MODULE HANDBOOK

Overview of modules

Lasers and Photonics - Master (1-Fach, PO 2015)

Mandatory modules LAP

English

Laser Metrology

Optoelectronics

Photonics

Laser Materials Processing

Laser Technology

Optical Metrology

Master Thesis LAP

Mandatory elective modules LAP

Mandatory Elective Courses

Practical subjects

Free elective courses LAP

Free elective courses

Module title: English

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149263	6 CP	180 h (according to the courses)	1. semester (MaLAP)	winter- and summer term	2 Semester

Courses / lectures	Contact hour	Self-Study	Group size
251230: English for Specific Academic Purposes: Producing and Presenting a Scientific Poster 251231: English for Specific Academic Purposes: Researching and Writing a Scientific Paper	see courses		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: LAP Coordinator: Prof. Dr. Martin R. Hofmann
Lecturer: Lecturers of the University language centre (ZFA)

Module use
Master Lasers and Photonics (PO 2015)

Learning outcomes
The students acquire competences in the English language. At the end of this module, students will be able to follow lectures in their subject area held in English as well as to participate actively in courses and exercises of their study programme and handle all related tasks and assignments independently. They will have a sound command of the idiom of LAP and thus be able to converse and write in English freely in the scope of study and research in their subject area. They will be capable of expressing concepts and ideas related to this scientific field and thus be equipped for active participation in scientific communication.

Content
In the module English the students first equalise their English language competences and then they learn how to write, present and communicate about their technical and scientifc topics in English. They will receive extensive training in linguistic competencies they need for participation in the Laser and Photonics study programme. In order to lay the foundation, general language use in academic contexts will be practised. For the development of listening comprehension, authentic lectures will be made available on Blackboard, while introductory texts and sections from textbook articles will serve as the basis for reading comprehension exercises. Speaking will be trained by means of short presentations and discussions in class, and writing skills will be developed mainly through short writing assignments. In the next step, students will receive further training in linguistic competencies necessary for study and research in the field of Lasers and Photonics. The typical idiom of this specific scientific field will be practised both actively and receptively. Speaking will be trained by means of short presentations and discussions in class, and writing skills will be improved mainly through writing assignments as well as contributions to Wikis and Blogs.

Teaching type
language skills training

Mode of assessment
continual assessement: The study progress will be assessed continually and students will be asked to hand in short essays or abstracts and hold short talks about scientifically related topics.

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
0/86

Module title: Laser Metrology

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149275	6 CP	180 h	1. semester (MaLAP)	winter term	1 Semester

Courses / lectures	Contact hour	Self-Study	Group size
139930: Laser Metrology	60 h		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: Prof. Dr.-Ing. Andreas Ostendorf
Lecturer: Prof. Dr.-Ing. Andreas Ostendorf

Module use

Master Lasers and Phtonics (PO 2015)

Learning outcomes
The students have gained knowledge of the principles and opportunities in laser based measurement. They understand the difference between non-coherent and coherent light and how to make use of coherence in interferometry. Third they understand how the different laser measurement principles can be used to measure physical or mechanical parameters.

Content
Based on the solution of Maxwell´s equations the description of electromechanical waves is derived. In this context the important parameters temporal and spatial coherence are defined. Next, Mach-Zehnder and Michelson interferometers are presented and analyzed. In the following recording and reconstruction of holograms is described. By merging the two technologies holographic interferometry is introduced especially for applications in mechanics to analyze oscillations and vibrations. Another important principle is Doppler measurements. After introducing the Doppler-principle and Doppler interferometers/vibrometers Laser Doppler Anemometry (LDA) is presented in more detail. An important chapter in this lecture is also the understanding of important detectors like photodiodes or photomultipliers.

Teaching type
lecture with integrated tutorials

Mode of assessment
oral (30 min)

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
6/86

Module title: Optoelectronics

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149277	6 CP	180 h	1. semester (MaLAP)	winter term	1 Semester

Courses / lectures	Contact hour	Self-Study	Group size
141267: Optoelectronics	60 h		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: Prof. Dr.-Ing. Nils C. Gerhardt
Lecturer: Prof. Dr.-Ing. Nils C. Gerhardt

Module use

Master Lasers and Photonics (PO 2015)

Learning outcomes
Learn the functional principle of optoelectronic devices. Accumulate knowledge of the basic physics and on the function of the most important devices (solar cell, photodiode, light emitting diode, semiconductor laser).

Content
At first, the basic principles of semiconductors (lattice structure, band structure, doping) are introduced. In the second chapter, the elementary interactions between light and semiconductors are addressed. The third chapter contains the p-n-junction and hetero junctions. Then, the most important devices: solar cells, photodiodes, light emitting diodes, and semiconductor lasers are discussed in separate chapters. New devices like modulators and optical switches are referred to in the second last chapter and the last chapter consists of an overview about organic optoelectronics.

Teaching type
lecture with tutorials

Mode of assessment
oral (30 min)

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
6/86

Module title: Photonics

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149278	6 CP	180 h (according to the courses)	2. semester (MaLAP)	winter term	1 Semester

Courses / lectures	Contact hour	Self-Study	Group size
141261: Photonics 142269: Master Project Optics Fundamentals	see courses		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: Prof. Dr. Martin R. Hofmann
Lecturer: Prof. Dr. Martin R. Hofmann

Module use

Master Lasers and Photonics (PO 2015)

Learning outcomes
The students have learned the fundamentals of optical information transfer and retrieval. The have acquired basic knowledge of lasers, linear and non-linear optics and understand the concepts of optical memories (CD, DVD) and optical telecommunication.

Content
The lecture starts with the fundamentals of linear optics (refraction, diffraction, dispersion etc.). Afterwards, the interaction of light and matter is analyzed and the fundamentals of lasers are worked out. Important laser systems are discussed and principles of the generation of short light pulses are explained. Furthermore, the principles and applications of non-linear optics are discussed. As the most important photonic application, optical memories and optical telecommunications are discussed in separate chapters. The lecture is concluded with an outlook on the potential of photonic crystals.

Teaching type
- lecture with tutorials
- project

Mode of assessment
oral (30 min)
pro-ject

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
6/86

Module title: Laser Materials Processing

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149274	6 CP	180 h	2. semester (MaLAP)	summer term	1 Semester

Courses / lectures	Contact hour	Self-Study	Group size
139960: Laser Materials Processing	60 h		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: PD Dr.-Ing. Cemal Esen
Lecturer: M. Sc. Henrik Dobbelstein

Module use

Master Lasers and Photonics (PO 2015)

Learning outcomes
The students will learn about the basics of the different processing methods. They should be able to estimate benefits and limitations of the different methods and to compare them with conventional production techniques.

Content
First of all the principles of different high power lasers and their suitability for material processing are treated. Then the guiding and forming devices for laser beams are discussed. The properties of laser beams and material surfaces are discussed in own chapters. The following chapters include the interaction between laser beam and material as well as the different processing methods e.g. cutting, welding, surface treating and marking. The last two chapters contain an overview about laser safety and an introduction in laser applications in medical engineering.

Teaching type
lecture with tutorials

Mode of assessment
oral (30 min)

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
6/86

Module title: Laser Technology

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149272	6 CP	180 h	2. semester (MaLAP)	summer term	1 Semester

Courses / lectures	Contact hour	Self-Study	Group size
138950: Laser Technology	60 h		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: Prof. Dr.-Ing. Ostendorf
Lecturer: Prof. Dr. Evgeny Gurevich

Module use
Master Lasers and Phpptonics (PO 2015)

Learning outcomes
The students understand the principle of lasers and how coherent light is generated. Second, they have learned how these principles are used in different laser sources and how existing lasers are designed. Finally, they have accumulated knowledge of optical components to control and manipulate laser light e.g. to convert wavelengths and to generate short and ultrashort laser pulses.

Content
After an introduction into the different energy levels in atoms and molecules and a basic description of the quantum mechanics concept the different principles of light-matter interaction are derived, i.e. absorption, spontaneous emission and stimulated emission. Second, the rate equations will be presented and effective amplification of light will be discussed. In the following, resonator concepts will be investigated and a complete description of the laser becomes possible. In the next chapter optical components, polarisation and birefringence are explained and methods to generate short and ultrashort pulses. Based on this knowledge the different laser sources will be presented subdivided into solid-state lasers, gas lasers, liquid dye lasers and semiconductor lasers. Finally, non-linear optics is explained in order to generate new wavelengths.

Teaching type
lecture with tutorials

Mode of assessment
oral (30 min)

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
6/86

Module title: Optical Metrology

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149276	6 CP	180 h	2. semester (MaLAP)	summer term	1 Semester

Courses / lectures	Contact hour	Self-Study	Group size
141263: Optical Metrology	60 h		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: Prof. Dr.-Ing. Nils C. Gerhardt
Lecturer: Prof. Dr.-Ing. Nils C. Gerhardt
Dr.-Ing. Carsten Brenner

Module use
Master Lasers and Photonics (PO 2015)

Learning outcomes
The students understand the physical functional principles of optical metrology. They have learned the characteristics and limits of optical metrology. Furthermore, they got to know the selection criteria of suitable optical measuring techniques for a given application.

Content
Optical metrology is used as cross-sectional technology in many disciplines. At first, the basic characteristics of light and its interaction with matter are pointed out in a short fundamental chapter. Subsequently, the tools of optical metrology, i.e. active and passive optical elements are discussed. The main part of the lecture deals with measuring techniques like: geometry measurements, profilometry, shape measurements, spectroscopy, high-speed cameras, infrared imaging, and biophotonics.

Teaching type
lecture with tutorials

Mode of assessment
oral (30 min)

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
6/86

Module title: Master Thesis LAP

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149269	30 CP	900 h	4. semester (MaLAP)	winter- and summer term	1 Semester

Courses / lectures	Contact hour	Self-Study	Group size
144103: Master Thesis LAP			Studierende

Language	Requirements
english	see examination regulations

Responsible person and lecturer(s)
Module coordinator: LAP Coordinator: Prof. Dr. Martin R. Hofmann
Lecturer: Lectures of the RUB

Module use
Master Lasers and Photonics (PO 2015)

Learning outcomes
The students are familiar with the concepts of scientific research and with the organisation of projects. They are able to present their advanced knowledge and experience in an understandable way.

Content
Mostly self organised solution of a scientific task under supervision.

Teaching type
master thesis

Mode of assessment
thesis

Requirements for credits
Successful passing of the thesis.

Proportion of graded modules (based on a required coursework of 120 ECTS)
30/86

Module title: Mandatory Elective Courses

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149273	20 CP	at least 600 h (according to the courses)	1., 2. or 3. semester (MaLAP)	winter- and summer term	3 Semester

Courses / lectures	Contact hour	Self-Study	Group size
141271: Biomedical Optics 141378: Computational Engineering 2: Electrodynamics 141367: Electromagnetic Fields 139940: Fiber Optics 141482: Numerical Photonics in Python 141269: Photovoltaics 160311: Physics of Quantum Cascade Lasers 160328: Quantum Optics 141421: Ultrafast Laser Physics 1: Basics of ultrashort pulses 141423: Ultrafast Laser Physics 2: Generation and Applications of Ultrashort Pulses 184611: Biophysical Chemistry I ***discontinued courses:*** 139900: Introduction to Nonlinear optics (last offered in summer term 2019) 139950: Plasmonics (last offered in winter termin 2017/2018) 160308: Laser Spectroscopy (last offered in summer term 2019) 141266: Terahertz Technology (last offered in winter termin 2017/2018) 141420: Ultrafast Laser Physics and Technology (last offered in winter term 2017/2018)	see courses		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: LAP Coordinator: Prof. Dr. Martin R. Hofmann
Lecturer: Lectures of the RUB

Module use
Master Lasers and Photonics (PO 2015)

Learning outcomes
The students acquire specific competences in individually chosen special areas of Lasers and Photonics.

Content
The students chose specific topics out of the lecture programme of the participating faculties of the Ruhr-Universität in order to include an individual focus area into their studies. The courses listed below will be accepted automatically, other choices have to be accepted by the LAP coordinator.

Teaching type
- lecture
- tutorials

Mode of assessment
oral
written

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
20/86

Module title: Practical subjects

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149279	6 CP	at least 180 h (according to the courses)	1., 2. or 3. semester (MaLAP)	winter- and summer term	Semester

Courses / lectures	Contact hour	Self-Study	Group size
142266: Competitive International Research Project Presentation 142265: Competitive International Research Project 143263: Journal Club 141422: Laser Colloquium 142262: Master Project Advanced Optics 1 142263: Master Project Advanced Optics 2 139040: Master-Project Applied Optics 1 139050: Master-Project Applied Optics 2 143261: Master Seminar Biomedical Optics 143264: Master-Seminar Photonics 143265: Master-Seminar Terahertz Technology 142268: Research Project Conference Participation 142267: Research Project 142264: Science Project ***discontinued courses:*** 141270: Scientific Working (last offered in summer term 2019) 143261: Master Seminar Biomedical Optics (last offered in summer term 2017) 141262: Maths for Laser engineers (last offered in summer term 2022)	see courses		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: LAP Coordinator: Prof. Dr. Martin R. Hofmann
Lecturer: Lectures of the RUB

Module use

Master Lasers and Photonics (PO 2015)

Learning outcomes
The students have acquired specific competences in laboratory work and know how to give scientific presentations in the area of Lasers and Photonics. They have learned to find individual solutions to a scientific project and have expertise in scientific communication. They are familiar with different experimental techniques and are able to present a project to a scientific international community. They know how to study actual scientific literature.

Content
The students perform practical courses together in small groups, participate in scientific seminars and give presentations of their work to each other. The detailed content depends on their specific choices between the offered practical courses.

Teaching type
- lecture with integrated tutorials
- colloquium
- project
- seminar

Mode of assessment
lab
seminar
project

Requirements for credits
Successful passing of the module examination.

Proportion of graded modules (based on a required coursework of 120 ECTS)
0/86

Module title: Free elective courses

Module no./Code	Credits	Workload	Recommended study semester	Cycle	Duration
149271	16 CP	at least 480 h ((according to the courses)	1., 2. or 3. semester (MaLAP)	winter- and summer term	3 Semester

Courses / lectures	Contact hour	Self-Study	Group size
141109: Free Choice	see courses		Studierende

Language	Requirements
english	none

Responsible person and lecturer(s)
Module coordinator: LAP Coordinator: Prof. Dr. Martin R. Hofmann
Lecturer: Lectures of the RUB

Module use

Master Lasers and Photonics (PO 15)

Learning outcomes
In this module the students acquire either deeper knowledge of specifc topical areas or new soft skills like, e.g. further languages or economic aspects.

Content
Courses of free choice from the programme of the Ruhr-Universität.

Teaching type
see courses

Mode of assessment
see courses

Requirements for credits
see courses

Proportion of graded modules (based on a required coursework of 120 ECTS)
0/86