Course Handbook Medical Physics Master

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Qualifikation Goals of Study Programme

Medical Physics Master - mandatory courses (overview)

Module name (EN)	Code	SAP-P	Semester	Hours per semester week / Teaching method	ECTS	Module coordinator
Master Thesis	MP3301.THS	P213-0263	3	-	30	N.N.
Medical Optics and Laser Medicine	MP3202.OPT	P213-0110	2	4V	5	Dr. Sebastian Markert

(2 modules)

Medical Physics Master - optional courses (overview)

Module name (EN)	Code	SAP-P	Semester	Hours per semester week / Teaching method	ECTS	Module coordinator
Bioinformatics	MP2106.BIOI		1	4V	6	Prof. Dr. Gerald Kroisandt
Current Methods in Molecular and Microbiology	MP2208.MBIO	P213-0156	2	2V+1P	3	Prof. Dr. Timo Gehring
Industrial Robotics	MP2206.IR		1	2V+2P	5	Prof. Dr. Michael Kleer

(3 modules)

Medical Physics Master - mandatory courses

Master Thesis

Module name (EN): Master Thesis
Degree programme: Medical Physics, Master, regulation 01.10.2025
Module code: MP3301.THS
Hours per semester week / Teaching method: -
ECTS credits: 30
Semester: 3
Mandatory course: yes
Language of instruction: German
Assessment: Master thesis [*updated 21.10.2024*]
Applicability / Curricular relevance: MP2301.THS (T213-0130) Medical Physics, Master, regulation 01.04.2019 , semester 3, mandatory course MP3301.THS (P213-0263) Medical Physics, Master, regulation 01.10.2025 , semester 3, mandatory course
Workload: The total student study time for this course is 900 hours.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: N.N.
Lecturer: N.N. [*updated 29.11.2024*]
Learning outcomes: Within a given period of maximum 6 months, students will work on a clearly defined task with high practical relevance and a high level of complexity in a goal and result-oriented manner in independent

cooperation with a practice partner or within the framework of a research project. They will document their results in either German or English and present and discuss them in a colloquium.

The Master´s thesis is an integral part of the Master s degree program, as well as a component of the Master s examination. The Master´s thesis is the final thesis.

[*updated 21.10.2024*]

Module content:
Compared to a diploma thesis, the Master s thesis is characterized by a high practical relevance and a higher level of complexity. The thesis will - if possible - be worked on and written together with an industry partner or within the framework of a research project. In it, the skills and knowledge acquired in all subject areas are to be applied to a concrete task. The maximum duration for the Master s thesis is 6 months. It can be written in both German or English in consultation with the thesis supervisor.

[*updated 21.10.2024*]

Teaching methods/Media:
Project-dependent

[*updated 21.10.2024*]

Recommended or required reading:

[*updated 21.10.2024*]

Medical Optics and Laser Medicine

Module name (EN): Medical Optics and Laser Medicine
Degree programme: Medical Physics, Master, regulation 01.10.2025
Module code: MP3202.OPT
Hours per semester week / Teaching method: 4V (4 hours per week)
ECTS credits: 5
Semester: 2
Mandatory course: yes
Language of instruction: German
Assessment: Oral examination [*updated 21.10.2024*]
Applicability / Curricular relevance: MP2202.OPT (P213-0110) Medical Physics, Master, regulation 01.04.2019 , semester 2, mandatory course MP3202.OPT (P213-0110) Medical Physics, Master, regulation 01.10.2025 , semester 2, mandatory course
Workload: 60 class hours (= 45 clock hours) over a 15-week period. The total student study time is 150 hours (equivalent to 5 ECTS credits). There are therefore 105 hours available for class preparation and follow-up work and exam preparation.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: Dr. Sebastian Markert
Lecturer: Dr. Sebastian Markert [*updated 29.11.2024*]
Learning outcomes: After successfully completing this course, students will be able to explain the physical properties of light and - depending on the application - describe light as a beam, wave or particle. They will be able to formally describe imaging systems and quantify deviations from the assumptions of geometric optics. Students will be

able to explain the interaction of light with biological tissue, identify the dominant mechanisms in different situations and assign them to different diagnostic and therapeutic requirements.
On the basis of this knowledge, they will be able to explain the function and application of different medical-optical devices and procedures.
Students will be able to assess the properties of the laser radiation relevant for medical technology and explain its interaction with biological tissue. They will be able to assess the hazards posed by different lasers and take the appropriate safety measures. They will be familiar with different types of lasers and can assign them to different diagnostic and therapeutic applications based on their properties.

[*updated 21.10.2024*]

Module content:
1. Basics:
 1.1 Electromagnetic spectrum
 1.2 Reflection and refraction
 1.3 Interference and coherence
 1.4 Diffraction
 1.5 Interaction between light and matter
2. Imaging optics:
 2.1 Refraction on spherical surfaces
 2.2 Projection equation
 2.3 ABCD matrix formalism
 2.4 Classic eye-related devices
 2.5 Apertures and pupils
 2.6 Diffraction-limited resolution and optical transfer function
3. Other optical components:
 3.1 Sources of light
 3.2 Radiation detectors
 3.3 Glass fibers
 3.4 Optical filters
4. Tissue optics: Propagation of light in biological tissue
 4.1 Absorption
 4.2 Multiple scattering
 4.3 Fluorescence
5. Medical-optical devices and procedures:
 5.1 Scanning electron microscopy
 5.2 Ophthalmological equipment
 5.3 Light microscopy and high-resolution microscopy
 5.4 Electron microscopy
6. Laser physics and technology:
 6.1 Properties of laser radiation
 6.2 Basic structure of a laser
 6.3 Different types of lasers
7. Laser safety
8. Lasers in diagnostics
 8.1 Laser spectroscopy and fluorescence diagnostics
 8.2 Optical coherence tomography (OCT)
9. Lasers in therapy:
 9.1 Basics: Interaction of lasers with tissue
 9.2 Photodynamic therapy (PDT)
 9.3 Coagulation, vaporization, ablation, laser scalpel ,
 9.4 Examples from ophthalmology, dermatology and dentistry

[*updated 21.10.2024*]

Teaching methods/Media: Blackboard, lecture notes, transparencies, animations [*updated 21.10.2024*]
Recommended or required reading: Berlien, Hans-Peter; Müller, Gerhard J.: Applied Laser Medicine, Springer, 2003 Hecht, Eugene: Optik, De Gruyter, (akt. Aufl.) Kühlke, Dietrich: Optik: Grundlagen und Anwendungen, Harri Deutsch, (akt. Aufl.) Lipson, Stephen G.; Lipson, Henry S.; Tannhauser, David S.: Optik, Springer, 1997 Niemz, Markolf H:: Laser-Tissue-Interactions, Springer, (akt Aufl.) Pedrotti, Frank L.; Pedrotti, Leno S.; Bausch, Werner; Schmidt, Hartmut: Optik für Ingenieure, Springer, (akt Aufl.) Gerhard, Christoph: Tutorium Optik: Ein verständlicher Überblick für Physiker, Ingenieure und Techniker (akt. Aufl.), online in der htw Bibliothek verfügbar [*updated 21.10.2024*]

Medical Physics Master - optional courses

Bioinformatics

Module name (EN): Bioinformatics
Degree programme: Medical Physics, Master, regulation 01.10.2025
Module code: MP2106.BIOI
Hours per semester week / Teaching method: 4V (4 hours per week)
ECTS credits: 6
Semester: 1
Mandatory course: no
Language of instruction: German
Assessment: Project and presentation [*updated 20.12.2017*]
Applicability / Curricular relevance: KI850 Computer Science and Communication Systems, Master, regulation 01.04.2016 , semester 2, optional course, informatics specific KIM-BIOI (P221-0152) Computer Science and Communication Systems, Master, regulation 01.10.2019 , semester 2, optional course, informatics specific MP2106.BIOI Medical Physics, Master, regulation 01.04.2019 , semester 1, optional course MP2106.BIOI Medical Physics, Master, regulation 01.10.2025 , semester 1, optional course PIM-WI57 Applied Informatics, Master, regulation 01.10.2011 , semester 2, optional course, informatics specific PIM-BIOI (P221-0152) Applied Informatics, Master, regulation 01.10.2017 , semester 2, optional course, informatics specific PIM-BIOI (P221-0152) Applied Informatics, Master, regulation 01.10.2026 , semester 2, optional course, informatics specific TIM-BIOI Technical Computer Science, Master, regulation 01.10.2026 , semester 2, optional course, informatics specific
Workload: 60 class hours (= 45 clock hours) over a 15-week period. The total student study time is 180 hours (equivalent to 6 ECTS credits). There are therefore 135 hours available for class preparation and follow-up work and exam preparation.
Recommended prerequisites (modules): None.

Recommended as prerequisite for:

Module coordinator:
Prof. Dr. Gerald Kroisandt

Lecturer: Prof. Dr. Gerald Kroisandt

[*updated 29.11.2024*]

Learning outcomes:
Students will be familiarized with several application areas of bioinformatics and will be able to efficiently solve typical problems such as the sequencing of genomes or the structure of proteins using algorithms.

[*updated 20.12.2017*]

Module content:
Computer-aided research in the natural sciences (biology, pharmacy, biotechnology,...) generates large amounts of data that must be archived and analyzed. This requires efficient algorithms.

First, the algorithms used in the sequencing of the human genome will be introduced in the lecture. Then, methods for the identification of genes (gene prediction) will be described. Hidden Markov models are an important part of this process. The methods discussed make it possible to predict the 3-D structure and function of proteins.

In conclusion, we will discuss the algorithms and procedures used by pharmaceutical companies in the computer-aided search for new active ingredients (computer-aided drug design).

1. Basics
2. Genome sequencing algorithms
3. Hidden Markov models
4. The application of hidden Markov models for the identification of genes
5. Protein structure predictions and databases
6. Computer-aided drug design

[*updated 24.02.2018*]

Teaching methods/Media:
50% of the lecture will take place in the PC lab AMSEL "Angewandte Mathematik, Statistik und eLearning". Computer-supported practical case studies will be worked through using the algorithms taught in this module.
In addition, the e-learning system ActiveMath: Statistics will be used to learn about topics from the field of stochastics, especially the Markov models.

[*updated 24.02.2018*]

Recommended or required reading:
BALDI, BRUNAK: Bioinformatics, The Machine Learning Approach

[*updated 20.12.2017*]

Current Methods in Molecular and Microbiology

Module name (EN): Current Methods in Molecular and Microbiology
Degree programme: Medical Physics, Master, regulation 01.10.2025
Module code: MP2208.MBIO
Hours per semester week / Teaching method: 2V+1P (3 hours per week)
ECTS credits: 3
Semester: 2
Mandatory course: no
Language of instruction: German
Assessment: Exam [*updated 08.01.2024*]
Applicability / Curricular relevance: BMT2512.MBIO (P213-0156) Biomedical Engineering, Bachelor, regulation 01.10.2018 , optional course, medical/technical, course inactive since 06.09.2022 BMT2512.MBIO (P213-0156) Biomedical Engineering, Bachelor, regulation 01.10.2025 , optional course, medical/technical, course inactive since 06.09.2022 BMT1932 (P213-0156, P213-0164) Biomedical Engineering, Master, regulation 01.04.2014 , optional course, general subject MAM.2.1.6.20 Engineering and Management, Master, regulation 01.10.2019 , optional course, general subject MAM.2.1.6.20 Engineering and Management, Master, regulation 01.10.2024 , optional course, general subject MP2208.MBIO (P213-0156) Medical Physics, Master, regulation 01.04.2019 , semester 2, optional course, medical/technical MP2208.MBIO (P213-0156) Medical Physics, Master, regulation 01.10.2025 , semester 2, optional course, medical/technical
Workload: 45 class hours (= 33.75 clock hours) over a 15-week period. The total student study time is 90 hours (equivalent to 3 ECTS credits). There are therefore 56.25 hours available for class preparation and follow-up work and exam preparation.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:

Module coordinator:
Prof. Dr. Timo Gehring

Lecturer: Prof. Dr. Timo Gehring

[*updated 29.11.2024*]

Learning outcomes:
After successfully completing this course, students will have significantly increased their knowledge in molecular biology, microbiology and hygiene. They will be proficient in the molecular biological methods currently used in clinical practice and research that enable a better understanding of modern medical diagnostic procedures and biotechnological processes.
Students will be familiar with the most important pathogenic bacteria and viruses, as well as antibiotics and the growing problem of antibiotic resistance. They will be able to assess which disinfection and sterilisation procedures should be used and when. They will be familiar with biotechnological processes and be able to cultivate the algae that also play a role in the pharmacological field.

[*updated 08.01.2024*]

Module content:
Basics of molecular biology
Current molecular biological and microbiological methods used for clinical diagnosis and in biotechnology.
Molecular biological methods:
- Polymerase Chain Reaction (PCR)
- DNA-modifying methods (e.g. restriction digestion, CRISPR-CAS, detailed implementation of cloning)
- Southern blot analyses, DNA microarray and chip technology
- DNA sequencing (Sanger method and Next Generation Sequencing)

Micro-biological procedures
- Medical microbiology (pathogenic bacteria, viruses and others)
- Hospital infections
- Antibiotics and development of resistance against antibiotics
- Desinfection and sterilization
- Photosynthesis and the use of algae in biotechnology

Safety seminar for the practical course
Use of the following molecular biological/biotechnological methods in the practical course:
- Isolating DNA from various algae (cyanobacteria)
- Amplification of 16S rDNA of these cyanobacteria by PCR
- DNA gel electrophoresis

[*updated 08.01.2024*]

Teaching methods/Media:
Video projector, Powerpoint presentation, lab experiments

[*updated 08.01.2024*]

Recommended or required reading:
Biochemie - H.R. Horton, L.A. Moran, K.G. Scrimgeour, M.D. Perry, J.D. Rawn.
Brock Mikrobiologie - M.T. Madigan, J.M. Martinko.

Hygiene und medizinische Mikrobiologie - M. Dülligen, A. Kirov, H. Unverricht.

[*updated 08.01.2024*]

Industrial Robotics

Module name (EN): Industrial Robotics
Degree programme: Medical Physics, Master, regulation 01.10.2025
Module code: MP2206.IR
Hours per semester week / Teaching method: 2V+2P (4 hours per week)
ECTS credits: 5
Semester: 1
Mandatory course: no
Language of instruction: German
Assessment: [*updated 19.12.2023*]
Applicability / Curricular relevance: E2845 (P221-0199) Electrical Engineering and Information Technology, Master, regulation 01.04.2019 , semester 1, optional course KIM-IR (P221-0199) Computer Science and Communication Systems, Master, regulation 01.10.2019 , semester 1, optional course MTM.IRO (P221-0199) Mechatronics, Master, regulation 01.04.2020 , optional course MP2206.IR Medical Physics, Master, regulation 01.04.2019 , semester 1, optional course MP2206.IR Medical Physics, Master, regulation 01.10.2025 , semester 1, optional course PIM-IR (P221-0199) Applied Informatics, Master, regulation 01.10.2017 , semester 1, optional course PIM-IR (P221-0199) Applied Informatics, Master, regulation 01.10.2026 , semester 3, optional course TIM-IR Technical Computer Science, Master, regulation 01.10.2026 , semester 1, optional course
Workload: 60 class hours (= 45 clock hours) over a 15-week period. The total student study time is 150 hours (equivalent to 5 ECTS credits). There are therefore 105 hours available for class preparation and follow-up work and exam preparation.
Recommended prerequisites (modules): None.
Recommended as prerequisite for:
Module coordinator: Prof. Dr. Michael Kleer

Lecturer: Prof. Dr. Michael Kleer

[*updated 29.11.2024*]

Learning outcomes:
Students will be able to identify, apply and derive the most important methods for describing and designing industrial robot systems. They will be able to independently describe, explain and calculate the interaction of industrial robot systems with various coordinate systems and the associated coordinate transformations in detail. In addition, they will be able to independently calculate the forward and inverse kinematics, as well as the velocity kinematics of typical industrial robots and solve path and trajectory planning tasks. They will be able to derive the Jacobian matrix of typical industrial robot systems and use it for further calculations.

[*updated 19.12.2023*]

Module content:
Classifying industrial robots
Rotations, transformations, coordinate system representations
Derivation of the general homogeneous transformation matrix
Derivation of the Denavit-Hartenberg transformation method
Forward and inverse kinematics of serial industrial robots
Derivation of velocity kinematics
Derivation of the Jakobi matrix (analytical & geometric Jakobi matrix)
Path and trajectory planning for industrial robots

[*updated 19.12.2023*]

Recommended or required reading:
Springer Handbook of Robotics, https://doi.org/10.1007/978-3-540-30301-5
Robot Modeling and Control, ISBN: 978-1-119-52404-5

[*updated 19.12.2023*]