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3rd Amendment to the Examination regulations for the degree programme “Computer Simulation in Science” with the degree of Master of Science at the University of Wuppertal

Dated 13 November 2023

In accordance with § 2, Section 4 and § 64 Section 1 of the Higher Education Act (HE Act) of the State of North Rhine-Westphalia (NRW) dated 16 September 2014 (GV. NRW. p. 547), last amended on 29 August 2023 (GV. NRW. p. 1072), the University of Wuppertal has enacted the following examination regulations.

Article 1

The Examination regulations for the degree programme “Computer Simulation in Science” with the degree of Master of Science at the University of Wuppertal from 17.12.2020 (Official Announcement 110/20), amended on 22 February 2023 (Official Announcement 06/23), is amended as follows:

1. § 1, Section 3, Point 1 is redrafted as follows:

„1. A Bachelor's degree of at least 6 semesters in the subjects of applied natural sciences, chemistry, electrical engineering, financial mathematics, mechanical engineering, mathematics, physics, safety engineering or a related subject with a total of at least 180 ECTS credit points at a state or state-recognised higher education institution and possibility to prove through the degree certificates a final grade of 3.0 or higher. Only the first decimal place of the final grade is taken into account; any further decimal places shown are disregarded – without rounding. In addition, applicants must have gained the following credit points (CP) either in, or transferable to, the following areas:

Knowledge of a programming language	8 CP	and
Atmospheric Physics: Experimental Physics (Mechanics, Electricity and Magnetism, Atoms and Molecules), Thermodynamics, Data Analysis and Statistics	24 CP	or
Computational Electromagnetics: Electromagnetics/Electromagnetic Theory, Applied Mathematics, Numerical Techniques in Engineering/Computational Engineering	24 CP	or
Computational Finance: Analysis I, II and III, Linear Algebra I and Introduction to Stochastic Calculus, Introduction into Numerical Analysis, Theory of Ordinary Differential Equations, Functional Analysis	24 CP	or
Computational Fluid Mechanics: Fluid Mechanics, Numerical Methods (or similar)	24 CP	or
Detector Physics: Newton's laws, circular motion, harmonic oscillator, forced oscillations, energy and momentum conservation, elastic scattering. Basic relations of relativistic kinematics. Coloumb's law of electric forces, Lorentz force, law of induction, propagation of planar electromagnetic waves in vacuum and matter. Quantisation of energy levels in atoms, excitations of atoms, photoelectric effect, description of microscopic particles with wave functions, Compton scattering. Radioactive decays.	24 CP	or

Imaging in Medicine: Atomic Physics, Nuclear Physics, Basic Quantum Mechanics	24 CP	or
Molecular and Materials Modelling: Physical Chemistry (including Introductory Thermodynamics), Modern General Physics	24 CP	or
Theoretical Particle Physics: Quantum Mechanics, Elementary Particle Physics, Theoretical Physics (Mechanics, Electromagnetism, Thermodynamics).	24 CP	

The recognition and transfer of credit points is decided by the examination committee. If an applicant's knowledge does not suffice to select one of the specializations, extra conditions may be specified in the admission letter. Mathematical knowledge at science or engineering bachelor's degree level is presupposed."

2. **§ 10, Section 2** is redrafted as follows:

„2. The master's examination comprises one compulsory module, one module of an area of specialisation and the Master's Thesis. A total of 74 credit points (CP) must be achieved in modules of the compulsory subject. Modules with credit points listed in brackets are elective modules (WP):

MT: Master's Thesis **30 CP**

Computer Simulation: **36 CP**

CSim1: Computer Simulation 1 11 CP

CSim2: Computer Simulation 2 13 CP

CSim3: Computer Simulation 3 12 CP

Computer Science: **16 CP**

CS1: Computer Science 1 9 CP

CS2: Computer Science 2 7 CP

Numerical Methods: **22 CP**

NM3: Numerical Methods 3 6 CP

and elective

NM1: Numerical Methods 1 (8 CP)

or

NM1a: Advanced Numerics (8 CP)

and elective

NM2a: Numerical Methods 2a (8 CP)

or

NM2b: Numerical Methods 2b (8 CP)

An area of specialization must be chosen. In modules within the chosen area of specialization, 16 credit points (CP) are to be achieved at the candidate's choice. Modules with credit points listed in brackets are elective modules (WP):

Atmospheric Physics

AtmP1: Atmospheric Physics 1 8 CP

and elective

EAP: Introduction to the Atmospheric Physics (8 CP)

AtmP2b: Atmospheric Physics 2b (8 CP)

Computational Electromagnetics	
CEM1: Computational Electromagnetics 1	8 CP
CEM2: Computational Electromagnetics 2	8 CP
Computational Finance	
CompFin1: Computational Finance 1	8 CP
CompFin2: Computational Finance 2	8 CP
Computational Fluid Mechanics	
CFM1.1: Computational Fluid Mechanics 1.1	4 CP
CFM1.2: Computational Fluid Mechanics 1.2	4 CP
<i>and elective two modules among the following:</i>	
CFM2: Computational Fluid Mechanics 2	(4 CP)
CFM3: Computational Fluid Mechanics 3	(4 CP)
CFM4: Computational Fluid Mechanics 4	(4 CP)
CFM5: Computational Fluid Mechanics 5	(4 CP)
Detector Physics	
PDP: Particle Detector Project	8 CP
DET: Detector Physics	8 CP
Imaging in Medicine	
IMG1: Imaging 1	8 CP
<i>and</i>	
IMG2: Imaging 2	8 CP
Molecular and Materials Modelling	
MMM1: Molecular and Materials Modelling 1	8 CP
MMM2: Molecular and Materials Modelling 2	8 CP
Theoretical Particle Physics:	
<i>One of the modules:</i>	
SMTP: The Standard Model of Elementary Particle Physics	(8 CP)
VTT: Many Particle Theory	(8 CP)
SFT: Statistical Field Theory	(8 CP)
<i>and one of the modules:</i>	
COS: Cosmology and General Relativity	(8 CP)
EQFT: Introduction to Quantum Field Theory	(8 CP)
FQM: Advanced Quantum Mechanics	(8 CP)"

3. § 17, Section 2 is redrafted as follows:

- a) The following **sentence 3** is inserted after **sentence 2**:
“The combination of modules IMG1 and DET is not permitted”.
- b) The previous **Sentences 3 and 4** become **Sentences 4 and 5**.

4. **Appendix:** The module description is to be amended and reworded:

The following modules will be amended:

- MT Master’s Thesis
- FQM Advanced Quantum Mechanics
- CompFin1 Computational Finance 1
- CompFin2 Computational Finance 2
- CSim3 Computer Simulation 3
- EQFT Introduction to Quantum Field Theory
- DET Detector Physics
- IMG1 Imaging 1
- EAP Introduction to the Atmospheric Physics

- VTT Many Particle Theory
- SFT Statistical Field Theory
- SMTP The Standard Model of Elementary Particle Physics.

The following modules will be added:

- NM1a Advanced Numerics
- CFM1.1 Computational Fluid Mechanics 1.1
- CFM1.2 Computational Fluid Mechanics 1.2
- MMM1 Molecular and Materials Modelling 1
- MMM2 Molecular and Materials Modelling 2
- PDP Particle Detector Project.

The following modules will be deleted:

- CFM1 Computational Fluid Mechanics 1
- GETA Foundations of Elementary Particle and Astroparticle Physics
- NMvM Numerical Methods for Physics of Soft Matter
- SMwM Statistical Mechanics of Soft Matter
- TC1 Theoretical Chemistry 1
- TC2 Theoretical Chemistry 2.

Article 2

Transitional provisions

1. These examination regulations apply to all students enrolled for the first time in the "Computer Simulation in Science" Master of Science degree programme at the University of Wuppertal from the 2023/2024 winter semester onwards.
2. Students who have enrolled on their degree programme in accordance with the Examination Regulations dated 17 December 2022 (Official Announcement 110/20), as last amended on 7 November 2023 (Official Announcement 111/23), may take their module examinations by 30 September 2025, unless they request the Examination Board to apply these new examination regulations. The request to apply the new examination regulations is irrevocable.

Article 3

Promulgation and publication

These examination regulations come into force retroactively as of 1 October 2023, following their publication in the Official Bulletin of the University of Wuppertal.

Executed in accordance with the resolution of the Faculty Board of the School of Mathematics and Natural Sciences dated 12 July 2023.

Dated Wuppertal, 13.11.2023

The Rector
of the University of Wuppertal
Professor Dr. Birgitta Wolff

MT	Abschlussarbeit („Master-Thesis“)	Gewicht der Note 30	Workload 30 LP	
Qualifikationsziele: 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.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Voraussetzung für die Modulabschlussprüfung: Voraussetzung für die Ausgabe des Themas der Abschlussarbeit ist der Nachweis von mindestens 70 LP, die den erfolgreichen Abschluss der Module CSim1, CSim3 und mindestens einem Modul in der gewählten Spezialisierung beinhalten. Bei Wahl der Spezialisierung Computational Fluid Mechanics müssen die Module CFM1.1 und CFM1.2 erfolgreich abgeschlossen sein. English Translation: The requirements for getting the topic of the master thesis are 70 credit points including the conclusion of the module examinations CSim1, CSim3 and of at least one module in the chosen specialization. Students of the specialization CFM must have completed the module examinations CFM1.1 and CFM1.2.				
Modulabschlussprüfung ID: 80222	Abschlussarbeit (Thesis)	6 Monate	1	30
Anzahl der unbenoteten Studienleistungen: 0				

NM1a	Advanced Numerics	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: Students have gained advanced knowledge in an area of numerical mathematics and can apply advanced methods. They can independently develop advanced methods and concepts of numerics and apply them to new situations.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses: Inhalt, Frist und Form der jeweiligen Einzelleistungen der Sammelmappe werden zu Semesterbeginn vom Prüfungsausschuss bekannt gegeben. English Translation: Content, deadline and form of the respective individual assignments of the MAP will be announced by the lecturer at the beginning of the semester.				
Modulabschlussprüfung ID: 81060	Sammelmappe mit Begutachtung		unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				

FQM	Advanced Quantum Mechanics	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: The students learn advanced methods and techniques of quantum mechanics, in particular the relativistic formulation and the field quantization. They are able to derive and solve the formulation of advanced quantum mechanical problems. They will gain an overview of various computational methods and approximations as well as the fundamental importance of relativistic phenomena in physics. They will also learn the foundations of theoretical particle physics.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses: Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English Translation: The form of the examination of the module is announced at the beginning of the semester in which the examination will be conducted.				
Modulabschlussprüfung ID: 39291	Mündliche Prüfung	30 Minuten	unbeschränkt	8
Modulabschlussprüfung ID: 39113	Schriftliche Prüfung (Klausur)	120 Minuten	unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				

CompFin1	Computational Finance 1	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: The students are familiar with basic concepts in Computational Finance. They have learnt how to model in finance, develop and use simulation tools and judge their efficiency and practicability in front offices.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses: Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English Translation: The form of the examination of the module is announced at the beginning of the semester in which the examination will be conducted.				
Modulabschlussprüfung ID: 39158	Mündliche Prüfung	30 Minuten	unbeschränkt	8
Modulabschlussprüfung ID: 38959	Schriftliche Prüfung (Klausur)	120 Minuten	unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				

CompFin2	Computational Finance 2	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: The students are familiar with basic concepts numerical methods applied in Computational Finance. They are able to solve numerically partial differential equations arising in finance, and can interpret the numerical results.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses: Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English Translation: The form of the examination of the module is announced at the beginning of the semester in which the examination will be conducted.				
Modulabschlussprüfung ID: 38978	Mündliche Prüfung	30 Minuten	unbeschränkt	8
Modulabschlussprüfung ID: 38992	Schriftliche Prüfung (Klausur)	120 Minuten	unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				

CFM1.1	Computational Fluid Mechanics 1.1		Gewicht der Note 4	Workload 4 LP
Qualifikationsziele: Mastering of the basics of fluid dynamics. Students shall be enabled to apply different models to simulate flows (turbulence models etc.) for the purposes of research and development. Students shall be enabled to critically evaluate CFD results.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Voraussetzung für die Modulabschlussprüfung: Die Anmeldung zur Modulabschlussprüfung kann erst erfolgen, wenn das Modul CSim1 erfolgreich abgeschlossen wurde. English Translation: The registration to the final module exam is possible only when the module CSim1 has been successfully passed.				
Zusammensetzung des Modulabschlusses: Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English Translation: The type of the final module exam will be announced at the beginning of the lecture.				
Modulabschlussprüfung ID: 80227	Schriftliche Prüfung (Klausur)	120 Minuten	2	4
Modulabschlussprüfung ID: 80228	Mündliche Prüfung	30 Minuten	2	4
Anzahl der unbenoteten Studienleistungen: 0				

CFM1.2	Computational Fluid Mechanics 1.2		Gewicht der Note 4	Workload 4 LP
Qualifikationsziele: Mastering of the basics of radiative heat transfer. Students shall be enabled to apply different models to simulate radiative heat transfer for the purposes of research and development. They are further able to apply and implement selected methods relevant for radiative heat transfer methods.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Voraussetzung für die Modulabschlussprüfung: Die Anmeldung zur Modulabschlussprüfung kann erst erfolgen, wenn die Module CSim1 und CFM1.1 erfolgreich abgeschlossen wurden. English Translation: The registration to the final module exam is possible only when the module CSim1 and CFM1.1 have been successfully passed.				
Zusammensetzung des Modulabschlusses: Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English Translation: The type of the final module exam will be announced at the beginning of the lecture.				
Modulabschlussprüfung ID: 80211	Schriftliche Prüfung (Klausur)	120 Minuten	2	4
Modulabschlussprüfung ID: 80843	Elektronische Prüfung	120 Minuten	2	4
Modulabschlussprüfung ID: 80844	Mündliche Prüfung	30 Minuten	2	4
Anzahl der unbenoteten Studienleistungen: 0				

CSim3	Computer Simulation 3	Gewicht der Note 12	Workload 12 LP	
Qualifikationsziele: Mastering the fundamental mathematical concepts underlying the master program. Acquisition of basic knowledge of numerical algorithms and their applications in natural sciences and mathematics. Ability to write computer programs to implement the algorithms. The students are parallel able to use this knowledge independently and apply it to solve projects in a laboratory course.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Voraussetzung für die Modulabschlussprüfung: Die Anmeldung zur Modulabschlussprüfung kann erst erfolgen, wenn die Module CSim1 und CS1 erfolgreich abgeschlossen und die UBL 47002 erbracht wurden. English Translation: The registration to the final module exam is possible only when module CSim1 and CS1 and UBL 47002 are successfully completed.				
Modulabschlussprüfung ID: 47028	Elektronische Prüfung	180 Minuten	2	10
Anzahl der unbenoteten Studienleistungen: 1				

DET	Detector Physics	Gewicht der Note	Workload	
		8	8 LP	
Qualifikationsziele:				
The students master the physical principles and the components of particle accelerators as well as their functions. They can perform simple computations of linear beam optics. The students know how to describe the interaction of different forms of particle radiation with matter and they are able to connect this knowledge to techniques, methods and components of modern detectors and experiments in particle and astro-particle physics. The students will be enabled to discuss the advantages and disadvantages of different detector types. They can explain the use and the interplay of detectors in large experiments. The students know about basic laboratory techniques of detecting particles, perform simple experiments and analyse recorded data.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Voraussetzung für die Modulabschlussprüfung:				
Die Anmeldung zur Modulabschlussprüfung kann erst erfolgen, wenn die UBL 81023 und die UBL 81024 erbracht wurden.				
English Translation:				
The UBL 81023 and the UBL 81024 are required for the registration for the final module exam.				
Modulabschlussprüfung ID: 81022	Mündliche Prüfung	30 Minuten	unbeschränkt	4
Anzahl der unbenoteten Studienleistungen:				
2				

IMG1	Imaging 1	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: The students master the basics of quantitative medical imaging. They learn the underlying physical principles, detection methods, and analysis tools. The students understand the advantages and disadvantages of different brain imaging approaches.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Voraussetzung für die Modulabschlussprüfung: Die Anmeldung zur Modulabschlussprüfung kann erst erfolgen, wenn die UBL 81044 erbracht wurde. English Translation: The UBL 81044 is required for the registration for the final module exam.				
Modulabschlussprüfung ID: 46963	Mündliche Prüfung	30 Minuten	unbeschränkt	6
Anzahl der unbenoteten Studienleistungen: 1				

EQFT	Introduction to Quantum Field Theory	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: The students shall be enabled to carry out modern research in the field of theoretical particle physics and its computer assisted applications.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses: Für die Hausarbeit gilt: Umfang: 20 - 25 Seiten. English Translation: Scope of written homework: 20 - 25 pages. Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English translation: The form of the examination of the module is announced at the beginning of the semester in which the examination will be conducted.				
Modulabschlussprüfung ID: 40901	Schriftliche Hausarbeit	12 Wochen	unbeschränkt	8
Modulabschlussprüfung ID: 40963	Mündliche Prüfung	45 Minuten	unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				

EAP	Introduction to the Atmospheric Physics	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele:				
The lecture Introduction to Atmospheric Physics leads to an understanding of the fundamental concepts of atmospheric physics. Students shall be enabled to apply the basic equations including the interaction of physical and chemical processes. With this knowledge they are able to understand basic phenomena of weather and climate.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Modulabschlussprüfung ID: 76363	Sammelmappe mit Begutachtung		unbeschränkt	8
Anzahl der unbenoteten Studienleistungen:				
0				

VTT	Many Particle Theory	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: The students know advanced phenomena in solid state physics which can not be explained by one particle properties. They are able to describe and compute the interaction of phonons with electrons within the framework of perturbation theory.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses: Für die Hausarbeit gilt: Umfang: 20 - 25 Seiten. English Translation: Scope of written homework: 20 - 25 pages. Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English Translation: The form of the examination of the module is announced at the beginning of the semester in which the examination will be conducted.				
Modulabschlussprüfung ID: 39197	Mündliche Prüfung	30 Minuten	unbeschränkt	8
Modulabschlussprüfung ID: 39146	Schriftliche Hausarbeit	12 Wochen	unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				

MMM1	Molecular and Materials Modelling 1	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: Students are able to describe material properties from the microscopic to the macroscopic scale. They are acquainted with the fundamental concepts of quantum mechanics, thermodynamics and essential knowledge in quantum chemistry and statistical thermodynamics.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Voraussetzung für die Modulabschlussprüfung: The UBL 80403 is required for the registration for the final module exam.				
Modulabschlussprüfung ID: 80402	Mündliche Prüfung	30 Minuten	unbeschränkt	6
Anzahl der unbenoteten Studienleistungen: 1				

MMM2	Molecular and Materials Modelling 2	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: The students learn and apply numerical methods for the simulations of materials at the molecular level. The necessary concepts in quantum chemistry and molecular dynamics are presented and the students acquires skills to perform atomistic simulations of complex systems using modern software.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Modulabschlussprüfung ID: 80845	Präsentation mit Kolloquium	60 Minuten	unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				

PDP	Particle Detector Project	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele:				
The students know how to apply techniques of particle detection and reconstruction to particular detector setups. They are able to simulate the response of particle detectors to incident particles. They know how to operate and control detectors, record data in laboratory setups and analyse these data. They are able to use modern software tools, including parallel computing techniques, in performing to above mentioned tasks. The students obtain hands-on experience in state-of-the-art experimental equipment (tunneling microscopy). The students can choose their detector project from the following fields: Implementation of multivariate techniques for track reconstruction in field programmable gate arrays, simulation and optimisation of calorimetric measurements with the GEANT package, simulation of air showers with the CORSIKA package, simulation of the propagation of charged particles and their interactions in the universe, simulation of radio-interferometric measurements in air showers, and operation and calibration of large particle detectors using modern distributed computing techniques and web architectures, scanning probe techniques, x-ray probes.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses:				
Inhalt, Frist und Form der jeweiligen Einzelleistungen der Sammelmappe wird zu Semesterbeginn vom Prüfungsausschuss bekannt gegeben. English Translation: Assessment of folder, contents, time and form of each single achievement will be announced at the beginning of the semester.				
Modulabschlussprüfung ID: 80219	Sammelmappe mit Begutachtung		unbeschränkt	8
Anzahl der unbenoteten Studienleistungen:				
0				

SFT	Statistical Field Theory	Gewicht der Note 8	Workload 8 LP	
Qualifikationsziele: The students know the phenomenology 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 integrability of low dimensional systems,in particular the Bethe-Ansatz.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses: Für die Hausarbeit gilt: Umfang: 20 - 25 Seiten. English Translation: Scope of written homework: 20 - 25 pages. Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English translation: The form of the examination of the module is announced at the beginning of the semester in which the examination will be conducted.				
Modulabschlussprüfung ID: 39170	Mündliche Prüfung	30 Minuten	unbeschränkt	8
Modulabschlussprüfung ID: 38942	Schriftliche Hausarbeit	12 Wochen	unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				

SMTP	The Standard Model of Elementary Particle Physics		Gewicht der Note 8	Workload 8 LP
Qualifikationsziele: The students learn the properties and foundations of the Standard Model of Elementary Particle Physics.				
Nachweise	Form	Dauer/ Umfang	Wiederholbarkeit	LP
Zusammensetzung des Modulabschlusses: Für die Hausarbeit gilt: Umfang: 20 - 25 Seiten. English Translation: Scope of written homework: 20 - 25 pages. Die Form der Modulabschlussprüfung wird zu Beginn des Semesters bekannt gegeben, in dem die Modulabschlussprüfung stattfindet. English Translation: The form of the examination of the module is announced at the beginning of the semester in which the examination will be conducted.				
Modulabschlussprüfung ID: 40980	Mündliche Prüfung	30 Minuten	unbeschränkt	8
Modulabschlussprüfung ID: 40957	Schriftliche Hausarbeit	12 Wochen	unbeschränkt	8
Anzahl der unbenoteten Studienleistungen: 0				