UNIVERSITÄT KOBLENZ · LANDAU

List of Modules

Master of Science (M.Sc.)

„Mathematical Modeling of Complex Systems“

at the Campus Koblenz

Faculty 3: Mathematics / Science

Mathematisches Institut

PHYSIK
Experimentalphysik
Materialwissenschaft

Faculty 4: Computational Science

Version: January 23, 2017

Contents

Course Guide Master Program (M.Sc.)
„Mathematical Modeling of Complex Systems“
for students starting in the winter semester

Sem.	recommended order of study for the master program starting in winter							LP
7 W	Applied Differential Equations **9 LP**			Physics in applications	Computer based methods	Advance Mathematics	*possibility for studying abroad*	**30**
8 S	Optimization **9 LP**	Numerics of Partial Differential Equations **9 LP**	Project seminar **3 LP**	Physics in applications	Computer based methods	Advance Mathematics		**30**
9 W		Optimization 2 **9 LP**	Project seminar **12 LP**	Physics in applications	Computer based methods	Advance Mathematics		**30**
10 S	Master thesis **30 LP**							**30**
M.Sc.								**120**

Course Guide Master Program (M.Sc.)
„Mathematical Modeling of Complex Systems“
for students starting in the summer semester

Sem.	recommended order of study for the master program starting in summer							LP
7 S	Optimi-zation **9 LP**			Physics in applica-tions	Computer based me-thods	Advance Mathe-matics	*possibility for study-ing abroad*	**30**
8 W	Applied Differential Equations **9 LP**	Optimi-zation 2 **9 LP**	Project seminar **3 LP**	Physics in applica-tions	Computer based me-thods	Advance Mathe-matics		**30**
9 S		Numerics of Partial Differential Equations **9 LP**	Project seminar **12 LP**	Physics in applica-tions	Computer based me-thods	Advance Mathe-matics		**30**
10 W	Master thesis **30 LP**							**30**
M.Sc.								**120**

Modules of the Master Program
„Mathematical Modeling of Complex Systems “

The following abbreviations are used:

V: lecture
Ü: exercises
VmÜ: lecture with integrated exercises
P: practical course
PS: project seminar
S: seminar
LP: ECTS-Credit points
CH: contact hours (weekly hours of 45 min of contact time per semester)
h: hour (means 60 minutes of work)

In the following list of all modules and the included courses are listed together with the maximum number of credit points attainable for each module of the master program.

The number of credit points per Module sums up the students' workload, contact time and private studies following the formula 1 LP = 30 h.

Since the workload of the students varies in different teaching forms in terms of preparation and training/reworking, no fix factor between credit points (LP) and contact time (CH) is possible. The listed contact time is converted in time following the estimate 1 CH = 15 h.

In this master program 52 CH of pure contact time, 26 CH in compulsory modules, equal 90 LP. In addition 30 LP are given for the master thesis.

Module abbreviations (Module codes)

The Modules are abbreviated according to the following pattern into a Module code:

- The first two characters are the numbers of the faculty:
  „03“ Faculty 3: Mathematics / Science and
  „04“ Faculty 4: Computational Science.
- The next two characters indicate the institute in charge for this Module:
  „CV“ Institute for Computervisualistics,
  „IN“ Institute for Computational Science
  „MA“ Mathematical Institute,
  „PH“ Department of Physics,
  „WI“ Institute for “Wirtschafts- und Verwaltungsinformatik”;
  for soft skills as well as the thesis „XX“ is used instead.
- The fifth character shows, if the Module was initially built for a bachelor program („1“) or a master program („2“).
- The last three characters are given by the teaching unit in charge.

Modules of the Master program

Compulsory Modules

List of Modules

Module Code	Module Name	Credit points
03MA2501	Applied Differential Equations	9
03MA2502	Optimization	9
03MA2503	Numerics of Partial Differential Equations	9
03MA2504	Optimization 2	9
03XX2501	Project seminar	15
03XX2590	Master thesis final oral exam	27 3

Module 03MA2501 **Applied Differential Equations**					
Module Code		**Workload**	**Credit points**	**Semester**	**Duration**
03MA2501		270 h	9 LP	1. or 2. Master semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 3625011 V Applied Differential Equations		60 h	120 h	6 LP
	2. 3625012 Ü/S Applied Differential Equations		30 h	60 h	3 LP
2	**Teaching forms** Course 1: Lecture (4 CH) Course 2: Exercises / Seminar (2 CH)				
3	**Group size** Course 1: 31 (Lecture) Course 2: 30 (Exercises) / 15 (Seminar)				
4	**Qualification targets / Skills** The students know the fundamental definitions, theorems and methods related to the theory and numerical methods for differential equations. Applying known results from calculus, linear algebra and numerics, they can tackle advanced problems, analyze them mathematically and solve them numerically. The students broaden their analytical and problem-solving skills in the field of differential equations. They are able to acquire, adapt and apply current research results.				
5	**Contents** e.g. • Elementary methods for initial value problems of ordinary differential equations • Existence and uniqueness results for initial value problems • Qualitative behavior and stability • Linear first and higher order systems of differential • One-step methods for initial value problems, consistency and convergence • Runge-Kutta methods and adaptive step size selection • Classification of partial differential equations and elementary cases				
6	**Usability of Module for other Programs** M.Ed. Mathematik (Module 03MA2501)				
7	**Prerequisites for Participation**				
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)				
9	**Requirement for Credit Points** Regular participation in Course 2 Passing the coursework Passing examination				
10	**Percentage of grade in final mark** 9/120				
11	**Frequency of Course**				

	annually (winter semester)
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Thomas Götz
13	**Further information** Compulsory module

Module 03MA2502 **Optimization**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
03MA2502		270 h	9 LP	1. or 2. Master semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 3625021 V Optimization		60 h	120 h	6 LP
	2. 3625022 Ü/S Optimization		30 h	60 h	3 LP
2	**Teaching form** Course 1: Lecture (4 CH) Course 2: Exercises / Seminar (2 CH)				
3	**Group size** Course 1: 31 (Lecture) Course 2: 30 (Exercises) / 15 (Seminar)				
4	**Qualification targets / Skills** The students know fundamental methods and algorithms for optimization problems. They are able to model small real-world problems and to apply optimization techniques to solve those problems. The students broaden their analytical and problem-solving skills. They are able to acquire, adapt and apply current research results.				
5	**Contents** e.g. • Linear programs in standard form, fundamental theorem of linear optimization, Simplex-method • Duality theorem, degenerate problems • Inner point methods • Optimality conditions for unconstrained and constrained problems • One-dimensional minimization; direct methods • Descent methods in higher dimensions, cg-methods • Basics of graph theory, optimization on graphs				
6	**Usability of Module for other Programs** M.Ed. Mathematik (Module 03MA2502)				
7	**Prerequisites for Participation**				
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)				
9	**Requirement for Credit points** Regular participation in course 2 Passing the coursework Passing Module exam				
10	**Percentage of grade in final mark** 9/120				
11	**Frequency of Course**				

	annually (summer semester)
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Stefan Ruzika
13	**Further information** Compulsory module

Module 03MA2503 **Numerics for Partial Differential Equations**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
03MA2503		270 h	9 LP	2. - 3. Master semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 3625031 V Numerics for Partial Differential Equations		60 h	120 h	6 LP
	2. 3625032 Ü/S Numerics for Partial Differential Equations		30 h	60 h	3 LP
2	**Teaching form** Course 1: Lecture (4 CH) Course 2: Exercises / Seminar (2 CH) Alternative forms, e.g. reading course, may be possible.				
3	**Group size** Course 1: 31 (Lecture) Course 2: 30 (Exercises) / 15 (Seminar)				
4	**Qualification targets / skills** The students know the fundamental definitions, theorems and methods related to the theory and numerical methods for partial differential equations (PDEs). Applying known results from calculus, linear algebra, numerics and ordinary differential equations, they can tackle advanced problems, analyze them mathematically and solve them numerically.				
5	**Contents** e.g. • Elementary theory of PDEs (first and second order) • Method of characteristics for first order PDEs • Finite Difference Methods • Finite Element Methods				
6	**Usability of Module for other Programs**				
7	**Prerequisites for Participation** Module 03MA2501				
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)				
9	**Requirement for Credit points** Regular participation in course 2 Passing Module exam				
10	**Percentage of grade in final mark** 9/120				
11	**Frequency of Course** annually (summer semester)				
12	**Module Coordinator and Lecturer**				

	Module coordinator:	Prof. Dr. Thomas Götz
13	**Further information** Compulsory Module	

Module 03MA2504 **Optimization 2**				
Module code	**Workload**	**Credit points**	**Semester**	**Duration**
03MA2504	270 h	9 LP	2. - 3. Master semester	1 Semester

1	**Courses**	**Contact time**	**Self-study**	**Credit points**
	1. 3625041 V Optimization 2	60 h	120 h	6 LP
	2. 3625042 Ü/S Optimization 2	30 h	60 h	3 LP

2 Teaching form

Course 1: Lecture (4 CH)

Course 2: Exercises / Seminar (2 CH)

Alternative forms, e.g. reading course, may be possible.

3 Group size

Course 1: 31 (Lecture)

Course 2: 30 (Exercises) / 15 (Seminar)

4 Qualification targets / skills

The students know the fundamental definitions, theorems and methods related to the theory and algorithmic methods for integer and combinatorial optimization problems. Applying known results from calculus, linear algebra, numerics and optimization, they can tackle advanced problems, analyze them mathematically and solve them algorithmically.

5 Contents

e.g.

- Polyhedral theory
- Complexity classes P and NP; NP-completeness proofs
- Modeling with integer and linear programs; Relaxation and bounds
- Solution strategies: dynamic programming, branch and bound, cutting planes, column generation, Lagrangian duality, approximation algorithms
- Genetic Algorithms, Variational Methods, Constrained Optimization

6 Usability of Module for other Programs

7 Prerequisites for Participation

Module 03MA2502

8 Method of Examination

Written exam (90 min) or oral exam (30 min) (module exam)

9 Requirement for Credit points

Regular participation in course 2

Passing Module exam

10 Percentage of grade in final mark

9/120

11 Frequency of Course

annually (winter semester)

12 Module Coordinator and Lecturer

Module coordinator: Prof. Dr. Stefan Ruzika

13	**Further information** Compulsory Module

Module 03XX2501 **Project Seminar**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
03XX2501		450 h	15 LP	2. and 3. Master semester	2 semesters
1	**Courses** 1. 3525015 / 3625015 Project 2. 3525016 / 3625016 Seminar		**Contact time** 30 h	**Self-study** 420 h	**Credit points** 12 LP 3 LP
2	**Teaching form** Project and seminar, where results are reported				
3	**Group size** Project: alone or in small groups (max. 5) Seminar: 5				
4	**Qualification targets / skills** The students are able to acquire, adapt and apply current research results. They can utilize computing and/or experimental facilities for the purpose of modeling, understanding and solving complex systems. Communication and social skills are trained in phases of team work, intermediate and final presentations as well as peer-group discussions.				
5	**Contents** The project seminar gives insight into interdisciplinary scientific work. The students work on a given scientific problem subsuming components from computer science, mathematics and/or physics. The students revisit relevant research results, adapt them to the problem at hand and derive a suitable model. Simulations, experiments and/or theoretical analysis have to be carried out based on the knowledge gained in the previous course of studies. The students validate, interpret as well as present and discuss their results.				
6	**Usability of module for other programs**				
7	**Prerequisites for Participation**				
8	**Method of Examination** Written portfolio (coursework) Oral presentation (approx. 30 min) (Module exam)				
9	**Requirement for Credit points** Participation in the seminar on a steady basis Passing the coursework Passing the oral exam				
10	**Percentage of grade in final mark** 15/120				
11	**Frequency of Course** As needed				
12	**Supporting Lecturer**				

	all Lecturers of the Faculty of Computational Science all Lecturers of Mathematics all Lecturers of Physics
13	**Further information** Compulsory Module

Module 03XX2590 **Master thesis and oral final exam**				
Module code 03XX2590	**Workload** 900 h	**Credit points** 27 + 3 LP	**Semester** 4. Master semester	**Duration** 1 semester

1	**Courses** 1. 3525901 / 3625901 Master thesis 2. 3525902 / 3625901 Oral final exam	**Contact time**	**Self-study** 810 h 90 h	**Credit points** 27 LP 3 LP
2	**Teaching form** 1. Largely independent production of a master thesis 2. Oral final exam			
3	**Group size** Usually 1			
4	**Topic, Qualification target and expected skills** The Master program concludes with the Master thesis. The Master thesis can be completed in all fields of Computational Science, Mathematics and Physics as well as in industry or external research institutes nationally or internationally, if a professor is in charge of the support. The master student must work on a scientific topic under guidance within a given time. The thesis must document the results in writing in an adequate form with regard to the subject and be presented in the final exam as a basis for discussion. The candidate must be able to achieve research results under guidance but largely independently, detect, solve and critically assess problems and to classify them on the basis of the given knowledge. The results have to be documented in written form (27 LP) und this work is to be defended in an oral exam (3 LP). Examination is carried out by the supporting professor and a second auditor. Content of the final exam is the topic of the Master thesis. The candidate has the opportunity to present his/her work within the given time.			
5	**Contents** • Largely independent work on a research question under professional guidance • Commanding the basic techniques of scientific work and publication			
6	**Usability of module for other programs**			
7	**Prerequisites for Participation**			
8	**Method of Examination** Master thesis Oral exam (Colloquium)			
9	**Requirement for Credit points** Passing Master thesis Passing the oral exam			
10	**Percentage of grade in final mark**			

	30/120
11	**Frequency of Course** As needed
12	**Departmental Coordinator** All Lecturers of the Faculty Computational Science All Lecturers of Mathematics All Lecturers of Physics
13	**Further information** Compulsory Module

Optional Compulsory Section

It is strongly recommended to inform oneself about the actual opportunities already in the first semester of the Master program.

The modules equivalent to at least 39 LP could be chosen freely from the three fields “Advanced Mathematics”, “Physics in Applications” and “Computer based methods” as long as the topics were not part of the Bachelor program.

In “Computer based methods” all modules from the master programs “Computervisualistik” and “Web Science” could be chosen in addition.

Some optional compulsory modules are taught in German exclusively, while all compulsory modules are taught in English.

List of Modules

Module Code	Module Name	Credit points
	“Advanced Mathematics”	
03MA2108	Special topics of Mathematics	9
03MA2109	Special topics of Applied Mathematics	9
03MA2110	Specialization in Mathematics	9
	“Physics in Applications”	
03PH2110	Theoretische Physik 2	6
03PH2402	Aktuelle Fragen der Physik	6
03PH2501	Solid State Physics	6
03PH2503	Surface Science	6
03PH2504	Applied Theoretical Physics	6
03PH2505	Polymer Science	6
	“Computer based Methods”	
04CV2001	Foundations of autonomous mobile systems	6
04CV2005	Pattern Recognition	6
04CV2006	Robotics and Computer Vision	6
04IN2002	Formal specification and verification	6
04IN2028	Machine Learning & Data Mining	6
04IN2035	Wireless Data Communication	6
04IN2037	Software Language Engineering	6
04WI2013	Enterprise Architecture Modeling	6
04WI2027	Mobile Systems Engineering	6

Module 03MA2108 **Special topics of Mathematics**				
Module code	**Workload**	**Credit points**	**Semester**	**Duration**
03MA2108 | MA 08	270 h	9 LP	1. - 3. Master semester	1 Semester

1	**Courses**	**Contact time**	**Self-study**	**Credit points**
	1. 3621081 V Special topics of Mathematics	60 h	120 h	6 LP
	2. 3621082 Ü Special topics of Mathematics	30 h	60 h	3 LP

2	**Teaching form** Course 1: Lecture (4 CH) Course 2: Exercises (2 CH)
3	**Group size** Course 1: 30 (Lecture) Course 2: 30 (Exercises)
4	**Qualification targets / Skills** The students know the basic concepts and results of the respective field of mathematics. The students have learned in the tutorials a precise, solid and autonomous handling of the definitions, theorems and methods presented in the lecture. The students broaden their analytical skills in one special topic of mathematics. They are able to acquire, adapt and apply current research results.
5	**Contents** One field of modern mathematics related to applications, e.g. • applied algebra and computer algebra • differential geometry • functional analysis and inverse problems • number theory and its relevance for cryptography
6	**Usability of Module for other Programs** M.Ed. Mathematik (Module 03MA2108)
7	**Prerequisites for Participation**
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)
9	**Requirement for Credit points** Regular participation in course 2 Passing module exam
10	**Percentage of grade in final mark** 9/120
11	**Frequency of Course** irregularly
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Rolfdieter Frank
13	**Further information**

	Optional Compulsory Module

Module 03MA2109 **Special topics of Applied Mathematics**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
03MA2109 | MA 09		270 h	9 LP	1. - 3. Master semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 3621091 V Applied Mathematics		60 h	120 h	6 LP
	2. 3621092 Ü Applied Mathematics		30 h	60 h	3 LP
2	**Teaching form** Course 1: Lecture (4 CH) Course 2: Exercises (2 CH)				
3	**Group size** Course 1: 30 (Lecture) Course 2: 30 (Exercises)				
4	**Qualification targets / skills** The students know the basic concepts and results of the respective field of applied mathematics. The students have learned in the tutorials a precise, solid and autonomous handling of the definitions, theorems and methods and algorithms presented in the lecture. The students broaden their analytical and problem-solving skills in one field of applied mathematics. They are able to acquire, adapt and apply current research results.				
5	**Contents** One field of applied mathematics, e.g. • Fourier transforms • Financial mathematics • Mathematics models in natural sciences • Asymptotic Analysis				
6	**Usability of Module for other Programs** M.Ed. Mathematik (Module 03MA2109)				
7	**Prerequisites for Participation**				
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)				
9	**Requirement for Credit points** Regular participation in course 2 Passing Module exam				
10	**Percentage of grade in final mark** 9/120				
11	**Frequency of Course** irregularly				
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Thomas Götz				
13	**Further information**				

	Optional Compulsory Module

Module 03MA2110 **Specialization in Mathematics**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
03MA2110| MA 10		270 h	9 LP	1. - 3. Master semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 3621101 V Specialization in Mathematics		60 h	120 h	6 LP
	2. 3621102 Ü/S Specialization in Mathematics		30 h	60 h	3 LP
2	**Teaching form** Course 1: Lecture (4 CH) Course 2: Exercises / Seminar (2 CH)				
3	**Group size** Course 1: 30 (Lecture) Course 2: 30 (Exercises) / 15 (Seminar)				
4	**Qualification targets / skills** The students specialize their knowledge in a field of mathematics. The students have learned in the tutorials a precise, solid and autonomous handling of the definitions, theorems and methods presented in the lecture. The students broaden their analytical and problem-solving skills in one specialized field of mathematics. They are able to acquire, adapt and apply current research results.				
5	**Contents** One field of modern applied mathematics specializing and/or continuing the contents of one of the modules 03MA2501 or 03MA2502				
6	**Usability of Module for other Programs** M.Ed. Mathematik (Module 03MA2110)				
7	**Prerequisites for Participation**				
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)				
9	**Requirement for Credit points** Regular participation in course 2 Passing Module exam				
10	**Percentage of grade in final mark** 9/120				
11	**Frequency of Course** irregularly				
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Stefan Ruzika				
13	**Further information** Optional Compulsory Module				

Modul 03PH2110
Theoretische Physik 2: Quantentheorie, statistische Physik und Thermodynamik

Kennnummer	Workload	Leistungs-punkte	Studien-semester	Dauer
03PH2110	180 h	6 LP	5. Semester	1 Semester

1	Lehrveranstaltungen	Kontakt-zeit	Selbst-studium	Leistungs-punkte
	1. 3521101 V Theoretische Physik 2	45 h	75 h	4 LP
	2. 3521102 Ü Theoretische Physik 2	15 h	45 h	2 LP

2 Lehrformen

Veranstaltung 1: Vorlesung (3 SWS)
Veranstaltung 2: Übung (1 SWS)

3 Gruppengröße

Veranstaltung 1: 36 (Vorlesung)
Veranstaltung 2: 36 (Übung)

4 Qualifikationsziele / Kompetenzen

Die Studierenden

- beherrschen die grundlegenden Konzepte, Methoden und Denkweisen der theoretischen Physik;
- verstehen das Wechselspiel von Theoretischer Physik und Experimentalphysik, den Beitrag der Theoretischen Physik zu Begriffsbildung und Begriffsgeschichte, die wichtigsten Arbeitsstrategien und Denkformen der Theoretischen Physik sowie die Kulturverflechtung und den Kultur- und Zivilisationsbeitrag der Theoretischen Physik;
- entwickeln die Fähigkeit, die spezifische Rolle der Theorie im Aufbau der Physik, ihr gedankliches Arsenal an Arbeitsstrategien und Denkformen und ihre Kulturverflechtung an schulrelevanten Beispielen zu verdeutlichen.

5 Inhalte

Quantentheorie:

- Postulate und mathematischer Formalismus der Quantentheorie
- Schrödingergleichung
- Eigenwerte und -zustände
- zeitliche Entwicklung
- Orts- und Impulsdarstellung
- Schrödingerbild
- Heisenbergbild
- eindimensionale Probleme
- unitäre Transformationen und Symmetrien
- Drehimpuls
- Spin
- Addition von Drehimpulsen
- Spin-Bahn-Kopplung
- Wasserstoffatom

	• harmonischer Oszillator • Pfadintegral-Formulierung • identische Teilchen • Interpretation und Information in der Quantenphysik • Quantenmechanik geladener Teilchen • Zusammenhang zur klassischen Physik • Störungstheorie • Streuamplitude und Wirkungsquerschnitt Statistische Physik und Thermodynamik: • Entartungsfunktion und Entropie • Zusammenhang zu Thermodynamischen Variablen • Boltzmann- und Maxwell-Verteilung • Bose-Einstein- und Fermi-Dirac-Verteilung • Nichtgleichgewichtsthermodynamik und dissipative Strukturen Querschnittsthemen: • Approximationsverfahren der Theoretischen Physik • Variationsrechnung
6	**Verwendbarkeit des Moduls in anderen Studiengängen** Lehramt Physik und Zwei-Fach-Bachelor (Modul 03PH2110) B.Sc. Mathematische Modellierung (Modul 03PH2110) M.Sc. Applied Physics (Modul 03PH2110)
7	**Teilnahmevoraussetzungen** Kompetenzen aus: Modul 03PH1101 Modul 03PH1102 Modul 03PH1106 Modul 03PH1109
8	**Prüfungsformen** Klausur - 90 Minuten (Modulprüfung)
9	**Voraussetzungen für die Vergabe von Leistungspunkten** Regelmäßige Teilnahme an der Übung Bestehen der Modulprüfung
10	**Stellenwert der Note in der Endnote** 6/210
11	**Häufigkeit des Angebots** jährlich (Wintersemester)
12	**Modulbeauftragter und hauptamtlich Lehrende** Modulbeauftragter: Prof. Dr. Stefan Wehner hauptamtlich Lehrende: N.N.

13	**Sonstige Informationen** Pflichtmodul

Modul 03PH2402
Aktuelle Fragen der Physik

Kennnummer	**Workload**	**Leistungs-punkte**	**Studien-semester**	**Dauer**
03PH2402	180 h	6 LP	1. und 2. Master-Semester	2 Semester

1	**Lehrveranstaltungen** **2 aus 5 sind zu wählen** **(zum Teil unregelmäßiges Angebot)**	**Kontakt-zeit**	**Selbst-studium**	**Leistungs-punkte**
	1. 3524021 S/P Physikalische Materialanalyse	30 h	60 h	3 LP
	2. 3524022 VmÜ Prozesse an Materialgrenzen	30 h	60 h	3 LP
	3. 3524023 VmÜ Physikalische Basis der Medizintechnik in Diagnostik und Therapie	30 h	60 h	3 LP
	4. 3524024 VmÜ Einführung in die Biophysik	30 h	60 h	3 LP
	5. 3521164 VmÜ Angewandte Mikrocontroller	30h	60h	3 LP

2 Lehrformen

Veranstaltung 1:	Seminar/Praktikum (2 SWS)
Veranstaltung 2:	Vorlesung mit integrierten Übungen (2 SWS)
Veranstaltung 3:	Vorlesung mit integrierten Übungen (2 SWS)
Veranstaltung 4:	Vorlesung mit integrierten Übungen (2 SWS)
Veranstaltung 5:	Vorlesung mit integrierten Übungen (2 SWS)

3 Gruppengröße

Veranstaltung 1:	10 (Seminar/Praktikum)
Veranstaltung 2:	30 (Vorlesung mit integrierten Übungen)
Veranstaltung 3:	30 (Vorlesung mit integrierten Übungen)
Veranstaltung 4:	30 (Vorlesung mit integrierten Übungen)
Veranstaltung 5:	30 (Vorlesung mit integrierten Übungen)

4 Qualifikationsziele / Kompetenzen

Die Studierenden lernen wichtige Messverfahren für die gewählte Fragestellungen kennen.
Sie beherrschen deren physikalische Grundlagen.
Sie sind in der Lage diese selbstständig auszuwählen und einzusetzen.

5 Inhalte

3524021/3524022:

- Messverfahren der Materialanalyse
- Physikalische Grundlagen des Messprozesses
- Apparative Beschränkungen und Fehlerquellen
- Typische Anwendungsbeispiele und Einsatzgebiete

3524023:

	• Wechselwirkung von Röntgenstrahlung mit Materie, Detektion von Röntgenstrahlung, • Bilderzeugung durch Röntgenstrahlung, Röntgengerät, Computertomographie, • Physik und Technik der Strahlentherapie, Linearbeschleuniger, Bestrahlungsplanung • Kernspinresonanz (MR) • Positronen-Emissionen Tomographie (PET) 3524024: • Einführung in die Biophysik 3521164: • Grundlagen der Mikrocontroller an praktischen Beispielen
6	**Verwendbarkeit des Moduls in anderen Studiengängen** M.Sc. Chemie und Physik funktionaler Materialien (03PH2402) M.Sc. Applied Physics (03PH2402)
7	**Teilnahmevoraussetzungen**
8	**Prüfungsformen** Klausur - 90 Minuten oder mündliche Prüfung - 30 Minuten (Modulprüfung)
9	**Voraussetzungen für die Vergabe von Leistungspunkten** Regelmäßige Teilnahme an Seminar, Praktikum und Übung Bestehen der Modulprüfung
10	**Stellenwert der Note in der Endnote** 6/90
11	**Häufigkeit des Angebots** unregelmäßig
12	**Modulbeauftragter und hauptamtlich Lehrende** Modulbeauftragter: Prof. Dr. Stefan Wehner hauptamtlich Lehrende:
13	**Sonstige Informationen** Wahlpflichtmodul

Module 03PH2501 **Solid State Physics**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
03PH2501		180 h	6 LP	1. or 2. Master semester	1 semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 3525011 V Solid State Physics		45 h	75 h	4 LP
	1. 3525012 Ü Solid State Physics		15 h	45 h	2 LP
2	**Teaching form** Course 1: Lecture (3 CH) Course 2: Exercises (1 CH)				
3	**Group size** Course 1: 40 (Lecture) Course 2: 40 (Exercises)				
4	**Qualification targets / Skills** The students know basic ideas, fundamental experiments and methods of solid state physics. They understand macroscopic material properties on the basis of microscopic interactions. The students are able to describe different kinds of matter mathematically and can predict material properties, both electronic and thermal, in solids. They become familiar with the language of condensed matter and key theories and concepts. The students broaden their analytical and problem-solving skills. They are able to acquire, adapt and apply current research results.				
5	**Contents** • crystal structure • binding mechanisms • mechanical, thermal and electronic properties • semi-conductors				
6	**Usability of the module for other programs** M.Sc. Chemie und Physik funktionaler Materialien (03PH2501) M.Sc. Applied Physics (03PH2501)				
7	**Prerequisites for Participation** Needed Competences: - experimental physics (mechanics, thermodynamics, electrodynamics, optics, quantum mechanics, atomic physics, molecular physics) - theoretical physics (mechanics, electrodynamics)				
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)				
9	**Requirement for Credit points** Participation in the exercises on a steady basis Passing the coursework Passing the module exam				
10	**Percentage of grade in final mark** 6/120				
11	**Frequency of Course**				

	annually (summer semester)
12	**Module Coordinator and Lecturer** Module Coordinator: Prof. Dr. Stefan Wehner
13	**Further information** Optional Compulsory Module

Module 03PH2503 **Surface Science**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
03PH2503		180 h	6 LP	1. – 3. Master semester	1 semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 3525031 VmÜ Vacuum Technology		30 h	60 h	3 LP
	2. 3525032 VmÜ Surface Science		30 h	60 h	3 LP
2	**Teaching form** Course 1: Lecture with integrated exercises (2 CH) Course 2: Lecture with integrated exercises (2 CH)				
3	**Group size** Course 1: 30 (Lecture with integrated exercises) Course 2: 30 (Lecture with integrated exercises)				
4	**Qualification targets / Skills** Vacuum Technology The students • know the physical basis of vacuum technology, • can explain the basic concepts and ideas of vacuum, • develop an understanding of the countervailing effects relevant in the realization of vacuum and are able to evaluate technical problems on the basis of the resulting limitations, • can transfer their knowledge to technical solutions and develop own experimental schemes. Surface Science The students • know the basics of reaction kinetics and other phenomena on surfaces, • can explain the particular characteristics of surfaces and discuss related problems, • are able to describe and analyze common detection techniques and evaluate their limitations, • can evaluate existing experimental setups, • are able to transfer their knowledge to experiments for specific tasks and develop own experimental schemes.				
5	**Contents** Vacuum Technology • equations of state • motion in diluted gases • transport • flow • conductance and pumping speed • calculating conductance • design of vacuum systems • pumps				

	• measuring pressure • materials for HV and UHV • flange systems and components Surface Science: • surface structure • diffraction on surfaces • microscopy on surfaces • scattering methods • chemical surface analysis • electronic states on surfaces • vibrations on surfaces • gas adsorption on surfaces • surface reactions
6	**Usability of the module for other programs** M.Sc. Chemie und Physik funktionaler Materialien (03PH2503) M.Sc. Applied Physics (03PH2503)
7	**Prerequisites for Participation** Necessary Competences: - fundamental knowledge in experimental physics
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)
9	**Requirement for Credit points** Participation in the exercises on a steady basis Passing the module exam
10	**Percentage of grade in final mark** 6/120
11	**Frequency of Course** Annually (winter semester)
12	**Module Coordinator and Lecturer** Module Coordinator: Prof. Dr. Stefan Wehner
13	**Further information** Optional Compulsory Module

Module 03PH2504
Applied Theoretical Physics

Module code	Workload	Credit points	Semester	Duration
03PH2504	180 h	6 LP	1. - 3. Master semester	1 semester

1	Courses	Contact time	Self-study	Credit points
	1. 3525041 VmÜ Applied Theoretical Physics 1	30 h	60 h	3 LP
	2. 3525042 VmÜ Applied Theoretical Physics 2	30 h	60 h	3 LP

2 Teaching form

Course 1: Lecture with integrated exercises (2 CH)
Course 2: Lecture with integrated exercises (2 CH)

3 Group size

Course 1: 30 (Lecture with integrated exercises)
Course 2: 30 (Lecture with integrated exercises)

4 Qualification targets / Skills

The students:

- can name various fields, where modern concepts of theoretical physics are important for the description of real world problems in nature and technology
- know the fundamental definitions, theorems and methods related to the application of theoretical physics,
- can analyze the relation between parameters in given systems,
- can apply mathematical methods to solve problems in these fields
- can evaluate suggested solutions and develop own solving schemes.

5 Contents

Applied Theoretical Physics:

- modern concepts in theoretical physics
- reaction-diffusion-systems
- nonlinear physics
- nonequilibrium thermodynamics
- applications of theoretical physics in nature and technology

6 Usability of the module for other programs

M.Sc. Chemie und Physik funktionaler Materialien (03PH2504)
M.Sc. Applied Physics (03PH2504)

7 Prerequisites for Participation

Necessary Competences:
- fundamental knowledge in theoretical physics

8 Method of Examination

Written exam (90 min) or oral exam (30 min) (module exam)

9 Requirement for Credit points

Participation in the exercises on a steady basis
Passing the module exam

10 Percentage of grade in final mark

	6/120
11	**Frequency of Course** Irregularly
12	**Module Coordinator and Lecturer** Module Coordinator: N.N.
13	**Further information** Optional Compulsory Module

Module 03PH2505
Polymer Science

Module code	Workload	Credit points	Semester	Duration
03PH2505	180 h	6 LP	1. - 3. Master semester	1 semester

1	Courses	Contact time	Self-study	Credit points
	1. 3525051 VmÜ Polymer Physics	30 h	60 h	3 LP
	2. 3525052 VmÜ Characterization methods in Polymer Science	30 h	60 h	3 LP

2 Teaching form

Course 1: Lecture with integrated exercises (2 CH)
Course 2: Lecture with integrated exercises (2 CH)

3 Group size

Course 1: 30 (Lecture with integrated exercises)
Course 2: 30 (Lecture with integrated exercises)

4 Qualification targets / Skills

Course Polymer Physics:

The students

- can independently explain basic models describing the properties of different types of polymers and in different states,
- are able to understand how the peculiarities of the polymer structure such as connectivity affects their physical properties and of which relevance these are for applications,
- develop on the basis of the covered basic concepts their own solving schemes,
- are able to transfer the discussed basic concepts to actual, scientific topics in polymer science.

Course Characterization methods in Polymer Science:

The students

- can independently explain the characterization method covered in this course,
- can identify for the most important physical properties of polymer materials (Course Polymer Physics) the correct characterization methods,
- are aware of the technical realization and of the application potential of the different methods,
- they can give an overview over representative results for typical polymer systems,
- develop strategies for data analysis, presentation and interpretation,
- are able to transfer the discussed basic concepts to actual, scientific topics in polymer science.

5 Contents

Basic Concepts in Polymer Physics

- Synthesis & molecular weight distributions
- Chain models
- Polymer solutions, polymer blends, block copolymers
- Semicrystalline state
- Polymer dynamics & viscoelasticity
- Networks
- Glassy state

	Polymer Characterization • Determination of molecular weights • Thermal characterization • Mechanical testing • Dielectric spectroscopy & electrical characterization • Scattering methods • Microscopy
6	**Usability of the module for other programs** M.Sc. Chemie und Physik funktionaler Materialien (03PH2505) M.Sc. Applied Physics (03PH2505)
7	**Prerequisites for Participation** Necessary Competences: - fundamental knowledge in experimental physics
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)
9	**Requirement for Credit Points** Participation in the exercises on a steady basis Passing the module exam
10	**Percentage of grade in final mark** 6/120
11	**Frequency of Course** Annually (summer semester)
12	**Module Coordinator and Lecturer** Module Coordinator: Prof. Dr. Silke Rathgeber
13	**Further information** Optional Compulsory Module

Module 04CV2001
Foundations of autonomous mobile systems

Module code	Workload	Credit points	Semester	Duration
04CV2001	180 h	6 LP	1. - 3. Master-Semester	1 Semester

1	Courses	Contact time	Self-study	Credit points
	1. 4120011 V Foundations of autonomous mobile systems	30 h	60 h	3 LP
	2. 4120012 Ü Foundations of autonomous mobile systems	30 h	60 h	3 LP

2 Teaching form

Course 1: Lecture (2 CH)
Course 2: Exercises (2 CH)

3 Group size

Course 1: 30 (Lecture)
Course 2: 30 (Exercises)

4 Qualification targets / skills

Students understand the role of incorrect robotic control commands and of uncontrolled behavior. They can program and use real robots. They can trace the effect of the use of robots on its theoretical foundations. They can use their theoretical knowledge in order to improve fail-controlled robot. They can develop active vision through a combination of image analysis and robotics. They can evaluate the benefits of specific programming languages (e.g. Matlab (Octave)).

5 Contents

Foundations of visual navigation are mediated. Mono or stereo camera systems serve as input devices and are used with gray-scale, color or infrared sensors. Central problems of sensor data processing (filtering and fusion) are presented. Students will learn current techniques that are used in autonomous systems. Practical exercises on several types of robots with various sensors provide an impression of the real problems.

I. Basics
- Basic concepts, terminology, Statistics
- Areas of application

II. Sensors and their characteristics, pre-processing
- Color infrared
- Radar, Laser Range Finder
- Stereo systems and distance measurement
- Compass,(Differential) GPS
- Odometry and vehicle sensor(Inertial sensors)

III. Sensor data analysis
- Localization
- Object recognition
- Motion estimation

IV. Sensor data fusion
- Kalman filter and condensation algorithm
- Bayes Filter

	• Democratic Integration • Mapping and map representation • SLAM (Simultaneous localization and mapping) V. Application Examples • Motor vehicles, service robotics • Exploration, disaster relief
6	**Usability of module for other programs** M.Sc. Computervisualistik (Module 04CV2001) M.Sc. Informatik (Module 04CV2001) M.Sc. Wirtschaftsinformatik (Module 04CV2001)
7	**Prerequisites for Participation**
8	**Method of Examination** Written exam (90 min) or oral exam(30 min) (Module exam)
9	**Requirement for Credit points** Regular participation in course 2 Passing Module exam
10	**Percentage of grade in final mark** 6/120
11	**Frequency of Course** irregularly
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Dietrich Paulus
13	**Further information** Optional Compulsory Module

Module 04CV2005 **Pattern Recognition**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
04CV2005		180 h	6 LP	1. - 3. Master-Semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 4120051 V Pattern Recognition		45 h	75 h	4 LP
	2. 4120052 Ü Pattern Recognition		15 h	45 h	2 LP
2	**Teaching form** Course 1: Lecture (3 CH) Course 2: Exercises (1 CH)				
3	**Group size** Course 1: 30 (Lecture) Course 2: 30 (Exercises)				
4	**Qualification targets / skills** After successful completion of the course, students will be able to design a complete pattern recognition system for a specific problem, so that the optimization of its components can be carried out prior to development (based on theoretical expertise).				
5	**Contents** The course provides state-of-the-art algorithms and methods for automatic, computer-based pattern recognition. Pattern recognition is the ability to detect data regularities and repetitions or similarities in data. Typical examples of the countless application areas include speech recognition, text recognition, face recognition, or the automatic waste separation on the basis of spectrometric recordings. The modality of the signal is mostly separated from the particular problem, to provide general methods that can be used for images as well as audio, text, or other types of signals. The contents are divided into two categories. While the so-called supervised algorithms are shown in the first part of the course, the second part deals with unsupervised methods. The supervised learning strategy is based on well-known and manually categorized training samples. Unsupervised methods recognize the regularities in the data without prior knowledge of this. The following topics of supervised strategies are taught in the course: Bayes Classifiers, Linear Classifiers, Nonlinear Classifiers, Feature Selection, Feature Generation, Template-Matching, Context-Dependent Classification. In the unsupervised methods selected clustering algorithms are shown: Sequential Algorithms, Hierarchical Algorithms, Schemes Based on Function Optimization.				
6	**Usability of module for other programs** M.Sc. Computervisualistik (Module 04CV2005) M.Sc. Informatik (Module 04CV2005) M.Sc. Wirtschaftsinformatik (Module 04CV2005)				
7	**Prerequisites for Participation**				
8	**Method of Examination** Written exam (90 min) (Module exam)				
9	**Requirement for Credit points**				

	Regular participation in course 2 Passing Module exam
10	**Percentage of grade in final mark** 6/120
11	**Frequency of Course** Annually (summer semester)
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Dietrich Paulus
13	**Further information** Optional Compulsory Module

Module 04CV2006 **Robotics and Computer Vision**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
04CV2006		180 h	6 LP	1. - 3. Master-Semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 4120061 V Robotics and Computer Vision		30 h	60 h	3 LP
	1. 4120062 Ü Robotics and Computer Vision		30 h	60 h	3 LP
2	**Teaching form** Course 1: Lecture (2 CH) Course 2: Exercises (2 CH)				
3	**Group size** Course 1: 30 (Lecture) Course 2: 30 (Exercises)				
4	**Qualification targets / skills** Students will define the function of an autonomous mobile system. Transfer established methods from statistics to problems of localization and up for navigation. Students make decisions to select appropriate methods for configuring a vision-based autonomous system.				
5	**Contents** The course gives deep insight into Probabilistic Robotics“. Bayesian networks, Kalman-Filter, Markov-Random fields und Conditional Random Fields are introduced to solve the SLAM-Problem (“Simultaneous Localization and Mapping“). Different sensor modalities are presented and their properties are modeled. As well-established software tool ROS is introduced.				
6	**Usability of module for other programs** M.Sc. Computervisualistik (Module 04CV2006)				
7	**Prerequisites for Participation**				
8	**Method of Examination** Written exam (90 min) (Module exam)				
9	**Requirement for Credit points** Regular participation in course Passing Module exam				
10	**Percentage of grade in final mark** 6/120				
11	**Frequency of Course** Annually (summer semester)				
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Dietrich Paulus				
13	**Further information** Optional Compulsory Module				

Module 04IN2002 **Formal Specification and Verification**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
04IN2002		180 h	6 LP	1. to 3. Master-Semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 4320021 V Formal Specification and Verification		45 h	75 h	4 LP
	2. 4320022 Ü Formal Specification and Verification		15 h	45 h	2 LP
2	**Teaching form** Course 1: Lecture (3 CH) Course 2: Exercises (1 CH)				
3	**Group size** Course 1: 30 (Lecture) Course 2: 30 (Exercises)				
4	**Qualification targets / skills** The students learn about various methods and languages for formal specification and can use them. They know techniques for model checking and deductive verification (e.g. of software) and understand their logical foundation. They can verify (with suitable tools) the correctness of certain classes of programs.				
5	**Contents** Preliminaries - Propositional logic, First-order logic Specification and analysis - algebraic specification - model-based specification - declarative modeling Verification - programming logics (Hoare logic, dynamic logic, temporal logic) - model checking - deductive verification; software model checking Examples, Applications				
6	**Usability of module for other programs** M.Sc. Computervisualistik (Module 04IN2002) M.Sc. Informatik (Module 04IN2002) M.Sc. Web Science (Module 04IN2002)				
7	**Prerequisites for Participation** Basic knowledge of logic: propositional logic, predicate logic				
8	**Method of Examination** Written exam (90 min) or oral exam(30 min) (Module exam)				
9	**Requirement for Credit points**				

	Regular participation in course 2 Passing Module exam
10	**Percentage of grade in final mark** 6/120
11	**Frequency of Course** irregularly
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Viorica Sofronie-Stokkermans
13	**Further information** Optional Compulsory Module

Module 04IN2028 **Machine Learning & Data Mining**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
04IN2028		180 h	6 LP	1. to 3. Master-Semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 4320281 V Machine Learning & Data Mining		45 h	75 h	4 LP
	2. 4320282 Ü Machine Learning & Data Mining		15 h	45 h	2 LP
2	**Teaching form** Course 1: Lecture (3 CH) Course 2: Exercises (1 CH)				
3	**Group size** Course 1: 30 (Lecture) Course 2: 30 (Exercises)				
4	**Qualification targets / skills** Machine Learning is devoted to automated learning from input data. It suggests explanation models and estimates their parameters for understanding and predicting the future system behavior. Machine learning serves a formal backbone for many methods and models of computer science.				
5	**Contents** The lecture addresses master students in computer science, computer visualistics, information management, business informatics and Web science that want to extend and to structure their knowledge in machine learning. Lecture topics include linear discriminators, kernel-based methods, Bayesian methods, as well as common applications in Computer Science problems. Special attention is paid to morn, state of the art methods and approaches that are currently widely used in different fields of Computer Science.				
6	**Usability of module for other programs** M.Sc. Computervisualistik (Module 04IN2028) M.Sc. Informatik (Module 04IN2028) M.Sc. Web Science (Module 04IN2028)				
7	**Prerequisites for Participation** Basic knowledge in linear algebra, stochastics, data structures and algorithms.				
8	**Method of Examination** Written exam (90 min) or oral exam(30 min) (Module exam)				
9	**Requirement for Credit points** Regular participation in course 2 Passing Module exam				
10	**Percentage of grade in final mark** 6/120				
11	**Frequency of Course** Annually (summer semester)				
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Steffen Staab				
13	**Further information**				

	Optional Compulsory Module

Module 04IN2035 **Wireless Data Communication**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
04IN2035		180 h	6 LP	1. to 3. Master-Semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 4320351 V Wireless Data Communication		45 h	75 h	4 LP
	2. 4320352 Ü Wireless Data Communication		15 h	45 h	2 LP
2	**Teaching form** Course 1: Lecture (3 CH) Course 2: Exercises (1 CH)				
3	**Group size** Course 1: 30 (Lecture) Course 2: 30(Exercises)				
4	**Qualification targets / skills** After this course has been taught, students will know the fundamentals of wireless communication. They have learned to assess wireless Systems analytically and by simulation studies. Furthermore, they will know how far particular wireless communication forms are suitable for given applications. As well, they will also know the limitations of wireless communication. Last but not this course will convey students the potential of wireless communication for exciting novel IT applications.				
5	**Contents** • Derivation of physical models for wireless communication (e.g. log-normal shadowing, Ricean-Fading, Rayleigh-Fading) • Coding techniques especially for wireless communication (e.g. convolutional codes) • Special wireless media access control mechanisms (e.g. energy efficient MAC layer for wireless sensor networks) • Mobile communication systems (e.g. GSM, UMTS, LTE) • Wireless local networks (e.g. WLAN, Bluetooth) • Mobile and wireless internetworking (e.g. mobile IP, TLP adaptations)				
6	**Usability of module for other programs** M.Sc. Informatik (Module 04IN2035)				
7	**Prerequisites for Participation** Basic knowledge of the layer model for communication systems.				
8	**Method of Examination** Written exam (90 min) (Module exam)				
9	**Requirement for Credit points** Regular participation in course 2 Passing Module exam				
10	**Percentage of grade in final mark** 6/120				
11	**Frequency of Course** irregularly				
12	**Module Coordinator and Lecturer**				

	Module coordinator: Prof. Dr. Hannes Frey
13	**Further information** Optional Compulsory Module

Module 04IN2037 **Software Language Engineering**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
04IN2037		180 h	6 LP	1. to 3. Master-Semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 4320371 V Software Language Engineering		30 h	60 h	3 LP
	1. 4320372 Ü Software Language Engineering		30 h	60 h	3 LP
2	**Teaching form** Course 1: Lecture (2 CH) Course 2: Exercises (2 CH)				
3	**Group size** Course 1: 30 (Lecture) Course 2: 30 (Exercises)				
4	**Qualification targets / skills** Students master design and implementation of languages and language-centric software components as relevant, for example, in domain-specific language engineering, model-driven engineering, compiler construction, and software re-/reverse engineering. To this end, students apply declarative programming techniques, lightweight formal and executable specification, and specialized software engineering methods.				
5	**Contents** Overview and motivation Grammars and parsing Grammar-based testing Interpreters and typecheckers Attribute grammars and semantic analysis Rewrite systems and software transformation Domain-specific languages Principles of language design Design patterns for language implementation Staged computation and program generation Software reverse engineering (application) Software re-engineering (application) Model-driven engineering (application)				
6	**Usability of module for other programs** M.Sc. Informatik (Module 04IN2037)				
7	**Prerequisites for Participation** Basic knowledge in declarative programming				
8	**Method of Examination** Written exam (90 min) or oral exam (30 min) (module exam)				
9	**Requirement for Credit points**				

	Regular participation in course 2 Passing Module exam
10	**Percentage of grade in final mark** 6/120
11	**Frequency of Course** irregularly
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Ralf Lämmel
13	**Further information** Optional Compulsory Module

Module 04WI2013
Enterprise Architecture Modeling

Module code	Workload	Credit points	Semester	Duration
04WI2013	180 h	6 LP	1. to 3. Master-Semester	1 Semester

1	Courses	Contact time	Self-study	Credit points
	1. 4420131 V Enterprise Architecture Modeling	30 h	90 h	4 LP
	2. 4420132 Ü Enterprise Architecture Modeling	15 h	45 h	2 LP

2 Teaching form

Course 1: Lecture (2 CH)
Course 2: Exercises (1 CH)

3 Group size

Course 1: 75 (Lecture)
Course 2: 30 (Exercises)

4 Qualification targets / skills

Aims of module are: Students will understand and be able to mastering the concept of Enterprise Architecture as a means to develop an enterprise concept at different levels of consideration (strategic vision, business architecture, information systems architecture, technology architecture) and from distinct perspectives (processes, organizational structures, data structures, application and system structures, etc.). This includes knowing the principles of enterprise architectures, knowing different frameworks for Enterprise Architecture (e.g. Zachman Framework, TOGAF, FEAF, etc.), knowing the functions and governance of EA, and knowing which Modeling notations and methods of analysis are to be applied at what level of architecture consideration. Students know distinct toolkits for enterprise architecture development (ARIS, ADONIS, Intalio, Enterprise Architect, etc.), their advantages and disadvantages, their best coverage of enterprise architecture phases, and they can master a selected tool to develop a comprehensive enterprise architecture. Students are capable of assessing and elaborating larger tasks by knowing what to do (the phases of an EA) and which techniques of analysis and Modeling to choose. They are capable of assessing the different EA tools and selecting the best suitable for the EA works they are confronted with.

5 Contents

1. Introduction: Enterprise Architecture (EA) as an approach to model, design and analyze Information Systems & socio-technical systems in public and private sector
2. Key EA concepts: Different architecture frameworks, EA functions and governance, EA principles
3. Domain of Organization: Model of organizational networks of influence, business strategy, synthesis of technologies and domain understanding, technology trends
4. Elaborating an Enterprise Architecture for a given scenario: Applying the TOGAF framework
5. Architecture views and viewpoint design: architecture for multiple applications, interpretation of EA models and artefacts, documentation and presentation of EA
6. Commercial architectural constructs: distinct solutions of toolsets

6 Usability of module for other programs

	M.Sc. Computervisualistik (Module 04WI2013) M.Sc. Informatik (Module 04WI2013) M.Sc. Informationsmanagement (Module 04WI2013) M.Sc. Wirtschaftsinformatik (Module 04WI2013)
7	**Prerequisites for Participation** Basic knowledge in analysis of information systems, including knowing methods of surveys, questionnaires, interviews, scenario technique, soft systems method, gap analysis, requirements engineering. Students are expected to know Modeling notations such as Event-driven-Process-Chains, Adonis process Modeling notation, Business Process Modeling Notation, Modeling organisational aspects and work environments, Modeling of data via ER-diagrams or UML class diagrams.
8	**Method of Examination** Written Assignment (2 weeks) (Module exam)
9	**Requirement for Credit points** Regular participation in course 2 Passing coursework Passing Modul exam
10	**Percentage of grade in final mark** 6/120
11	**Frequency of Course** irregularly
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. Maria Wimmer
13	**Further information** Optional Compulsory Module

Module 04WI2027 **Mobile Systems Engineering**					
Module code		**Workload**	**Credit points**	**Semester**	**Duration**
04WI2027		180 h	6 LP	1. to 3. Master-Semester	1 Semester
1	**Courses**		**Contact time**	**Self-study**	**Credit points**
	1. 4420271 V Mobile Systems Engineering		30 h	60 h	3 LP
	2. 4220272 Ü Mobile Systems Engineering		30 h	60 h	3 LP
2	**Teaching form** Course 1: Lecture (2 CH) Course 2: Exercises (2 CH)				
3	**Group size** Course 1: 75 (Lecture) Course 2: 30 (Exercises)				
4	**Qualification targets / skills** Students will gain the following competencies / skills: - gain an overview of the breadth of mobile applications - be motivated to dig into most recent research projects in the field - grasp the complexity and interdisciplinarity of MSE.				
5	**Contents** Introduction and understanding of terminology of MSE. The Lecture covers approx. 12 units where teachers from distinct disciplines will present recent research work in the field of MSE.				
6	**Usability of module for other programs** M.Sc. Computervisualistik (Module 04WI2027) M.Sc. Informatik (Module 04WI2027) M.Sc. Web Science (Module 04WI2027)				
7	**Prerequisites for Participation** Basic knowledge of computer networks that can e.g. be gained from modules "Communication systems in business environments" or "Essentials in computer networks", and which comprises: - Design aspects and areas of data communication in enterprises - protocols and applications (IP, TCP, UDP, etc.) - knowledge about network infrastructures such as LAN, WLAN, mobile radio communication, etc. - knowing the standards, norms and application scenarios of the various business data communication systems Students should bring along interest in mobile systems and in research questions of mobile contexts.				
8	**Method of Examination** Written exam (90 min) or oral exam(30 min) (Module exam)				
9	**Requirement for Credit points**				

	Regular participation in course 2 Passing assigments in course 2 Passing module exam
10	**Percentage of grade in final mark** 6/120
11	**Frequency of Course** irregularly
12	**Module Coordinator and Lecturer** Module coordinator: Prof. Dr. J. Felix Hampe
13	**Further information** Optional Compulsory Module