BERGISCHE
UNIVERSITÄT
WUPPERTAL

AMTLICHE MITTEILUNGEN

Verkündungsblatt der Bergischen Universität Wuppertal
Herausgegeben vom Rektor

NR_41 **JAHRGANG 46**
28.07.2017

Zweite Änderung der Prüfungsordnung für den Masterstudiengang Computer Simulation in Science an der Bergischen Universität Wuppertal

vom 28.07.2017

Auf Grund des § 2 Abs. 4 und des § 64 Abs. 1 des Gesetzes über die Hochschulen des Landes Nordrhein-Westfalen (Hochschulgesetz - HG) vom 16.09.2014 (GV. NRW S. 547), geändert am 15.12.2016 (GV. NRW S. 1154), hat die Bergische Universität Wuppertal die folgende Ordnung erlassen.

Artikel I

Die Prüfungsordnung für den Masterstudiengang Computer Simulation in Science an der Bergischen Universität Wuppertal vom 19.05.2014 (Amtl. Mittlg. 29/14)), geändert durch Ordnung vom 28.03.2017 (Amtl. Mittlg. 17/17), wird wie folgt geändert:

1. **§ 15 Absatz 1 Satz 2** erhält folgende Fassung:
   „Voraussetzung für die Ausgabe des Themas der Abschlussarbeit ist der Nachweis von 70 Leistungspunkten gemäß § 10 sowie der Abschluss aller beschränkt wiederholbarer Modulprüfungen."

2. **Anhang:** Die Form der **Modulbeschreibung** wird geändert und neu gefasst;
   darin werden die Module „CEM1 Computational Electromagnetics 1" und „MT Master Thesis" geändert.

Artikel II
Übergangsbestimmungen

Diese Prüfungsordnung findet auf alle Studierenden Anwendung, die für den Masterstudiengang Computer Simulation in Science ab dem Wintersemester 2017/2018 erstmalig an der Bergischen Universität Wuppertal eingeschrieben sind.
Studierende, die ihr Studium nach der Prüfungsordnung vom 19.05.2014 (Amtl. Mittlg. 29/14), geändert am 28.03.2017 (Amtl. Mittlg. 17/17), aufgenommen haben, können ihre Modulprüfungen bis zum 30.09.2019 ablegen, es sei denn, dass sie die Anwendung dieser neuen Prüfungsordnung beim Prüfungsausschuss beantragen. Der Antrag auf Anwendung der neuen Prüfungsordnung ist unwiderruflich.

Artikel III
In-Kraft-Treten, Veröffentlichung

Diese Ordnung tritt am Tage nach ihrer Veröffentlichung in den Amtlichen Mitteilungen als Verkündungsblatt der Bergischen Universität Wuppertal in Kraft.

Ausgefertigt auf Grund des Beschlusses des Fakultätsrates der Fakultät für Mathematik- und Naturwissenschaften vom 26.07.2017.

Wuppertal, den 28.07.2017

Der Rektor
der Bergischen Universität Wuppertal
Universitätsprofessor Dr. Dr. h.c. Lambert T. Koch

BERGISCHE
UNIVERSITÄT
WUPPERTAL

Module des Studiengangs
Computer Simulation in Science

Stand: 27. Juli 2017

Inhaltsverzeichnis

Modul-Nr.	**Name des Moduls** *ggf. in englischer Sprache*	**Workload in LP**	Gewicht der Note
Angaben zu Form und Dauer der Prüfung		xW [1]	x US [2]
Lernergebnisse /Kompetenzen			
Voraussetzung für das Modul (falls gegeben)			

Computer Simulation

CSim1	**Computer Simulation 1**	**10 LP**	10
Schriftliche Prüfung (Klausur) 180 min. Dauer English Translation: written module examination (180 minutes), can be repeated twice		2W	1 US
The students will learn basic algorithms and how to apply them in problems of physics and mathematics. In the lecture they will become familiar with the derivation of the principles of the algorithms and will understand simple examples. In the exercises they will program solutions of more complex problems. The accompanying laboratory course will extend the knowledge on algorithms and students will work out larger projects independently.			
unbenotete Übungen zu Introduction to Computer Simulation (2 LP), mindestens 50 Prozent dieser Übungspunkte sind Voraussetzung für die Anmeldung zur Modulabschlussprüfung. English Translation: ungraded exercises for Introduction to Computer Simulation (2 cr), at least 50 per cent of these exercise points are required for the registration for the final module exam.			

CSim2	**Computer Simulation 2**	**13 LP**	13
Schriftliche Prüfung (Klausur) 120 min. Dauer schriftliche Teilmodulprüfung zu Parallel Algorithms alternativ: mündliche Teilmodulprüfung zu Parallel Algorithms (30 Minuten), unbegrenzt wiederholbar Die Form der Modulabschlussprüfung wird zu Beginn der Veranstaltung bekannt gegeben. English Translation: written examination for Parallel Algorithms (120 minutes), unrestrictedly repeatable alternatively: oral examination for Parallel Algoriths (30 minutes), unrestrictedly repeatable The type of the final module exam will be announced at the beginning of the lecture. *und*		UW	-
Mündliche Prüfung 30 min. Dauer English Translation: oral examination of Data Analysis (30 minutes), unrestrictedly repeatable		UW	-

[1] Wiederholung: UW = uneingeschränkt, 1W = einmal, 2W = zweimal
[2] Anzahl unbenoteter Studienleistungen (US)

CSim2	**Computer Simulation 2**	(Fortsetzung)
Introduction to mathematical concepts and practical methods of data analysis strongly based on practical examples. The students shall be enabled to autonomously solve basic problems in data analysis. The students learn the specific algorithmic requirements in high performance computing. They are able to develop complex parallel algorithms, to analyze them and judge their efficiency.		
No formal pre-requisites.		

CSim3	**Computer Simulation 3**	**12 LP**	12
Schriftliche Prüfung (Klausur) 180 min. Dauer English Translation: written module examination (180 minutes), can be repeated twice		2W	1 US
The students will learn how to tackle problems which require parallelization. In Introduction to Computer Simulation II they will acquire the algorithmic skills and learn how to parallelize the solution of problems. In the Laboratory Course II they will program these solutions in C with Message Passing Interface (MPI) and at the end work on a larger simulation project, using a parallel supercomputer.			
CSim1, Modern Programming (CS1). *unbenotete Übungen zu Lab Course II (2 LP), mindestens 50 Prozent dieser Übungspunkte sind Voraussetzung für die Anmeldung zur Modulabschlussprüfung.* *English Translation: ungraded exercises for Lab Course II (2 cr), at least 50 per cent of these exercise points are required for the registrtion for the final module exam.*			

Computer Science

CS1	**Computer Science 1**	**10 LP**	10
Schriftliche Prüfung (Klausur) 120 min. Dauer English Translation: written module examination (120 minutes), unrestrictedly repeatable		UW	1 US
Designing and implementing larger software projects using object-oriented methods. GRID computing.			
Ein unbenotetes Referat zu Worldwide Distributed (GRID) Computing (2 LP) ist Voraussetzung für die Anmeldung zur Modulabschlussprüfung. *English Translation: an ungraded presentation for Worldwide Distributed (GRID) Computing (2 cr) is required for the registration for the final module exam.*			

CS2	**Computer Science 2**	**7 LP**	7

CS2	**Computer Science 2**	(Fortsetzung)	
Schriftliche Prüfung (Klausur) 120 min. Dauer English Translation: written module examination (120 minutes), unrestrictedly repeatable *oder*		UW	-
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable. Die Form der Modulabschlussprüfung wird zu Beginn der Veranstaltung bekannt gegeben. English Translation: The type of the final module exam will be announced at the beginning of the lecture.		UW	-
Overview of different tools for software engineering. The students will acquire knowledges about visualization of data and will learn to apply them in independent work.			
No formal pre-requisites.			

Atmospheric Physics

AtmP1	**Atmospheric Physics 1**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer mündliche Prüfung zu Summer School on Chemistry and Dynamics of the Atmosphere (Jülich) English Translation: oral module examination for Summer School on Chemistry and Dynamics of the Atmosphere (Jülich) (30 minutes), unrestrictedly repeatable		UW	1 US
With this lecture the students will deepen their knowledge of the basic concepts. The lecture is centered around communicating expertise and skills on specific topics of atmospheric physics, atmospheric chemistry, measurement techniques as well as numerical modelling. The Summer School on Chemistry and Dynamics of the Atmosphere is a one week course held at the Research Centre Jülich. The students will get an overview of the basics as well as special topics of atmospheric physics and chemistry. They will also get to know the relation of atmospheric research to adjacent disciplines to get a broader insight in interdisciplinary scientific questions. They will become acquainted with state-of-the-art measurement techniques and their applications. Furthermore, this course offers the opportunity to intensively discuss with the leading scientists in the field, who are available throughout the course. After the course the students should be able to summarize the basic concepts of atmospheric chemistry and physics and thorougly report their experience.			
Unbenotetes Protokoll eines Fachgesprächs zu Selectd Topics in Atmosperic Physics (3 LP) ist Voraussetzung für die Anmeldung zur Modulabschlussprüfung. *English Translation: ungraded record of an interview to Selectd Topics in Atmosperic Physics (3 cr) is required for the registration for the final module exam.*			

AtmP2a	**Atmospheric Physics 2a**	**8 LP**	8

AtmP2a	**Atmospheric Physics 2a**	(Fortsetzung)	
Mündliche Prüfung 30 min. Dauer mündliche Prüfung zu Introduction to Atmospheric Physics English Translation: oral module examination for Introduction to Atmospheric Physics (30 minutes)		UW	1 US
The lecture Introduction to Atmospheric Physics leads to an understanding of the fundamental concepts of atmospheric physics. The goal is to impart knowledge and application of the basic equations as well as the interaction of physical and chemical processes. This will be the basis for a general overview of trace gas budgets, the Earth's radiation budget, and atmospheric circulation. With this knowledge basic phenomena of weather and climate can be understood.			
Eine unbenotete kleine Hausarbeit zu Atmospheric Physics (3 LP) ist Voraussetzung für die Anmeldung zur Modulabschlussprüfung. *English Translation: an ungraded small homework for Introduction to Atmospheric Physics (3 cr) is required for the registration for the final module exam.*			

AtmP2b	**Atmospheric Physics 2b**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer mündliche Prüfung zu Selectd Topics in Atmospheric Physics in Kombination mit Seminar on Atmospheric Physics English Translation: oral module examination for Selected Topics in Atmospheric Physics (30 minutes), in combination with Seminar on Atmospheric Physics		UW	2 US
With this lecture and seminar the students will deepen their knowledge of the basic concepts. The lecture is centered around communicating expertise and skills on specific topics of atmospheric physics, atmospheric chemistry, measurement techniques as well as numerical modelling.			
ein unbenotetes Referat zu Selected Topics in Atmospheric Physics, dokumentiert durch ein schriftliches Manuskript/den Foliensatz des Vortrages (2 LP) ist Voraussetzung für die Anmeldung zur Modulabschlussprüfung. *English Translation: an ungraded presentation for Selected Topics in Atmospheric Physics, documented by a script/set of slides (2 cr) is required for the registration for the final module exam.* *und/and* *ein unbenotetes Referat zu Seminar on Atmospheric Physics, dokumentiert durch ein schriftliches Manuskript/den Foliensatz des Vortrages (3 LP) ist Voraussetzung für die Anmeldung zur Modulabschlussprüfung.* *English Translation: an ungraded presentation for Seminar on Atmospheric Physics, documented by a script/set of slides (3 cr) is required for the registration for the final module exam.*			

Computational Electromagnetics

CEM1	**Computational Electromagnetics 1**	**8 LP**	8

CEM1	**Computational Electromagnetics 1**	(Fortsetzung)	
Schriftliche Prüfung (Klausur) 120 min. Dauer English Translation: written module examination (120 minutes), unrestrictedly repeatable *oder*		UW	-
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable. Die Form der Modulabschlussprüfung wird zu Beginn der Veranstaltung bekannt gegeben. English Translation: The type of the final module exam will be announced at the beginning of the lecture.		UW	-
Getting an overview of an insight into various techniques to numerically simulate electromagnetic and coupled multiphysics field problems in highly complex technical systems or biological organisms.			
No formal pre-requisites.			

CEM2	**Computational Electromagnetics 2**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable		UW	-
Within small project teams, students will learn within small ïndustry style" projects given to them to effectively use modern (preferably industrial standard) commercial CEM simulation tools or to alternatively develop and use own implementations of electromagnetic field simulators. They will learn to use these tools to describe and possibly optimize the electromagnetic properties of devices and systems in electrical engineering applications of science and industry. The results of their CEM simulation project work are to be presented in oral and scientific report form.			
No formal pre-requisites.			

Computational Fluid Mechanics

CFM1	**Computational Fluid Mechanics 1**	**8 LP**	8
Sammelmappe mit Begutachtung Sammelmappe mit Begutachtung, Inhalt, Frist und Form der jeweiligen Einzelleistung wird zu Semesterbeginn vom Prüfungsausschuss durch Aushang bekannt gegeben. English Translation: assessment of folder, unrestrictedly repeatable Contents, time and form of each single achievement will be announced at the beginning of the semester through notice from the examination board.		UW	-

CFM1	**Computational Fluid Mechanics 1**	(Fortsetzung)

Computational Fluid Dynamics

- to understand the fluid mechanical equations (Navier-Stokes equations)
- to understand the mathematical background of CFD
- to choose and understand different models to simulate flows (turbulence models, etc.)
- to evaluate CFD-solutions
- to apply CFD for the purposes of research and development

Smooth Particle Hydrodynamics
Based on theoretical knowledge of the hydrodynamics of particle flow the application of computational models can be applied. The conceptual problem set-up of DEM/SPH can be described; a conceptual model can be developped and the problem can be converted into a computer model. The results of a numerical simulation can be interpreted and used for a general engineering design.

No formal pre-requisites.

CFM2	**Computational Fluid Mechanics 2**	**8 LP**	8
Sammelmappe mit Begutachtung Sammelmappe mit Begutachtung, Inhalt, Frist und Form der jeweiligen Einzelleistung wird zu Semesterbeginn vom Prüfungsausschuss durch Aushang bekannt gegeben. English Translation: assessment of folder, unrestrictedly repeatable. Contents, time and form of each single achievement will be announced at the beginning of the semester through notice from the examination board.		UW	-

Fire Simulation: Techniques and models for thermally driven turbulent fluid simulations are presented. Based on their general CFD knowledge, the students become familiar with theoretical modelling of turbulence, combustion, and pyrolysis, as used for fire and smoke simulations in civil engineering. An accompanying simulation project completes the course.

Pedestrian Dynamics: Models of pedestrian dynamics. Basic concepts for simulation of pedestrians (movement, routing, interactions). The students gain practical experience by the accompanying simulation project.

Groundwater Flow, Free Surface Water Flow: Based on theoretical knowledge of the hydrodynamics of flow the application of computational model can be applied. The problem can be described; a conceptual model can be developed and the problem can be converted into a computer model. The results of a numerical simulation can be interpreted and used for a engineering design.
Smooth Particle Hydrodynamics: Based on theoretical knowledge of the hydrodynamics of particle flow the application of computational models can be applied. The conceptual problem set-up of DEM/SPH can be described; a conceptual model can be developped and the problem can be converted into a computer model. The results of a numerical simulation can be interpreted and used for a general engineering design.

Fire Simulation:CFM1, NM1, CSim1, CS1
Groundwater Flow, Free Surface Water Flow:
CFM1

Experimental Particle Physics

EPP1	**Experimental Particle Physics 1**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer English Translation: oral exam (30 minutes)		UW	1 US
The Standard Model of Elementary Particle Physics: The students will learn the properties and foundations of the Standard Model of Elementary Particle Physics.			
Quantum Mechanics at bachelor level. Particularly suited for students with Bachelor of Physics or Applied Science *Unbenotete Übungen zu The Standard Model of Elementary Physics (5 LP) sind Voraussetzung für die Anmeldung zur Modulabschlussprüfung.* *English Translation: ungraded exercises for The Standard Model of Elementary Physics (5 cr) are required for the registration for the final module exam.*			

EPP2	**Experimental Particle Physics 2**	**8 LP**	8
Sammelmappe mit Begutachtung einschließlich mündlicher Prüfung 30 min. Dauer Das Modul hat folgende Wahlmöglichkeiten: 1) Foundations of Elementary Particle and Astroparticle Physics (Übungen, 2 LP; mündliche Prüfung, 6 LP) oder 2) Architectures (praktische Übung, 2 LP) + Introduction to Cosmology and General Relativity (Übungen, 3 LP; mündliche Prüfung, 3 LP) oder 3) Architectures (praktische Übung, 2 LP) + Detector Physics (Übungen, 3 LP; mündliche Prüfung, 3 LP) English Translation: Assessment of folder, including 30 minutes oral exam, unrestricted repeatable. For the module the following combinations are possible: 1) Foundations of Elementary Particle and Astroparticle Physics (exercises, 2 cr; oral examination, 6 cr) or 2) Architectures (practical exercise, 2 cr) + Introduction to Cosmology and General Relativity (exercises, 3 cr; oral examination, 3 cr) or 3) Architectures (practical exercise, 2 cr) + Detector Physics (exercises, 3 cr; oral examination, 3 cr)		UW	-

EPP2	**Experimental Particle Physics 2**	(Fortsetzung)
Foundations of Elementary Particle and Astroparticle Physics: The students will be familiar with the structure of the Standard Model of elementary particle physics and possible extensions of it. They will acquire the principles for the determination of particle properties and reactions at particle accelerators, both theoretically and experimentally. The interconnection between particle and astroparticle physics is stressed. Foundations of the origin and detection of cosmic rays are given. Introduction to the concepts and techniques of modern detectors for particle and astro-particle physics. Introduction to Cosmology and General Relativity: The students will understand the basic principles of general relativity as the theoretical foundation of cosmology. They will get familiar with the general structure and contents of the Universe and its evolution from the big bang to the far future and they will understand the concept and observational evidence for the big bang itself. A number of spectacular observations have been made in recent years which have put Cosmology forward to a quantitative science. Solving problems related to the lectures will lead to a consolidation of the achieved competences. Architectures: The development of computers is particularly important in Particle Physics applications. The lecture on architectures provides the basic understanding of the functioning of a computer.		
No formal pre-requisite.		

Financial Mathematics

FM1	**Financial Mathematics 1**	**8 LP**	8
Schriftliche Prüfung (Klausur) 120 min. Dauer English Translation: written module examination (120 minutes), unrestrictedly repeatable. *oder*		UW	-
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable. Die Form der Modulabschlussprüfung wird zu Beginn der Veranstaltung bekannt gegeben. English Translation: The type of the final module exam will be announced at the beginning of the lecture.		UW	-
The students become familiar with basic concepts in Computational Finance. They learn how to model in finance, develop and use simulation tools and judge their efficiency and practicability in front offices.			
No formal pre-requisites.			

FM2	**Financial Mathematics 2**	**8 LP**	8
Schriftliche Prüfung (Klausur) 120 min. Dauer English Translation: written module examination (120 minutes), unrestrictedly repeatable. *oder*		UW	-
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable. English Translation: The type of the final module exam will be announced at the beginning of the lecture.		UW	-
The students become familiar with basic concepts in Computational Finance. They learn how to model in finance, develop and use simulation tools and judge their efficiency and practicability in front offices.			

FM2	**Financial Mathematics 2**	(Fortsetzung)
Numerical Analysis at Bachelor Level, particularly suited for students with Bachelor of mathematics, Financial Mathematics or Applied Sciences		

Materials Science

MSci1	**Materials Science 1**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable.		UW	-
Understanding macroscopic (mostly polymer) material properties on the basis of microscopic interactions.			
No formal pre-requisites.			

MSci2	**Materials Science 2**	**8 LP**	8
Schriftliche Hausarbeit English Translation: written homework, unrestrictedly repeatable.		UW	-
Acquiring numerical modeling techniques used in industrial RD departments focussing on materials development and performance.			
Concepts in Soft Matter Physics			

Theoretical Chemistry

TC1	**Theoretical Chemistry 1**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable.		UW	1 US
Acquisition of extended knowledge on the quantum-mechanical description of molecular motion. This description covers electron structure calculations, rotation-vibration theory and, as the final step, the simulation of observable molecular spectra and theoretical prediction of other measurable molecular properties. Acquisition of the skill to understand the workings of existing computer programs for carrying out such calculations/simulations and to modify and extend these programs.			
Unbenotete Übungen (2 LP) sind Voraussetzung für die Anmeldung zur Modulabschlussprüfung. *English Translation: ungraded exercises (2 cr) are required for the registration for the final module exam.*			

TC2	**Theoretical Chemistry 2**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable.		UW	1 US
Acquisition of the skill to apply existing computer programs for carrying out electron structure calculations, the simulation of observable molecular spectra, and theoretical prediction of other measurable molecular properties, and of the skill to optimize the numerical procedures employed in these computer programs.			
TC1 *Unbenotete Übungen (2 LP) sind Voraussetzung für die Anmeldung zur Modulabschlussprüfung.* *English Translation: ungraded exercises (2 cr) are required for the registration for the final module exam.*			

Theoretical Particle Physics

TPP1	**Theoretical Particle Physics 1**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable.		UW	1 US
The Standard Model of Elementary Particle Physics: The students will learn the properties and foundations of the Standard Model of Elementary Particle Physics. Statistical Field Theory: Knowledge of phase transitions and criticality of lattice- and continuums-models, as well as the possible range of critical exponents and their deduction from scaling arguments within the framework of the renormalization group and finite-size-scaling arguments. Conveying the special properties of conformal invariance in two dimensions. Mastery of computational skills like perturbation theory and integrabillity of low dimensional systems, in particular the Bethe-Ansatz. Many Particle Theory: Knowledge of phenomena in solid state physics which can not be explained by one-particle properties. Interaction of phonons with electrons within the framework of perturbation theory. The aim is the understanding of the systematics and general properties of perturbation theory and the limits of perturbative theoretical methods.			
Voraussetzung für die Anmeldung zur Modulabschlussprüfung sind 5 LP aus der unbenoteten Studienleistung aus einer der Komponenten a, b oder c. *English Translation: ungraded exercsises (5 cr) from one of the components a, b or c are required for the registration for the final module exam.*			

TPP2	**Theoretical Particle Physics 2**	**8 LP**	8

TPP2	**Theoretical Particle Physics 2**	(Fortsetzung)	
Sammelmappe mit Begutachtung einschließlich mündlicher Prüfung 30 min. Dauer Das Modul hat folgende Wahlmöglichkeiten: 1) Quantum Field Theory in Particle Physics (Übungen, 2 LP; mündliche Prüfung, 6 LP) oder 2) Architectures (praktische Übung, 2 LP) + Introduction to Cosmology and General Relativity (Übungen, 3 LP; mündliche Prüfung, 3 LP) English Translation: Assessment of folder, including 30 minutes oral exam, unrestrictedly repeatable. For the module the following combinations are possible: 1) Quantum Field Theory in Particle Physics (exercises, 2 cr; oral examination, 6 cr) or 2) Architectures (practical exercise, 2 cr) + Introduction to Cosmology and General Relativity (exercises, 3 cr; oral examination, 3 cr)		UW	-
The students are prepared for modern research in the field of theoretical particle physics and its computer assisted applications. The students will understand the basic principles of general relativity as the theoretical foundation of cosmology. They will get familiar with the general structure and contents of the Universe and its evolution from the big bang to the far future and they will understand the concept and observational evidence for the big bang itself. A number of spectacular observations have been made in recent years which have put Cosmology forward to a quantitative science. Solving problems related to the lectures will lead to a consolidation of the achieved competences. The development of computers is particularly important in Particle Physics applications. The lecture on architectures provides the basic understanding of the functioning of a computer.in and detection of cosmic rays are given.			
No formal pre-requisites.			

Master Thesis

MT	**Master Thesis**	**30 LP**	30
Abschlussarbeit English Translation: master thesis, can be repeated once.		1W	-
Die in englischer Sprache zu verfassende Abschlussarbeit soll zeigen, dass die Kandidatin oder der Kandidat sein Fachgebiet beherrscht und in der Lage ist, innerhalb einer vorgegebenen Frist eine einschlägige Aufgabenstellung selbstständig zu bearbeiten. Das Thema der Masterarbeit wird mit Bezug zum Wahlfach gewählt. English Translation: The master thesis written in English has to prove that the candidate masters his field of study and that he/she is able to accomplish independently a task relevant to this field within a given time frame. The topic of the master thesis is chosen with reference to the specialization.			
Voraussetzung für die Ausgabe des Themas der Abschlussarbeit ist der Nachweis von 70 LP sowie der Abschluss aller beschränkt wiederholbarer Modulprüfungen. *English Translation: 70 credit points as well as the conclusion of all module examinations which can only be repeated a restricted number of times are required for getting the topic of the master thesis.*			

Numerical Methods

NM1	**Numerical Methods 1**	**8 LP**	8
Schriftliche Prüfung (Klausur) 120 min. Dauer English Translation: written examination of Numerical Analysis and Simulation I, (120 min), unrestrictedly repeatable *oder*		UW	1 US
Mündliche Prüfung 30 min. Dauer English Translation: oral examination of Numerical Analysis and Simulation I (30 minutes), unrestrictedly repeatable. Die Form der Modulabschlussprüfung wird zu Beginn der Veranstaltung bekannt gegeben. English Translation: The type of the final module exam will be announced at the beginning of the lecture.		UW	-
Students are familiar with complex algorithms for the numerical simulation of ordinary differential equations and are able to analyze and classify them, apply them properly and develop them further.			
Bearbeitung der wöchentlich ausgegebenen unbenoteten Übungsaufgaben zu Numerical Analysis and Simulation I (2 LP) ist Voraussetzung für die Anmeldung zur Prüfung. *English Translation: ungraded weekly exercises for Numerical Analysis and Simulation I (2 cr) are required for the registration for the exam.*			

NM2a	**Numerical Methods 2a**	**8 LP**	8
Schriftliche Prüfung (Klausur) 120 min. Dauer English Translation: written examination of Numerical Analysis and Simulation II (120 minutes), unrestrictedly repeatable. *oder*		UW	1 US
Mündliche Prüfung 30 min. Dauer English Translation: oral examination of Numerical Analysis and Simulation II (30 minutes), unrestrictedly repeatable. Die Form der Modulabschlussprüfung wird zu Beginn der Veranstaltung bekannt gegeben. English Translation: The type of the final module exam will be announced at the beginning of the lecture.		UW	-
Students are familiar with complex algorithms for the numerical simulation of partial differential equations and are able to analyze and classify them, apply them properly and develop them further.			
Bearbeitung der wöchentlich ausgegebenen unbenoteten Übungsaufgaben zu Numerical Analysis and Simulation II (2 LP) ist Voraussetzung für die Anmeldung zur Prüfung. *English Translation: ungraded weekly exercises for Numerical Analysis and Simulation II (2 cr) are required for the registration for the exam.*			

NM2b	**Numerical Methods 2b**	**8 LP**	8
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable.		UW	1 US

NM2b	**Numerical Methods 2b**	(Fortsetzung)
Numerical Methods in Classical Field Theory and Quantum Mechanics: The students will learn different numerical techniques to solve problems in classical field theory and quantum mechanics. The focus will be on the implementation on parallel computers. Students will have to write a term paper about one project, learning how to prepare a documentation.		
Unbenotete Übungsaufgaben und schriftliche Ausarbeitung zu Numerical Methods in Classical Field Theory and Quantum Mechanics (5 LP) sind Voraussetzung für die Anmeldung zur Modulabschlussprüfung. *English Translation: ungraded small homework and term paper for Numerical Methods in Classical Field Theory and Quantum Mechanics (5 cr), required for the registration for the final module exam.*		

NM3	**Numerical Methods 3**	**6 LP**	6
Schriftliche Prüfung (Klausur) 120 min. Dauer English Translation: written module examination (120 minutes), unrestrictedly repeatable *oder*		UW	-
Mündliche Prüfung 30 min. Dauer English Translation: oral module examination (30 minutes), unrestrictedly repeatable. Die Form der Modulabschlussprüfung wird zu Beginn der Veranstaltung bekannt gegeben. English Translation: The type of the final module exam will be announced at the beginning of the lecture.		UW	-
The students become familiar with basic concepts of Numerical Mathematics. They are able to analyze and develop basic schemes in Numerical Analysis of Linear and Nonlinear systems.			
No formal pre-requisites.			