Module Number: 33001 SPO-Version: 32

Module Name: Project / Soft Skills

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Mandatory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	4
Offered	Winter Semester, Summer Semester
Credits	5 CP
Workload Class	90 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

General
The student can organize and structure solutions to a particular problem. The students are able to determine fundamental data concerning signal power and noise by evaluation. They can use and perform basic measurements.

Professional Competence
The laboratory work enables students to gain practical experience, as they are able to carry out experiments and create measurement set-ups etc. on their own responsibility or in small teams.

Special Methods Competence
Die Studierenden können selbstständig neue Themengebiete erarbeiten, Informationen bewerten, praktische Schlussfolgerungen ziehen, neue Lösungen entwickeln und dabei sowohl gesellschaftliche/ soziale als auch ökologische und ökonomische Aspekte berücksichtigen.

Interdisciplinary Competence
Es werden die mit dem zivilgesellschaftlichen Engagement verbundenen Ziele, wie die ganzheitliche Bildung der Studierenden zu fördern, erreicht.

Course Content

Literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33101	Projects / Soft Skills	Prof. Dr. Jürgen Krapp	L	4	

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33101	PLS, PLR	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 22.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Hochschule Aalen

Module Number: 33002 SPO-Version: 32

Module Name: Interferometry

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Rainer Börret
Modul Type	Mandatory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	33035 Fundamental Optics
Use in other SG	none
Language	English

Module Objectives

General
The student can organize and structure solutions to a particular problem. The students are able to determine fundamental data concerning signal power and noise by evaluation. They can use and perform basic measurements.

Professional Competence
Students will be able to apply and perform the basic concepts and applications of inferferometry and optical measurement techniques. They will be able to interpret and discuss the results as well as alternative methods and solutions.

The Students are able to choose and specify suitable interferometric setups for different applications, choose and specify suitable light sources, sensors and components for interferometric setups and applications and design an interferometric setup for different applications by means of the learned methods and information.

They can specify and select the principles of fringe analysis and the appropriate assessment techniques.

They are able to select a suitable calibration technique to qualify an interferometer and are able to specify the range, resolution and accuracy of an interferometric setup.

They are able to apply the methods listed above in the lab and analyze and review critical the results

Special Methods Competence
They are enabled to systematically select the suitable metrology setup for various measurement problems. They are able to calibrate an interferomter and design and execute a process to define the Capability of aMeasurement System

Interdisciplinary Competence
Students can discuss, debate and work in groups about specific problems and about the best solutions and applications related to a particular measurement problem.

Course Content Lecture:

- Basic principles of interference
- Interferometers
- Detection techniques and algorithms
- Calibration techniques
- Accuracy and error sources
- Testing the quality of optical materials
- Examples for Application of Interferometry
- Testing the geometry of optical components

Literature

- Hand-out, detailed manuscript with exercises
- Dörband, Müller, Gross: "Handbook of Optical Systems, Vol. 5"
- Hecht „Optics“ (Fundamentals)
- Malacara „Optical Shop Testing“

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33102	Interferometry	Prof. Dr. Rainer Börret	V, L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33102	PLM (20 Minutes)	50 %	
	PLP	50 %	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 22.03.2023, Fritz; 26.09.2023 R.Boerret

---

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33001 SPO-Version: 32

Module Name: Project / Soft Skills

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Compulsory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

Professional Competence
The students can describe and use their knowledge of fiber optic communication systems, the structure and properties of the corresponding components.
Students will be able to obtain basic data about signal power and noise by evaluation.

The students are able to expand their knowledge and develop new consolidating insights. They are able to answer, evaluate and develop questions on the individual topics.

Special Methods Competence
Students can analyze literature and distinguish between relevant and irrelevant information.

Interdisciplinary Competence
The student

- is able to understand and handle complex problems and experiments
- has an increased ability to abstract thinking

Course Content

STRUCTURE AND LIGHT PROPAGATION IN FIBERS, FIBER ATTENUATION, FIBER DISPERSION, FIBER OPTIC SOURCES, FIBER COUPLING; OPTICAL AMPLIFIERS WITH ERBIUM DOPED FIBERS, PHOTODETECTORS; RECEIVERS

Literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33103	Photonics Communications Engineering	Prof. Dr. Jürgen Krapp	V, E	6	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33103	PLK	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 22.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Hochschule Aalen

Module Number: 33004 SPO-Version: 32

Module Name: Quantum Optics

Degree Program	Applied Photonics
Module Manager	Prof. Dr. A. Harth
Modul Type	Mandatory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Mathematics, physics of technical bachelor degree
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students are able to describe and understand quantum optical phenomena mathematically and to interpret the theoretical predictions in terms of experimental relevance.

Special Methods Competence
The students learn to apply quantum physical principles to technical applications.

Interdisciplinary Competence
The students solve exercises and laboratory tasks alone and in groups and present their results.

Course Content

- Introduction: Classical optics
- Semi-classical: Radiative transitions in atoms
- Photon statistics
- Entanglement
- Quantum Computer

Literature

Tipler: Physik; Mark Fox: Quantum Optics

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33201	Quantum Optics	Prof. Dr. A. Harth	V, Ü, L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33201	PLK (45 Minutes)	80 %	
33201	PLL	20 %	

Requirements for Admission to the Module Exam
Passed Preexam

Further Study-Related Feedback
None

Comments:

Last Update: 04.04.2023, AnHa

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33005 SPO-Version: 32

Module Name: Project / Soft Skills

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Heinrich
Modul Type	Mandatory Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students can understand wave optics. They can understand phenomena that describe the interaction of light waves with material. This will illustrate the difference between beam and wave optics. Students will be able to identify the limits of beam optics and describe improved optical effects using wave optics.

Special Methods Competence
Students are able to analyse literature. They can differ between relevant and non-relevant information and evaluate and judge optical phenomena.

Interdisciplinary Competence
Students are able to discuss the advantages and disadvantages of different approaches in a team. They can express themselves scientifically and complete their knowledge.

Course Content

basics of wave optics, light interference, light diffraction / inverse diffraction, light polarization, light scattering

Literature

Monographien und Originalartikel

B. E.A. Saleh, M.V. Teich: Fundamentals of Photonics

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33202	Physical Optics	Prof. Dr. Andreas Heinrich	V	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
1	PLK (60 Minutes)	100%	Allowed Exam Materials: none

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Hochschule Aalen	**Faculty** Optics and Mechatronics	Module Description
	Degree Program Applied Photonics (Master)	SPO 31
	Module Coordinator Prof. Dr. Andreas Heinrich	

Module Name	Illumination					**Module No : 33041**	
CP	**SHW**[1]	**Workload**	**Contact Time**	**Self-Study**	**Begin**	**Sem**	**Duration**
5	4	150	~~56~~0 h	~~109~~0 h	☐ Winter Semester ☒ Summer Semester	2	☒ 1 Semester ☐ 2 Semesters Semesters
Degree Objective			**Module Type (PM/WPM/WM)**		**Division (Upper/Lower)**	**Incorporated in Degree Programs**	
Master of Science			WM - Elective Module		HS - Hauptstudium	Photonics	
Study Form	☒ Lecture ☐ Tutorial ☐ Lab ☒ Self-Study ☐ Seminar ☐ Assignment ☐ Projekt Work ☐ Other: Paper, Report						
Prerequisites	no						

Supporting Modules / Courses							
Course No.	**Title of the Module / Course**	**Lecturer**	**Type**	**SHW**[1]	**CP**	**Sem**	**Module Exam Type/ Length/ Graded**
33241	Illumination	Dr. Johannes Eisenmenger	V	4	5	2	PLK 90 benotet
	Module Type (PM/WPM/WM)	**Division (Upper/Lower)**	**Incorporated in Degree Programs**				
	WM - Elective Mo	HS - Hauptstudium	Photonics				
Allowed Exam Materials	none						

[1] SHW = Semester Hours per Week

Learning Goals / Competences

Professional competence (professional knowledge and skills, professional expertise):

Students can understand the lighting in a basic way. They can describe their knowledge of phenomena that describe the interaction of light waves in optical systems. This allows them to represent the difference between beam and wave optics. This will allow students to see the limits and describe improved optical effects.
In addition, students can apply simulation software and transfer their understanding of lighting system design.
Special (methods) skills, if applicable:

Students are able to analyse literature and distinguish between relevant and irrelevant information. They can evaluate and judge optical phenomena.
Over professional competence (social skills und ability to work independently):
They can discuss and evaluate the advantages and disadvantages of different approaches in a team. They can express themselves scientifically and apply their knowledge.

Competence Area	Heavy	Medium	Light
Technical Competence	☒	☐	☐
Methods Competence	☐	☒	☐
Social Competence	☐	☒	☐

Course Contents

The students can choose out of this topics:

1 Introduction
2 Radiometry and apertures
3 Illumination in Imaging Systems
4 Illumination in Nonimaging Systems
5 Spectoradiometric Quantities
6 Radiometric and Photometric quantities
7 Color
8 Scattering of Light
9 Illumination Properties of Materials
10 Sources of Illumination
11 Coherence
12 Fibers, Lightpipes and Ligthguides
13 Classical Illumination Design
14 Uniform Illumination
15 Source Modeling Methods
16 Nonimaging Compound Concentrators
17 Displays
18 Characterizing Illumination Systems
19 Software Modelling
20 Architectural Illumination
21 Light and Visual Performance
22 Lighting Design
23 Illumination in Photography
24 Luminaire for Open-Plan Office
25 Daylight Compensation
26 Exterior Lighting
27 Parking
28 Roadway Lighting
29 Resolution Enhancement by Illumination in Microscopy and Photolithography
30 Special Illumination Techniques for Measurements
31 Illumination in Particle Optics

Language	☐ German	☒ English	☐ Spanish	☐ French
	☐ Chinese	☐ Portuguese	☐ Russian	Other:

[1] SHW = Semester Hours per Week

Literature	-
Composition of Final Grade	PLK (100%)
Comments / Other	
Last Updated	14.03.17 Andreas Heinrich

[1] SHW = Semester Hours per Week

Hochschule Aalen

Module Number: 33211 SPO-Version: 32

Module Name: Fourier Optics

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Heinrich
Modul Type	Compulsory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Mathematics, physics of technical Bachelor degree
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students are able to do Fourier analysis and calculations in the field of optics
The students learn to convince their team partners by a scientific discussion to come to a common accepted solution.

Special Methods Competence
The students will get a fundamental understanding Fourier methods techniques in order to apply Fourier Methods to simulate optical Elements for light propagation. Thereby Matalb will be used on order to perform the simulations.

Interdisciplinary Competence
The learning goal of the students' self study is to reach the level of optical knowledge regarding Diffractive optics. Setting up experiments enables the students to transfer their theoretical knowledge and to realize problems to be faced in a practical environment.

Course Content Refraction, reflection, paraxial optical systems, optical devices, polarization, interference

Literature lecture notes with bibliography

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33211	Fourier Optics	Prof. Dr. Andreas Heinrich	V, L	4	5

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33216	PLK (60 minutes)	100%	Allowed Exam Materials: none

Requirements for Admission to the Module Exam

Further Study-Related Feedback
None

Comments:

Last Update: 27.03.2023, Fritz

Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32

Hochschule Aalen	**Fakultät** Optik und Mechatronik	Modulbeschreibung
	Studiengang Photonics	
	Modulkoordinator Prof. Dr. Andreas Walter	

Modul-Name	Advanced Microscopy in Life Sciences					**Modul-Nr :**	
CP	**SWS**	**Workload**	**Kontakt-zeit**	**Selbst-studium**	**Angebot Beginn**	**Sem**	**Dauer**
5	4	150h	60h	90h	☒ Wintersemester ☐ Sommersemester	1	☒ 1 Semester ☐ 2 Semester Semester

Angestrebter Abschluss	**Modultyp (PM/WPM/WM)**	**Studienabschnitt**	**Einsatz in Studiengängen**
Master of Science	WPM - Wahlpflichtmodul		APh

Form der Wissensvermittlung	☒ Vorlesung ☒ Übung ☒ Labor ☒ Selbststudium ☐ Seminar ☐ Hausarbeit ☐ Projektarbeit ☒ Sonstiges: Referat, Bericht

Lernziele / Kompetenzen

Fachkompetenz („Wissen und Verstehen“ und „Fertigkeiten“): Die Studierenden werden ein tiefes technisches, mathematisches und anwendungsbezogenes Wissen Moderner optischer und nicht-optischer Mikroskopiemethoden inklusive derer optischen Grundlagen - von Linsenaberrationen bis hin zur Fourier-Optik und Punktspreizfunktion - erlangen. Die Mikroskopietechniken beinhalten fortgeschrittene Modalitäten wie zum Beispiel die sogenannte Super-Resolution unter dem Abbeschen Diffraction Limit, aber auch nicht-optische Techniken wie die Elektronen-, Röntgen- oder Ionenmikroskopie und ihre physikalischen Prinzipien und biomedizinschen Anwendungen. Zudem werden Aufbau und Bildprozessierung der jeweiligen Techniken behandelt.

Überfachliche Kompetenz („Sozialkompetenz“ und „Selbstständigkeit“): Die Studierenden lernen, peer-reviewed aktuelle Literatur zum Thema Mikroskopieentwicklung zu analysieren und zu durchdringen, einen Überblick in einem Kurzreferat zu präsentieren, und Labor-und Forschungsprojekte in 2 hands-on sessions als Team zu bearbeiten.
Die selbstständige Bearbeitung von speziellen Themen unter Berücksichtigung des bisherigen Fachwissens, Literatur und wissenschaftlichen Methodik bereitet die Studenten auf die Anforderungen der Masterthesis vor.

Ggf. besondere Methodenkompetenz: Die Studierenden optimieren ihre Präsentationstechniken (Vortragsgestaltung) und setzen Methoden zur Informationsgewinnung (Literaturrecherche, -sichtung, -verwaltung) zielgerichtet ein. Sie werden komplexe mathematische und physikalsiche Zusammenhänge auf konkrete Anwendungen in der Mikroskopie übertragen lernen.

Lehrinhalte

1. Motivation & Introduction
2. Fundamentals of Microscopy
a. Geometric Optics
b. Waves
c. Gaussian Beams
d. Fourier Optics
e. Diffraction
f. Diffraction Limit

g. OTF & PSF
3. Grundlagen der Zellbiologie
a. Zellaufbau
b. Zellkultur
4. Das Lichtmikroskopie
a. Aufbau & Strahlengang
b. Abbesche Theorie der Bildentstehung
c. Methoden zur Kontraststeigerung
5. Fluoreszenzmikroskopie & Konfokale Mikroskopie
a. Fluoreszenz & Absorption
b. Aufbau
c. Konfokale Mikroskopie
d. Dynamische Techniken: From Fluorescence Correlation Spectroscopy to Fluorescence Recovery After Photobleaching
6. Super-Resolution/Einzelmolekül-Mikroskopie
a. Structured Illumination Microscopy
b. STED
c. PALM/STORM
7. Mikroskopie dicker Proben
a. Lichtscheibenmikroskopie
b. Nicht-lineare Optik & Zweiphotonenmikroskopie
8. Elektronen- und Ionenmikroskopie
a. Transmissionelektronenmikroskopie
b. Rasterelektronenmikroskopie
c. Ionenmikroskop
9. Atomic Force Microscopy
10. Röntgenmikroskopie
11. Spektroskopie & Mikroskopie
a. Raman
b. Brillouin
c. X-ray Spectroscopy
d. Mass spec Imaging

Zugangsvoraussetzung	**Vorbereitung Teilnahme Modul:** keine **Modul:** keine **Prüfung:** keine

Enthaltene Teilmodule / Lehrveranstaltungen

Fach-Nr.	Titel des Teilmoduls / Lehrveranstaltung	Lehrende	Art	SWS	CP	Sem	Modulprüfung Art / Dauer / Benotung
XXXXX	Advanced Microscopy	Walter	V	4	5	1	PLK 90 benotet
	Teilmodultyp (PM/WPM/WM)	**Studienabschnitt**	**Einsatz in Studiengängen**				
	WPM - Wahlpflichtveranstaltung		APh				
Fach-Nr.	**Titel des Teilmoduls / Lehrveranstaltung**	**Lehrende**	**Art**	**SWS**	**CP**	**Sem**	

	Teilmodultyp (PM/WPM/WM)	**Studienabschnitt**	**Einsatz in Studiengängen**				
Zugelassene Hilfsmittel		Formelzettel					

Sprache	☐ Deutsch ☒ Englisch ☐ Spanisch ☐ Französisch ☐ Chinesisch ☐ Portugiesisch ☐ Russisch
Literatur	Literatur zu speziellen Themen der Optischen Mikroskopie, Fourier Optik, Elektronenmikroskopie wird bereitgestellt.
Zusammensetzung der Endnote	100% PLK - Klausur, 90 Minuten Zulassungsvoraussetzung: Kurzreferat
Bemerkungen / Sonstiges	
Letzte Aktualisierung	Andreas Walter, 12.Oktober 2022

Module Number: 33216 SPO-Version: 32

Module Name: Introduction to Diffractive Optics

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Heinrich
Modul Type	Compulsory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Mathematics, physics of technical Bachelor degree
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students are able to do Fourier analysis and calculations in the field of optics
The students learn to convince their team partners by a scientific discussion to come to a common accepted solution.

Special Methods Competence
The students will get a fundamental understanding on diffractive elements and are able to apply Fourier methods and other techniques in order to Design Difractive optical Elements for light propagation, Transmittance. Additional knowledge will be obtained on special diffractive elements like Gratings etc.

Interdisciplinary Competence
The learning goal of the students' self study is to reach the level of optical knowledge regarding Diffractive optics. Setting up experiments enables the students to transfer their theoretical knowledge and to realize problems to be faced in a practical environment.

Course Content

Refraction, reflection, paraxial optical systems, optical devices, polarization, interference

Literature

lecture notes with bibliography

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33216	Introduction to Diffractive Optics	Prof. Dr. Andreas Heinrich	V, L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33216	PLK (60 minutes)	100%	Allowed Exam Materials: none

Requirements for Admission to the Module Exam

Further Study-Related Feedback
None

Comments:

Last Update: 27.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33801 SPO-Version: 32

Module Name: Project / Soft Skills

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Thomas Hellmuth
Modul Type	Mandatory Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	4
Offered	Winter Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Mathematics, physics of technical bachelor degree
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Professional competence (professional knowledge and skills, professional expertise):
Students are able to describe and understand non-linear optical laser phenomena mathematically, to interpret the theoretical predictions in terms of experimental relevance, to analyse tolarances and specify non-linear crystals.

Special Methods Competence
The students are able to search specifications and physical properties of non-linear crystals to design non-linear laser devices for industrial applications.

Interdisciplinary Competence
The students simulate, design and validate crystals with the SNLO program. The results are presented by the respective groups.

Course Content Polarization optics, crystal optics, non-linear optics of second and third order

Literature Lecture notes with bibliography

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33104	Non-linear Optics	Prof. Dr. Thomas Hellmuth	V, Ü	4	5

[1] *V Lecture* *L Lab* *S Seminar* *PR Internship* *EX Experiment* *X Not Fixed*
E Excursion *Ü Practice* *P Project* *K Colloquium* *EL E-Learning*

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33104	PLK (60 Minutes)	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33802 SPO-Version: 32

Module Name: Photonics Detectors and Devices

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Heinrich
Modul Type	Mandatory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Basic knowledge in Optics & Math
Use in other SG	none
Language	English

Module Objectives

Professional Competence
The student can name and classify optical parts and electro-optical components. He can understand and apply the basic principles of this component.

Special Methods Competence
The students can evaluate scientific research and relevant literature.

Interdisciplinary Competence
The student can evaluate the advantages and disadvantages of different concepts and discuss them in a team. The student is able to communicate scientifically and apply his in-depth knowledge.

Course Content

- advanced optical components
  gradient-index lenses, diffusers, Fresnel lenses, light pipes, tapers, Axicons,
  optical filters (absorption filters, Fabry Perot filters, Interference filters, electrical tuneable filters, gratings)

- electro-optical components
  light sources and illumination (LED, SMD, OLED, structured illumination, requirements for an adequat
  illumination)
  projectors (SLMs, LCOS, LCDs, GLVs, DMDs, DLPs)
  detectors (CCD, CMOS, polarization camera, plenoptical camera)
  displays (3D Displays and imaging: stereoscopic, autoscopic, holographic)

Literature

Herbert Gross: Optical Systems

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33105	Photonics Detectors and Devices	Prof. Dr. Andreas Heinrich	V	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33105	PLR	100%	Allowed Aids: none

Requirements for Admission to the Module Exam
accomplished group work

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33803 SPO-Version: 32

Module Name: Applications of Photonics Detectors

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Mandatory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester, Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

General
The student can organize and structure solutions to a particular problem. The students are able to determine fundamental data concerning signal power and noise by evaluation. They can use and perform basic measurements.

Professional Competence
The laboratory work enables students to gain practical experience, as they are able to carry out experiments and create measurement set-ups etc. on their own responsibility or in small teams.

Special Methods Competence
Die Studierenden können selbstständig neue Themengebiete erarbeiten, Informationen bewerten, praktische Schlussfolgerungen ziehen, neue Lösungen entwickeln und dabei sowohl gesellschaftliche/ soziale als auch ökologische und ökonomische Aspekte berücksichtigen.

Interdisciplinary Competence
Es werden die mit dem zivilgesellschaftlichen Engagement verbundenen Ziele, wie die ganzheitliche Bildung der Studierenden zu fördern, erreicht.

Course Content

Literature

Recommendation: 3 to 5 references to basic literature;
explicitly mark further literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33106	Applications of Photonics Detectors	Prof. Dr. Jürgen Krapp	L	4	

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33106	PLS, PLR	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33804 SPO-Version: 32

Module Name: Advanced Image Processing

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Mandatory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester, Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

General
The student can organize and structure solutions to a particular problem. The students are able to determine fundamental data concerning signal power and noise by evaluation. They can use and perform basic measurements.

Professional Competence
The laboratory work enables students to gain practical experience, as they are able to carry out experiments and create measurement set-ups etc. on their own responsibility or in small teams.

Special Methods Competence
Die Studierenden können selbstständig neue Themengebiete erarbeiten, Informationen bewerten, praktische Schlussfolgerungen ziehen, neue Lösungen entwickeln und dabei sowohl gesellschaftliche/ soziale als auch ökologische und ökonomische Aspekte berücksichtigen.

Interdisciplinary Competence
Es werden die mit dem zivilgesellschaftlichen Engagement verbundenen Ziele, wie die ganzheitliche Bildung der Studierenden zu fördern, erreicht.

Course Content

Literature

Recommendation: 3 to 5 references to basic literature;
explicitly mark further literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33107	Advanced Image Processing	Prof. Dr. Jürgen Krapp	L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33107	PLS, PLR	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33805 SPO-Version: 32

Module Name: Advanced Laser Technology

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Mandatory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester, Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

General
The student can organize and structure solutions to a particular problem. The students are able to determine fundamental data concerning signal power and noise by evaluation. They can use and perform basic measurements.

Professional Competence
The laboratory work enables students to gain practical experience, as they are able to carry out experiments and create measurement set-ups etc. on their own responsibility or in small teams.

Special Methods Competence
Die Studierenden können selbstständig neue Themengebiete erarbeiten, Informationen bewerten, praktische Schlussfolgerungen ziehen, neue Lösungen entwickeln und dabei sowohl gesellschaftliche/ soziale als auch ökologische und ökonomische Aspekte berücksichtigen.

Interdisciplinary Competence
Es werden die mit dem zivilgesellschaftlichen Engagement verbundenen Ziele, wie die ganzheitliche Bildung der Studierenden zu fördern, erreicht.

Course Content

Literature

Recommendation: 3 to 5 references to basic literature;
explicitly mark further literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33108	Advanced Laser Technology	Prof. Dr. Jürgen Krapp	L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33108	PLS, PLR	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33806 SPO-Version: 32

Module Name: Current Topics in Photonics

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Mandatory Module
Academic Semester	1. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester, Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

General
The student can organize and structure solutions to a particular problem. The students are able to determine fundamental data concerning signal power and noise by evaluation. They can use and perform basic measurements.

Professional Competence
The laboratory work enables students to gain practical experience, as they are able to carry out experiments and create measurement set-ups etc. on their own responsibility or in small teams.

Special Methods Competence
Die Studierenden können selbstständig neue Themengebiete erarbeiten, Informationen bewerten, praktische Schlussfolgerungen ziehen, neue Lösungen entwickeln und dabei sowohl gesellschaftliche/ soziale als auch ökologische und ökonomische Aspekte berücksichtigen.

Interdisciplinary Competence
Es werden die mit dem zivilgesellschaftlichen Engagement verbundenen Ziele, wie die ganzheitliche Bildung der Studierenden zu fördern, erreicht.

Course Content

Literature

Recommendation: 3 to 5 references to basic literature;
explicitly mark further literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33109	Current Topics in Photonics 1	Prof. Dr. Jürgen Krapp	L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33109	PLS, PLR	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33807 SPO-Version: 32

Module Name: Optical Systems Workshop

Degree Program	Applied Photonics
Module Manager	M.Sc. Dipl. Ing. (FH) Michael Wagner
Modul Type	Mandatory Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Basic knowledge in Optics & Math and Matlab
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students can implement optical systems and wave optics. Parallel to the theoretical lecture, students can build up experiments and apply their theoretical knowledge. They are able to illustrate, analyze and discuss different experimental solutions.

Special Methods Competence
Students can set up and carry out experiments, transfer theoretical knowledge and identify and solve problems that arise in practice.

Interdisciplinary Competence
The students can discuss and convince their opponents with a scientific discussion. They can find a common solution.

Course Content

- Reflection and refraction
- Paraxial optics and lenses
- Matrix optics and ray tracing
- Optical instrument
- Waves and interference
- Gaussian beams
- Polarization

Literature

Hand-out, detailed manuscript
Fundamentals of Photonics, B.E. Saleh et al, Wiley (1991)
Principles of Optics, M. Born et al., Pergamon Press (1977)
Optics, Hecht, Addison (1980)

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33110	Optical Systems Workshop	M.Sc. Michael Wagner	V, L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33110	PLK (60 minutes)	100%	

Requirements for Admission to the Module Exam
all reports need to be handed in on time

Further Study-Related Feedback
None

Comments:

Last Update: 13.04.2023, Wagner

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33809 SPO-Version: 32

Module Name: Advanced Optical Communications Technology

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Elective Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	proved knowledge of optical fiber communication (admission for exam)
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students will be able to explain and evaluate a sound knowledge of fiber optic networks, including structure, functionality and properties of the corresponding components. They will be able to compare sustainable network concepts and understand the principles of coherent optical transmission.

Special Methods Competence
Methodically this subject emphasize on self-reliant learning by guided seminars.

The student can analyze the corresponding literature on his own responsibility and differentiate between relevant and irrelevant information. He is able to present solutions and results.

Course Content

LAN, MAN, WAN, PDH, SDH/SONET, ATM, QAM, xDSL, AON, PON, HFC/CATV, FSO, Satellite Communication, DWDM, OTN (Optical Transport Network), OMUX/ODMUX, OADM, ROADM, Optical Switches Technologies, Fiber Nonlinearities, Raman Fiber Amplifier, NRZ and RZ transmission, Duobinary optical transmission, DPSK and RZ-DPSK, Coherent Transmission.

Literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33203	Advanced Optical Communications Technology	Prof. Dr. Jürgen Krapp	L	4	5

[1] *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33203	PLK (90 minutes)	80%	
	PLR	20 %	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 22.03.2023, Fritz

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33810 SPO-Version: 32

Module Name: Optics Technology

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Rainer Börret
Modul Type	Elective Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Module 33035 (Fundmental Optics) or equivalent course
Use in other SG	none
Language	English

Module Objectives

Professional Competence

The students are able to describe and apply their profound knowledge of optical technologies and measurement techniques by themselves.

The Students are able to analyze the optical specifications in order to choose the right technologies and suppliers.

They are able to set up an adequate process chain for specific optical components due to the technical and economic constraints in companies.

Special Methods Competence

They can interpret and apply the DIN ISO specification.

Interdisciplinary Competence

Students can present and defend their results. They can work in a team.

Course Content

- specifications: From ISO 10 110 to power spectral density
- errorbudget optics
- selected processes for fabrication of different optical elements
- new moulding processes for glass and plastics
- coating design and coating technology
- design, specifications and fabrication of diffractive optical elements

Literature

Manuscript and publications

J. Bliedtner, G. Grafe, R. Hector, Optical Technology

Braunecker, Hentschel, Tiziani, Advanced Optics with Aspherics

J.D. Rancourt, Optical Thin Films

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33206	Optics Technology	Prof. Dr. Rainer Börret	V, L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33206	PLM (20 Minutes)	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz, 04.04.2023 R.Boerret

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33811 SPO-Version: 32

Module Name: Current Topics in Photonics 2

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Walter
Modul Type	Mandatory Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

General
The student will be able to follow scientific talks, evaluate the information critically, and gain new insights into international state-of-the-art research on photonics. The student will be able to broaden his horizon while, at the same time, focus on a dedicated topic of his/her interest and understand this in great detail.

Professional Competence
The lectures allow the students to stay ahead with state-of-the-art research in the field of photonics and get insights into a variety of optical topics that will help guide their interests and enable them to address research questions scientifically.

Special Methods Competence
Students will be able to independently develop new topics from the latest research, evaluate information, and draw practical conclusions.

Interdisciplinary Competence
Strong interdisciplinarity: a wide range of optics topics are covered, from image processing to biophotonics.

Course Content

Literature

Recommendation: 3 to 5 references to basic literature;
explicitly mark further literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33207	Current Topics in Photonics 2	Prof. Dr. Andreas Walter	V	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33207	PLS, PLR	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 05.06.2023, Andreas Walter

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33812 SPO-Version: 32

Module Name: Optical Systems

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Heinrich
Modul Type	Mandatory Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Basic knowledge in Optics & Math and Matlab
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students can implement optical systems and perform system tests. Parallel to the theoretical lecture, students can build up experiments and apply their theoretical knowledge. They are able to illustrate, analyze and discuss different experimental solutions.

Special Methods Competence
Students can set up and carry out experiments, transfer theoretical knowledge and identify and solve problems that arise in practice.

Interdisciplinary Competence
The students can discuss and convince their opponents with a scientific discussion. They can find a common solution.

Course Content

- basics in optical systems design
- Aberreations
- Image Quality
- Tolerancing
- Materials
- Optimechanics
- Coating
- Analysis
- optical System testing

Literature

Hand-out, detailed manuscript with exercises

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33204	Optical Systems	Prof. Dr. Andreas Heinrich	V, L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33204	PLK (60 minutes)	100%	

Requirements for Admission to the Module Exam
all reports need to be handed in on time

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Hochschule Aalen

Module Number: 33813 SPO-Version: 32

Module Name: Project / Soft Skills

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Compulsory Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

Professional Competence
The students are able to understand and validate different laser types.

Special Methods Competence
The students are able to design, analyse and validate resonator optics, align lasers and determine their performance experimentally.

Interdisciplinary Competence
The laboratory work enables students to apply theoretical knowledge. They are able to perform experiments in a self-reliant way within a small team.

Course Content

Laser dynamics, pulsed lasers and pulse dispersion, laser clocks, advanced resonator design, femtosecond lasers, coherence and stochastic optics

Literature

Laser photonics lecture notes with bibliography

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33209	Laser Photonics	Prof. Dr. Thomas Hellmuth	L	4	5

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33209	PLM (30 Minutes)	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33815 SPO-Version: 32

Module Name: Optical Systems

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Heinrich
Modul Type	Mandatory Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Basic knowledge in Optics & Math and Matlab
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students can implement optical systems and perform system tests. Parallel to the theoretical lecture, students can build up experiments and apply their theoretical knowledge. They are able to illustrate, analyze and discuss different experimental solutions.

Special Methods Competence
Students can set up and carry out experiments, transfer theoretical knowledge and identify and solve problems that arise in practice.

Interdisciplinary Competence
The students can discuss and convince their opponents with a scientific discussion. They can find a common solution.

Course Content

- basics in optical systems design
- Aberreations
- Image Quality
- Tolerancing
- Materials
- Optimechanics
- Coating
- Analysis
- optical System testing

Literature

Hand-out, detailed manuscript with exercises

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33204	Optical Systems	Prof. Dr. Andreas Heinrich	V, L	4	5

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33204	PLK (60 minutes)	100%	

Requirements for Admission to the Module Exam
all reports need to be handed in on time

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

2 *PLK Written Exams PLR Presentation PLL Lab Work PLT Study Diary*
PLS Term Paper/Research Report PLE Draft/Design PLF Portfolio PMC Multiple Choice
PLM Oral Exam PLP Project PPR Internship PLC Multimedia-Based Examination
PLA Practical Work (E-Exam)
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33816 SPO-Version: 32

Module Name: Optical Design Strategies

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Thomas Hellmuth
Modul Type	Elective Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Lecture "Fundamental Optics"
Use in other SG	none
Language	English

Module Objectives

Professional Competence
The students are able to design optical systems and analyze optical aberrations to optimize optical system performance and to compare and validate different approaches.

Special Methods Competence
They are able to handle tool elements of an optical design program to design, simulate and analyze optical system.

Interdisciplinary Competence
The project work enables students to design various parts of an optical system and combine them within a team for the development of optomechanical devices.

Course Content

Literature

Recommendation: 3 to 5 references to basic literature;
explicitly mark further literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33205	Optical Design Strategies	Prof. Dr. Thomas Hellmuth	V, Ü, P	4	5

[1] *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33205	PLM (30 Minutes)	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32

Hochschule Aalen

Module Number: 33817 SPO-Version: 32

Module Name: Advanced Optical Design

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Thomas Hellmuth
Modul Type	Elective Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students are able to design advanced optical systems with the optical design program CodeV, simulate physical optical phenomena, design and simulate illumination systems.

Special Methods Competence
Students are able to select and apply methods for the analysis and validation of optical systems to optimize and develop innovative solutions.

Interdisciplinary Competence
The students simulate, design and validate optical systems with an optical design program to develop optomechanical systems. The results are presented by the respective groups.

Course Content

Aberration theory, correction strategies, programming and handling of optical design programs

Literature

Lecture notes and data sheets

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33208	Advanced Optical Design	Pretorius/Frasch	L	4	5

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33208	PLK (90 Minutes)	100%	Allowed Exam Materials: Calculator

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32

Module Number: 33818 SPO-Version: 32

Module Name: Illumination

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Heinrich
Modul Type	Elective Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Winter Semester, Summer Semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	none
Use in other SG	none
Language	English

Module Objectives

Professional Competence
Students can understand the lighting in a basic way. They can describe their knowledge of phenomena that describe the interaction of light waves in optical systems. This allows them to represent the difference between beam and wave optics. This will allow students to see the limits and describe improved optical effects. In addition, students can apply simulation software and transfer their understanding of lighting system design.

Special Methods Competence
Students are able to analyse literature and distinguish between relevant and irrelevant information. They can evaluate and judge optical phenomena.

Interdisciplinary Competence
They can discuss and evaluate the advantages and disadvantages of different approaches in a team. They can express themselves scientifically and apply their knowledge.

Course Content The students can choose out of this topics:
1 Introduction
2 Radiometry and apertures
3 Illumination in Imaging Systems
4 Illumination in Nonimaging Systems
5 Spectoradiometric Quantities
6 Radiometric and Photometric quantities
7 Color
8 Scattering of Light
9 Illumination Properties of Materials
10 Sources of Illumination
11 Coherence
12 Fibers, Lightpipes and Ligthguides
13 Classical Illumination Design
14 Uniform Illumination
15 Source Modeling Methods
16 Nonimaging Compound Concentrators
17 Displays
18 Characterizing Illumination Systems
19 Software Modelling
20 Architectural Illumination
21 Light and Visual Performance
22 Lighting Design
23 Illumination in Photography
24 Luminaire for Open-Plan Office
25 Daylight Compensation
26 Exterior Lighting
27 Parking
28 Roadway Lighting
29 Resolution Enhancement by Illumination in Microscopy and Photolithography
30 Special Illumination Techniques for Measurements
31 Illumination in Particle Optics

Literature

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33210	Illumination	Dr. Johannes Eisenmenger	L	4	5

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33210	PLK (90 Minutes)	100%	

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

Last Update: 23.03.2023, Fritz

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32

Hochschule Aalen

Module Number: 33823 SPO-Version: 32

Module Name: Medical Physics

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Andreas Walter
Modul Type	Optional Module
Academic Semester	2. Semester
Module Duration	1 Semester
Number LV	1
Offered	Summer semester
Credits	5 CP
Workload Class	60 Hours
Workload Self-Study	90 Hours
Participation Requirements	Basic knowledge in physics & mathematics
Use in other SG	none
Language	English

Module Objectives

Professional Competence
The students will acquire technical, physical, and application-oriented knowledge regarding the interaction of radiation with tissue and modern physical techniques in medicine. This includes a preliminary advanced understanding of physics, such as quantum or nuclear physics. This knowledge will be interdisciplinary transferred to the field of biomedical research and diagnostics.
The students will learn to analyze and comprehend peer-reviewed current literature on the topic of medical physics, as well as present an overview in a short scientific presentation.
The independent processing of specific topics, taking into account previous subject knowledge, literature, and scientific methodology, prepares the students for the requirements of the master's thesis.

Special Methods Competence
The students optimize their presentation techniques (presentation design) and effectively utilize methods for acquiring information (literature search, review, management). They will learn to apply complex mathematical and physical concepts to concrete applications in medical physics.

Interdisciplinary Competence
By definition, the lecture combines technical and medical knowledge and explores the latest procedures and fundamentals for combating diseases and enhancing our understanding of them. Advanced physics understanding is essential for this purpose. The students will learn to evaluate biomedical research quantitatively.

Course Content

1. **Generation & Interaction of Radiation in Medical Diagnostics & Therapy**
   a. Motivation & Introduction to Anatomy
   b. Light & Medical Laser-Tissue Interactions
   c. Bremsstrahlung & X-Rays
   d. Radioactivity, Gamma and Particle Radiation
2. **Optical Diagnostics**
   a. Endoscopy
   b. Medical Optical Coherence Tomography & Photoacoustics
3. **Radiological Diagnostics & Imaging**
   a. X-ray Diagnostics
   b. Computed Tomography (CT)
   c. Magnetic Resonance Imaging (MRI)
   d. Ultrasound
4. **Nuclear Medicine: Diagnostics & Imaging**
   a. Single Photon Emission Computer Tomography (SPECT)
   b. Positron Emission Tomography (PET)
   c. SPECT/PET – Hybrid Setups
5. **Radiation Therapy**
   a. Optical Therapy
   b. Basics of Radiation Physics & Dosimetry
   c. Biological Basis of Radiation Therapy
   d. Radiation Delivery Techniques
   e. Radiation Therapy with Electrons & Neutrons
   f. Radiation Therapy with Charged Particles
6. **Medical Engineering**
   a. Portable Healthcare
   b. Treatment with Electrical Current
   c. Prothesis

Literature

- *An Introduction to Medical Physics*, edited by Muhammad Maqbool, Springer International Publishing AG, 2017
- *Medizinische Physik*, Wolfgang Schlegel, Springer Spektrum, 2018
- *Imaging Modalities for Biological and Preclinical Research: A Compendium, Volume II*, Andreas Walter, IPEM-IOP Series, 2021

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
33823	Medical Physics	Prof. Dr. Andreas Walter	V	4	5

[1] *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
33215	PLK (90 minutes)	100%	

Requirements for Admission to the Module Exam
Presentation in class

Further Study-Related Feedback
None

Comments:

Last Update: 02.06.2023, Andreas Walter

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32

Hochschule Aalen

Module Number: 9999 SPO-Version: 32

Module Name: Project / Soft Skills

Degree Program	Applied Photonics
Module Manager	Prof. Dr. Jürgen Krapp
Modul Type	Mandatory Module
Academic Semester	3. Semester
Module Duration	1 Semester
Number LV	2
Offered	Winter Semester, Summer Semester
Credits	30 CP
Workload Class	-
Workload Self-Study	900 Hours
Participation Requirements	50 credit points reduced by 5 credits for every extra-occupational semester, module 33001 (project) passed
Use in other SG	none
Language	English

Module Objectives

Professional Competence
The students can apply the contents of the curriculum independently in a scientific paper. They can analyze demanding specialist literature. They can analyze and evaluate the results and carry out experimental measurements in research areas. They are able to defend the results of the Master's thesis in an oral presentation and document them in a written report.

Course Content Actual work in different fields of photonics

Literature Subject specific books and publications

Included Courses (LV)

LV-Nr.	Course Name	Professor	Type[1]	SWS	CP
9999	Master Thesis	All Photonics Professors	P		24
9998	Colloquium	All Photonics Professors	K		6

1 *V Lecture L Lab S Seminar PR Internship EX Experiment X Not Fixed*
E Excursion Ü Practice P Project K Colloquium EL E-Learning
Bachelor from SPO 33 (§ 63); Master from SPO 32

Module Examination (Prerequisite for the Award of Credit Points)

LV-Nr.	Type and Duration of Proof of Performance[2]	Determination of Module Grades	Comments
9999	PLA	80 %	All parts of the thesis have to be performed individually; participation of more than one student is not permitted; each student works on its own topic.
9998	PLM	20 %	slides of presentation in English

Requirements for Admission to the Module Exam
None

Further Study-Related Feedback
None

Comments:

- Oral part of examination consists of an oral presentation in English (mandatory) of 15 minutes duration and 15 minutes oral questioning in English shared by first and second examiner. Student has to answer in English.
- Written report may be in English or German language according the requirement of first adviser/examiner.
- Maximum prolongation in case of delay that student doesn't take responsibility for is 8 weeks; prior approval of dean of students required.
- Submission of Master thesis includes (delivery signed in student`s separation form)
  - Abstract of thesis in English
  - Information sheet for database
  - PDF-file of thesis

Last Update: 22.03.2023, Fritz

2 *PLK Written Exams* *PLR Presentation* *PLL Lab Work* *PLT Study Diary*
PLS Term Paper/Research Report *PLE Draft/Design* *PLF Portfolio* *PMC Multiple Choice*
PLM Oral Exam *PLP Project* *PPR Internship* *PLC Multimedia-Based Examination (E-Exam)*
PLA Practical Work
Bachelor from SPO 33 (§ 20); Master from SPO 32