SWS) (elective, English) 3 ECTS	
contents	**Statistics 1:** Scales, Descriptive Statistics (Graphics, Tables, Parameters), Correlation and Regression, Diagnostic Tests, Confidenceintervals, Kaplan Meier Analysis of Survival Data Examples and Principles of statistical tests, Tests for independent samples, Tests for dependent Samples, Assessment of Normal Distribution, one factorial analysis of variance, Multiple Testing, Principles of sample size estimation **Anova:** One factorial analysis of variance, analysis of covariance, two factorial analysis of variance without interaction, two factorial analysis of variance with interaction, two factorial analysis of variance with one between and one within factor, multiple comparisons, mixed models and generalized estimating equations **Biostatistics of Clinical Studies:** Statistical methods for clinicial studies, sample size estimation, sequential and adaptive designs, diagnostic studies, studies with censored data	
objectives	The students are able to develop statistical modelling and analysis of experiments, interventional and observational clinical studies and of epidemiological studies. They are able to interpret the results. The students have knowledge of statistical analysis (descriptive, confirmatory, regressino, multivariate) and they are able to decide which method ist the most adequate in a specific study.	

Requirements for credit points / exams and grading scheme (where appropriate, weighting)	Course	Exam	Grading Scheme	Weighting
	Statistics 1 Analysis of Variance Clinical	Written exam Mandatory attendance Mandatory		3 ECTS 3 ECTS 3 ECTS

	Biostatistics	Attendance		
applicability	MSc Biomedical Technology and MSc Medizinische Strahlenwissenschaften			
recommended semester	1st / 2nd Semester			
participation requirements	The knowledge of the Course Statistics 1 is required to attend the other two courses which are independent of each others.			
person responsible for the module	Martus, Peter, Prof. Dr. rer. nat. Peter.martus@med.uni-tuebingen.de			
literature / teaching materials	To be announced at the beginning of the term			

Modulkennziffer: BM12.1 (Veranstaltungsnummer wird zugeteilt)	**Modultitel:** *Nuklearmedizin, diagnostische und interventionelle Radiologie, Strahlentherapie - Vorlesung*			**Art des Moduls:** Wahlfach
Leistungspunkte	3 LP			
Arbeitsaufwand* **- Kontaktzeit SWS** **- Selbststudium**	Gesamt: 90 h Kontaktzeit: 2 SWS (21 h) Selbststudium: 69 Stunden			
Moduldauer*	1 Semester			
Turnus*	Das Modul wird in jedem Wintersemester angeboten			
Unterrichtssprache	Deutsch			
Gruppengröße / beschränkte Teilnehmerzahl	Vorlesung: max. 20 Teilnehmer			
Lehrformen*	Vorlesung (2SWS)			
Modulinhalt*	Grundlagen der Nuklearmedizin, der diagnostischen und interventionellen Radiologie und der Strahlentherapie aus der Sicht des Mediziners: - Physikalische Grundlagen der Nuklearmedizin - Grundprinzipien nuklearmedizinischer Anwendungen (Radiopharmaka) - Anwendung offener und umschlossener Radionuklide in Diagnostik und Therapie - Nuklearmedizinische Therapie und intratherapeutische Dosismessung - Physikalische Grundlagen der Strahlentherapie - Indikationen für die Anwendung bestimmter diagnostischer und therapeutischer Verfahren - Radiographische Verfahren, Magnetresonanz-Tomografie, Ultraschall			
Qualifikationsziele*	- Die Studierenden kennen nach Abschluss des Moduls alle für die moderne Nuklearmedizin, Radiologie und Strahlentherapie relevanten klinischen Verfahren und Techniken. - Sie können diese hinsichtlich diagnostischer und therapeutischer Effektivität bewerten und das strahlungsbedingte Risiko für Patient und Personal quantifizieren.			
Prüfungsform / Benotung (ggf. Gewichtung)*	Veranstaltung	Prüfungsform	Benotung	Leistungspunkte
		Schriftliche Klausur		3 LP
Verwendbarkeit*	Die Vorlesung dieses Moduls ist Teilmodul des Moduls BM 12 im Masterstudiengang Medizinische Strahlenwissenschaften. Es kann nur die Vorlesung (2 SWS = 3 ECTS) belegt werden.			
Empfohlenes Semester	3. Fachsemester			
Teilnahme-voraussetzungen*	-			
Modul-verantwortlicher	Zips, Daniel, Prof., Dr. med. daniel.zips@med.uni-tuebingen.de			

Literatur / Lernmaterialien	Wird zu Semesterbeginn bekannt gegeben.

module number: BM 15	**title of the module:** *NanoBioPhysics and scanning probe microscopy*			**nature of the module:** elective course
credit points	3 CP			
work load **- contact hours (SWS)** **- self study**	Total: 90 h contact hours: 30 h self study (preparation for exams included): 60h			
duration of the module	1 semester			
time schedule (winter/summer term)	The module is offered once per year in the summer term			
language (English/German)	German or English			
maximum/minimum number of participants	Maximum: 20			
module structure /teaching methods	Lecture (2 SWS)			
contents	Thematic focus: - Interactions on the nanoscale, measurement of inter- and intramolecular forces, contact models, technology of scanning probe microscopy, biological basics, oscillations of nanostructures, static and dynamic imaging modes, magnetic nanostructures.			
objectives	Students - become familiar with a young field of nanobio-science - acquire fundamental knowledge about the area of NanoBioPhysics - learn interdisciplinary methods and applications of scanning probe microscopy			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Written exam (ca. 90 min) or oral exam	1-5	3 ECTS
applicability	M.Sc. in Biomedical Technologies (elective course)			
recommended semester	2nd semester			
participation requirements	B.Sc. degree			
person responsible for the module	Schäffer, Tilman, Prof., Dr. rer. nat.			
teaching staff	Schäffer, Tilman, Prof., Dr. rer. nat.			
literature / teaching materials	Literature will be announced at the beginning of term.			

<table>
<tr><td>module number:
BM17</td><td colspan="3">title of the module:
Ethical and Social Aspects of Biomedical Technolgoies</td><td>nature of the module:
elective course</td></tr>
<tr><td>credit points</td><td colspan="4">3 CP</td></tr>
<tr><td>work load
- contact hours (SWS)
- self study</td><td colspan="4">Total: 90 h
contact hours: 30 h
self study (preparation for exams included): 60 h</td></tr>
<tr><td>duration of the module</td><td colspan="4">1 semester</td></tr>
<tr><td>time schedule (winter/summer term)</td><td colspan="4">The module is offered once per year in the summer term</td></tr>
<tr><td>language (English/German)</td><td colspan="4">English</td></tr>
<tr><td>maximum/minimum number of participants</td><td colspan="4">Maximum: 20
Minimum: 6</td></tr>
<tr><td>module structure /teaching methods</td><td colspan="4">Seminar (2 SWS)</td></tr>
<tr><td>contents</td><td colspan="4">Basics:
- What makes and innovation a good innovation?
- What are ethical and social aspects of biomedical technologies?
- How to deal with those aspects?

Joint case study of a particular biomedical technology:
- What is the case?
- How can we detect ethical and social aspects of the case?
- How to deal with those aspects?

Individual case studies of the technologies the students develop in their master thesis:
- Which ethical and social aspects has my own work?
- How can I deal with them?</td></tr>
<tr><td>objectives</td><td colspan="4">- After the course the students have:
- An understanding of what ethical and social aspects of biomedical technologies are.
- The ability to express and to discuss ethical and social aspects of biomedical technologies and of their own development work.
- Access to tools which support ethical and social reflections.
- The ability to express and reflect their criteria for good innovations.
- Knowledge about responsible innovation and the debates about it.
- Made an interdisciplinary experience and widening of their perspectives.</td></tr>
<tr><td rowspan="2">Requirements for credit points / exams and grading scheme (where appropriate, weighting)</td><td>course</td><td>exam</td><td>Grading scheme</td><td>weighting</td></tr>
<tr><td>Seminar</td><td>Presentation during Seminar and writing of a</td><td>1-5</td><td>3 ECTS</td></tr>
</table>

		reflection paper		
applicability	M.Sc. in Biomedical Technologies (elective course)			
recommended semester	2nd semester			
participation requirements	B.Sc. degree			
person responsible for the module				
teaching staff				
literature / teaching materials	Literature will be announced at the beginning of term.			

<table>
<tr><td>module number:
BM18</td><td colspan="3">title of the module:
MEDTEC Innovation</td><td>nature of the module:
elective course</td></tr>
<tr><td>creditpoints</td><td colspan="4">9 CP</td></tr>
<tr><td>work load
- contact hours (SWS)
- self study</td><td colspan="4">Total: 180 h
Contact hours:60 h
Self-study: 120h</td></tr>
<tr><td>Durationofthemodule</td><td colspan="4">2 semester</td></tr>
<tr><td>time schedule (winter/summer term)</td><td colspan="4">The module is offered once per year in the winter and summer term</td></tr>
<tr><td>language (English/German)</td><td colspan="4">English</td></tr>
<tr><td>maximum/minimum number of participants</td><td colspan="4">Maximum: 12</td></tr>
<tr><td>module structure /teaching methods</td><td colspan="4">Lecture / Seminar combination (2 SWS)</td></tr>
<tr><td>contents</td><td colspan="4"><u>Thematic focus:</u>
- The module deals with the development process of a medical device from the industry perspective. The students will be undergoing an innovation process from primary identification of clinical unmet needs to concept generation to a functional demonstrator. During this process several steps such as self-assessment, needs finding, idea generation, IP and market analysis, as well as the physical process of drafting a design and building a demonstrator will be included.</td></tr>
<tr><td>objectives</td><td colspan="4">Students
- become familiar with the field of innovation management
- acquire fundamental knowledge about the importance of a structured process, challenging situations during the process and the application of ancillary tools
- learn important methods and processes along the definition of a project towards feasibility and fabrication of a demonstrator.</td></tr>
<tr><td rowspan="2">Requirements for credit points / exams and grading scheme (where appropriate, weighting)</td><td>course</td><td>exam</td><td>Grading scheme</td><td>weighting</td></tr>
<tr><td>Lecture / Seminar</td><td>Presentation/ Concept / Demonstrator</td><td>1-5</td><td>3 ECTS (WS)
6 ECTS (SS)</td></tr>
<tr><td>applicability</td><td colspan="4">M.Sc. in Biomedical Technologies (elective course)</td></tr>
<tr><td>recommended semester</td><td colspan="4">1st and 2nd semester</td></tr>
<tr><td>participation requirements</td><td colspan="4">B.Sc. degree</td></tr>
<tr><td>person responsible for the module</td><td colspan="4">Wahl, Siegfried, Prof. Dr. rer. nat.</td></tr>
<tr><td>literature / teaching materials</td><td colspan="4">Literature will be announced at the beginning of term.</td></tr>
</table>

Number: BM14	**Title:** *Phyton course*			**Nature:** compulsory
Credit points	6 CP			
Work load **- contact hours (SWS)** **- self study**	Total: 180 h 60 h/4 SWS 120 h			
Duration	1 semester,			
Time schedule	The module is offered once per year in the winter term as block course			
Language	English			
Number of participabnts				
Structure/Teaching methods	Practical Training (10 SWS)			
Contents	The Python Programming Fundamentals is an immersive and comprehensive course designed to equip students with a strong foundation in Python, one of the most popular and versatile programming languages. Throughout this course, students will embark on a journey that takes them from the basics of Python syntax to advanced concepts, enabling them to become proficient Python programmers. The main covered topics are data structures, operators and control structures, functions, I/O operations, object-oriented programming and several advanced libraries for tasks such as data analysis. The course is designed for students with little or no programming background.			
Objectives	Students acquire basic knowledge of Python syntax. They develop an understanding of data structures, operators, and control structures in Python. Students gain the ability to create and use functions in Python and gain knowledge of input and output operations in Python. They develop an understanding of object-oriented programming in Python and gain skills in using advanced libraries for tasks such as data analysis, as well as programming independently in Python to become a proficient Python programmer.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	seminar	Written examination	1-5	6ECTS
Applicability	This module is a compulsory module in the Master's program Strahlenwissenschaften/Medical Radiation Sciences, profile area "Artificial Intelligence in Med. Radiation Sciences" and an elective course for Biomedical Technologies M.Sc.			
Recommended semester	1st semester			
Participation requirements	B.Sc. degree			
Person responsible	tba			
Literature/Teaching materials	tba			

module number: BM 21	**title of the module:** *MRI-applications for neuroscientific and clinical research*			**nature of the module:** elective course
creditpoints	3 CP			
work load **- contact hours (SWS)** **- self study**	Total: 90h Contact hours:30 h Self-study: 60h			
Duration of the module	1 semesters			
time schedule (winter/summer term)	The module is offered once per year in summer term			
language (English/German)	English			
maximum/minimum number of participants	Maximum: 12			
module structure /teaching methods	Lecture			
contents	MRI has widely increased our knowledge about the structure and function of the human brain. The continuous development of new technologies and methods in this field allow investigations to be carried out at an ever-increasing level of detail. In this course, established and emerging methods that allow robust and reproducible quantification of physiologic and pathologic processes will be taught. Topics include: - How does connectivity analyses relate to the progression of neurodegenerative diesases? - How can I investigate the anatomical microstructure? - How can I measure the function of the blood-brain-barrier? - How can I follow the fate of stem-cells within the anatomical microstructure by MR -			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	Lecture / Seminar	exam	Grading scheme	weighting
	M.Sc. in Biomedical Technologies (elective course)	Final report 8-15 pages	1-5	3 ECTS
applicability	Biomedical technologies M.Sc, Master Programs of Graduate Schools of Neuroscience			
recommended semester	2nd semester			
participation requirements	B.Sc. degree			
person responsible for the module	PD Dr. Gisela Hagberg gisela.hagberg@tuebingen.mpg.dee			

literature / teaching materials	Literature will be announced at the beginning of term.

Number: E16	**Titel:** *Medical Technology Aspects of Cardiovascular Medicine*	**Nature:** Elective course

Credit points	3 CP			
Work load **- contact hours (SWS)** **- self study**	Total: 90 h contact hours: 20 h self-study (preparation for exams included): 70 h			
Duration	1 semester			
Time schedule	The module is offered 1 per year in the winter term			
Language	English			
Number of participants	Maximum: 12 Minimum: 7			
Structure/Teaching methods	Hands-On Seminar			
Contents	- Heart: Basics of Anatomy - Heart Disease - Heart Failure - Technical Products: Cardiac Implants, Cannulas, etc. - Technical challenges and solutions			
Objectives	- The students can explain and describe the basic anatomy, physiology and pathology of a heart - The students know a selection of relevant medical technology products and can compare the advantages and disadvantages. - The students are able to evaluate the medical technology products. - The students know the different requirements for the use of medical technology products			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Seminar	Written examination	1-5	3 ECTS
Applicability	M.Sc. in Biomedical Technologies (elective course)			
Recommended semester	1st semester			
Participation requirements	B.Sc. degree			
Person responsible	Prof. Dr. Tobias Walker			
Teaching staff				
Literature / Teaching materials	Literature will be announced at the beginning of term.			

Number: BM14	Title: Python course			Nature: compulsory
Credit points	6 CP			
Work load **- contact hours (SWS)** **- self study**	Total: 180 h 60 h/4 SWS 120 h			
Duration	1 semester,			
Time schedule	The module is offered once per year in the winter term as block course			
Language	English			
Number of participabnts				
Structure/Teaching methods	Practical Training (10 SWS)			
Contents	The Python Programming Fundamentals is an immersive and comprehensive course designed to equip students with a strong foundation in Python, one of the most popular and versatile programming languages. Throughout this course, students will embark on a journey that takes them from the basics of Python syntax to advanced concepts, enabling them to become proficient Python programmers. The main covered topics are data structures, operators and control structures, functions, I/O operations, object-oriented programming and several advanced libraries for tasks such as data analysis. The course is designed for students with little or no programming background.			
Objectives	Students acquire basic knowledge of Python syntax. They develop an understanding of data structures, operators, and control structures in Python. Students gain the ability to create and use functions in Python and gain knowledge of input and output operations in Python. They develop an understanding of object-oriented programming in Python and gain skills in using advanced libraries for tasks such as data analysis, as well as programming independently in Python to become a proficient Python programmer.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	seminar	Written examination	1-5	6ECTS
Applicability	This module is a compulsory module in the Master's program Strahlenwissenschaften/Medical Radiation Sciences, profile area "Artificial Intelligence in Med. Radiation Sciences" and an elective course for Biomedical Technologies M.Sc.			
Recommended semester	1st semester			
Participation requirements	B.Sc. degree			
Person responsible	tba			
Literature/Teaching materials	tba			

module number: AMT12	**title of the module:** *Master Thesis*			**nature of the module:** compulsory
credit points	30 CP			
work load **- contact hours (SWS)** **- self study**	Total: 900 h contact hours: 600 h self study: 300 h			
duration of the module	6 months			
frequency of the offer	each semester			
language of instruction	English			
maximum/minimum number of participants	maximal 24			
teaching methods	seminar (3 SWS), practical work (40 SWS)			
content	depending on the project			
qualification goals	- to study published data to get insight a research field - to understand the general flow from the idea of an experiment via the experimental design and methodology to interpretation of the results taking sufficient and appropriate controls and published data into account - documentation, oral and written presentation of experimental data At the end of the master thesis the students should be able to develop an own research project idea and design and perform the appropriate experiments with help of published data. They should be able to present their research in oral and written form.			
requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Master Thesis	- oral presentation - written thesis - performance - engagement => graded by two reviewers	1-5 1-5	20% 40% 20% 20%
usability	M.Sc. in Biomedical Technologies			
recommended semester	4th semester			
prerequisite to attend the activities	Successful completion of the theoretical and practical course work in the 1st, 2nd and 3rd semester			
person responsible for the module	The head of the examination committee			
teacher	Various teachers of the faculty of Medicine, faculty of Science and Biomedical Technologies Industry			
literature / teaching materials	will be provided by the supervisor before start of master thesis			