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: 149263
Credits: 6 CP
Workload: 180 h (according to the courses)
Recommended study semester: 1. semester (MaLAP)
Cycle: winter- and summer term
Duration: 2 Semester

Courses / lectures
251230: English for Specific Academic Purposes: Producing and Presenting a Scientific Poster
251231: English for Specific Academic Purposes: Researching and Writing a Scientific Paper

Contact hour: see courses
Self-Study
Group size: Studierende

Language: english
Requirements: 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 scientific 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 assessment: 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**

<table>
<thead>
<tr>
<th>Module no./Code</th>
<th>Credits</th>
<th>Workload</th>
<th>Recommended study semester</th>
<th>Cycle</th>
<th>Duration</th>
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<tbody>
<tr>
<td>149275</td>
<td>6 CP</td>
<td>180 h</td>
<td>1. semester (MaLAP)</td>
<td>winter term</td>
<td>1 Semester</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Courses / lectures</th>
<th>Contact hour</th>
<th>Self-Study</th>
<th>Group size</th>
</tr>
</thead>
<tbody>
<tr>
<td>139930: Laser Metrology</td>
<td>60 h</td>
<td></td>
<td>Studierende</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>english</td>
<td>none</td>
</tr>
</tbody>
</table>

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

**Module use**
Master Lasers and Photonics (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

<table>
<thead>
<tr>
<th>Module no./Code</th>
<th>Credits</th>
<th>Workload</th>
<th>Recommended study semester</th>
<th>Cycle</th>
<th>Duration</th>
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<tbody>
<tr>
<td>149277</td>
<td>6 CP</td>
<td>180 h</td>
<td>1. semester (MaLAP)</td>
<td>winter term</td>
<td>1 Semester</td>
</tr>
</tbody>
</table>

Courses / lectures
141267: Optoelectronics

<table>
<thead>
<tr>
<th>Contact hour</th>
<th>Self-Study</th>
<th>Group size</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 h</td>
<td></td>
<td>Studierende</td>
</tr>
</tbody>
</table>

Language
english
Requirements
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

<table>
<thead>
<tr>
<th>Module no./Code</th>
<th>Credits</th>
<th>Workload</th>
<th>Recommended study semester</th>
<th>Cycle</th>
<th>Duration</th>
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<tbody>
<tr>
<td>149278</td>
<td>6 CP</td>
<td>180 h (according to the courses)</td>
<td>2. semester (MaLAP)</td>
<td>winter term</td>
<td>1 Semester</td>
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<table>
<thead>
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<th>Contact hour</th>
<th>Self-Study</th>
<th>Group size</th>
</tr>
</thead>
<tbody>
<tr>
<td>141261: Photonics</td>
<td>see courses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>142269: Master Project Optics Fundamentals</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>english</td>
<td>none</td>
</tr>
</tbody>
</table>

**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. They 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)
project

**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

<table>
<thead>
<tr>
<th>Module no./Code</th>
<th>Credits</th>
<th>Workload</th>
<th>Recommended study semester</th>
<th>Cycle</th>
<th>Duration</th>
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<tbody>
<tr>
<td>149274</td>
<td>6 CP</td>
<td>180 h</td>
<td>2. semester (MaLAP)</td>
<td>summer term</td>
<td>1 Semester</td>
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<table>
<thead>
<tr>
<th>Courses / lectures</th>
<th>Contact hour</th>
<th>Self-Study</th>
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</thead>
<tbody>
<tr>
<td>139960: Laser Materials Processing</td>
<td>60 h</td>
<td></td>
<td>Studierende</td>
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<table>
<thead>
<tr>
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<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>english</td>
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</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Module no./Code</th>
<th>Credits</th>
<th>Workload</th>
<th>Recommended study semester</th>
<th>Cycle</th>
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<tbody>
<tr>
<td>149272</td>
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<td>180 h</td>
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<table>
<thead>
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<th>Courses / lectures</th>
<th>Contact hour</th>
<th>Self-Study</th>
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<tbody>
<tr>
<td>138950: Laser Technology</td>
<td>60 h</td>
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<td>Studierende</td>
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<table>
<thead>
<tr>
<th>Language</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>english</td>
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</tbody>
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### Responsible person and lecturer(s)
Module coordinator: Prof. Dr.-Ing. Ostendorf  
Lecturer: Prof. Dr. Evgeny Gurevich

### Module use
Master Lasers and Photonics (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

<table>
<thead>
<tr>
<th>Module no./Code</th>
<th>Credits</th>
<th>Workload</th>
<th>Recommended study semester</th>
<th>Cycle</th>
<th>Duration</th>
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<tbody>
<tr>
<td>149276</td>
<td>6 CP</td>
<td>180 h</td>
<td>2. semester (MaLAP)</td>
<td>summer term</td>
<td>1 Semester</td>
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<table>
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<th>Courses / lectures</th>
<th>Contact hour</th>
<th>Self-Study</th>
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<tbody>
<tr>
<td>141263: Optical Metrology</td>
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<table>
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<th>Requirements</th>
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</thead>
<tbody>
<tr>
<td>english</td>
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**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

<table>
<thead>
<tr>
<th>Module no./Code</th>
<th>Credits</th>
<th>Workload</th>
<th>Recommended study semester</th>
<th>Cycle</th>
<th>Duration</th>
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<tbody>
<tr>
<td>149269</td>
<td>30 CP</td>
<td>900 h</td>
<td>4. semester (MaLAP)</td>
<td>winter- and summer term</td>
<td>1 Semester</td>
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<table>
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<tr>
<th>Courses / lectures</th>
<th>Contact hour</th>
<th>Study</th>
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<tbody>
<tr>
<td>144103: Master Thesis LAP</td>
<td>Self-Study</td>
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<table>
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<tr>
<th>Language</th>
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</thead>
<tbody>
<tr>
<td>english</td>
<td>see examination regulations</td>
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<table>
<thead>
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<th>Responsible person and lecturer(s)</th>
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<tbody>
<tr>
<td>Module coordinator: LAP Coordinator: Prof. Dr. Martin R. Hofmann</td>
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<tr>
<td>Lecturer: Lectures of the RUB</td>
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<table>
<thead>
<tr>
<th>Module use</th>
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</thead>
<tbody>
<tr>
<td>Master Lasers and Photonics (PO 2015)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning outcomes</th>
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</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>Mostly self organised solution of a scientific task under supervision.</td>
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<table>
<thead>
<tr>
<th>Teaching type</th>
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<tbody>
<tr>
<td>master thesis</td>
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<table>
<thead>
<tr>
<th>Mode of assessment</th>
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<tbody>
<tr>
<td>thesis</td>
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<table>
<thead>
<tr>
<th>Requirements for credits</th>
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</thead>
<tbody>
<tr>
<td>Successful passing of the thesis.</td>
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<table>
<thead>
<tr>
<th>Proportion of graded modules (based on a required coursework of 120 ECTS)</th>
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<tbody>
<tr>
<td>30/86</td>
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</table>
# Mandatory Elective Courses

<table>
<thead>
<tr>
<th>Module no./Code</th>
<th>Credits</th>
<th>Workload</th>
<th>Recommended study semester</th>
<th>Cycle</th>
<th>Duration</th>
<th>Courses / lectures</th>
</tr>
</thead>
</table>

**Discontinued courses:**

- 141378: Computational Engineering 2: Electrodynamics (last offered in winter term 2020/21)
- 184611: Biophysical Chemistry I (last offered in summer term 2022)
- 139900: Introduction to Nonlinear optics (last offered in summer term 2019)
- 139950: Plasmonics (last offered in winter term 2017/2018)
- 160308: Laser Spectroscopy (last offered in summer term 2019)
- 141266: Terahertz Technology (last offered in winter term 2017/2018)
- 141420: Ultrafast Laser Physics and Technology (last offered in winter term 2017/2018)

<table>
<thead>
<tr>
<th>Language</th>
<th>Requirements</th>
<th>Responsible person and lecturer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>english</td>
<td>none</td>
<td>Module coordinator: LAP Coordinator: Prof. Dr. Martin R. Hofmann Lecturer: Lectures of the RUB</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Contact hour</th>
<th>Self-Study</th>
<th>Group size</th>
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</thead>
<tbody>
<tr>
<td>see courses</td>
<td></td>
<td>Studierende</td>
</tr>
</tbody>
</table>

Seite 10 von 14
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

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

### Courses / lectures

- 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)

### Language

- english

### Requirements

- 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

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

### Courses / lectures
- **141109: Free Choice**

### Contact hour
- see courses

### Self-Study

### Group size
- Studierende

### Language
- english

### Requirements
- 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 specific 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