Note:
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Curriculum for the

Extension Programme Scientific Computing

at the Faculty of Mathematics, Computer Science and Physics of the University of Innsbruck

Table of contents

§ 1 Allocation of the study programme

According to §54 Universities Act 2002, the Extension Programme in Scientific Computing is allocated to the engineering study programmes.

§ 2 Qualification profile

(1) The Extension Programme in Scientific Computer at the University of Innsbruck is targeted at students and graduates, who wish to broaden their qualification profile through a scientifically based additional education in the field of scientific computing.

(2) Graduates of the Extension Programme in Scientific Computing possess the necessary interdisciplinary competences for the identification and responsible handling of current questions from science, economy and society, to the solution of which the understanding of models and efficient computer simulations can contribute:

- They have advanced knowledge in relevant sub-areas of the underlying disciplines of mathematics, computer science, natural and technical sciences and – in selected areas – tie in with the latest research in scientific computing.
- They are familiar with the methods of scientific-mathematical modelling; in particular with the need to consider model assumptions and resulting limitations of validity, to communicate this clearly both to laypersons and experts in order to enable responsible handling of calculated results beyond the scientific context.
- They will have advanced knowledge of numerical mathematics and efficient programming of common computer systems and computer systems optimised for high-performance computing. Beyond this, they have acquired the competence to evaluate realistic models for practice-relevant tasks by means of simulation.
- They are able to critically question and interpret calculated results and to communicate them responsibly to experts and laypersons alike.
- They are able to identify those problems of a rapidly changing environment (scientific world, working world and society) which can be meaningfully dealt with using suitable methods of scientific computing.
- The acquired competence to acquire a wide range of skills and to link them in an interdisciplinary way allows graduates to autonomously develop their knowledge and understanding in the field of scientific computing. Raising awareness of gender issues and gender relations in the sciences through adapted teaching and experience allows graduates to contribute to a gender equitable society in their future fields of action.

(3) Due to their acquired qualifications, the following fields of activity are open to graduates of the Extension Programme in Scientific Computing in particular:

- Development-related professions in the context of Industry 4.0, in which relevant problems in modelling and simulation are worked on in interdisciplinary teams in a well-founded and practice-oriented manner.
- Advanced modelling and simulation-related research activity in the areas of the disciplines underlying scientific computing, as well as activity in departments that wish to use scientific computing methods to answer appropriately prepared questions.

§ 3 Scope and duration

The Extension Programme in Scientific Computing covers 60 ECTS-Credits. This corresponds to a duration of the studies of two semesters. One ECTS-Credit corresponds to a workload of 25 hours.

§ 4 Language

The Extension Programme in Scientific Computing is offered in English. In justified exceptional cases, examinations may be taken in German.

§ 5 Admission

(1) The admission to the Extension Programme in Scientific Computing requires the admission to or previous completion of one of the following Bachelor's, Master's or Diploma programmes:

- Master's Programme in Chemistry, Master's Programme in Chemical Engineering, Master's Programme in Pharmacy,
- Bachelor's Programme in Atmospheric Sciences, Master's Programme in Atmospheric Sciences, Master's Programme in Environmental Meteorology,
- Secondary School Teacher Training - Bachelor's Programme (General Education) with at least one of the following subjects: Computer Sciences, Mathematics, Physics,
- Secondary School Teacher Training - Master's Programme (General Education) with at least one of the following subjects: Computer Sciences, Mathematics, Physics,
- Secondary School Teacher Training - Diploma Programme with at least one of the following subjects: Computer Sciences, Mathematics, Physics,
- Bachelor's Programme in Computer Sciences, Bachelor's Programme in Physics, Bachelor's Programme in Mathematics, Master's Programme in Computer Sciences, Master's Programme in Phyisics, Master's Programme in Mathematics,
- Bachelor's Programme in Civil and Environmental Engineering, Bachelor's Programme in Electrical Engineering, Bachelor's Programme in Mechatronics, Master's Programme in Civil Engineering, Master's Programme in Mechatronics, Master's Programme in Environmental Engineering

(2) In order to be admitted to the Extension Programme in Scientific Computing, students must have completed a certain number of ECTS-Credits of the programme to be expanded, namely 30 ECTS-Credits in the case of master's and diploma programmes and 60 ECTS-Credits in the case of bachelor's programmes.

(3) If admission to the regular study programme that is to be expanded expires, admission to the Extension programme expires at the same time.

§ 6 Types of courses and maximum number of students per course

(1) Courses without continuous performance assessment:

Lectures (VO) are courses held in lecture format. They introduce the research areas, methods and schools of thought for a given subject. No maximum number of participants

(2) Courses with continuous performance assessment:

1. Working groups (AG 'Arbeitsgemeinschaften') serve to treat a topic in collective fashion, examining the theories, methods and techniques of an area using group work. Maximum number of participants: 12
2. Lectures with integrated practical parts (VU) focus on the practical treatment of concrete scientific tasks that are discussed during the lecture parts of the course. Maximum number of participants: 20

§ 7 Procedure for the allocation of places in courses with a limited number of participants

In courses with a limited number of participants, course places are allocated as follows:

1. Students for whom the study duration would be extended due to the postponement are to be given priority.
2. If the criterium in no. 1 does not suffice to regulate the admission, the available places are allocated randomly.

§ 8 Compulsory modules

The following compulsory modules covering altogether 60 ECTS-Credits are to be passed:

1.	Compulsory Module: Introduction to Scientific Computing	h	ECTS-Credit
a.	**VO Introduction to Scientific Computing and Gender Competence**	2	2
b.	**VU Software Management for Scientific Computing**	2	3
c.	**VU Basics of Scientific Computing**	3	5
d.	**VU Modelling as Basis for Simulation**	3	5
	Total	**10**	**15**
	Learning Outcomes: – The students know the most important application possibilities of scientific computing as well as its potential to provide interdisciplinary efficient answers to current questions in research, economy and society. They are aware of gender issues and gender relations in the natural and technical sciences. – Students understand aspects of conventional computer architecture particularly relevant to scientific computing, as well as useful techniques for software development and management, which also guide forms of collaborative work. They are able to implement simple numerical algorithms - basic components of more complex simulations - and to analyse their properties. – They can explain and apply the scientific principles and basic methods of mathematical modelling as a basis for simulation. They are able to analyse simple existing models, select and apply suitable ones from established procedures for their evaluation, and interpret the resulting data in a professional manner.		
	Prerequisites: none		

2.	Compulsory Module: Methods in Scientific Computing	h	ECTS-Credits
a.	**VU C and C++ in Simulation Development**	3	5
b.	**VU Numerics of Partial Differential Equations**	3	5
c.	**VU Numerics of Selected Problems**	3	5
	Total	**9**	**15**
	Learning Outcomes: – After completion of the module, students will be able to use common mathematical models of real-world processes and evaluate them efficiently on conventional computer systems. – They have a detailed understanding of performance-relevant aspects of conventional computer architectures as well as appropriate programming skills to efficiently implement numerical methods on them and analyse their properties. – They will be able to correctly discretise the descriptive equations and to identify suitable numerical methods for further evaluation based on the current state of research and adapt them to problems as well as to programming requirements. – Based on this, students develop the competence to improve relevant aspects of numerical methodology and concrete implementation in a reciprocal and evaluation-based way in order to generate and evaluate practical solutions for new numerical problems.		
	Prerequisites: none		

3.	Compulsory Module: Methods in High-Performance Computing	h	ECTS-Credits
a.	**VU Numerics for the HPC**	3	5
b.	**VU HPC-Implementation A: Parallelisation**	3	5
c.	**VU HPC-Implementation B: Accelerators**	3	5
	Summe	**9**	**15**
	Learning Outcomes: – Students will have a detailed understanding of the computer architectures relevant to high-performance computing: the use of massively networked conventional computer systems, the access to perform certain computational operations of specialised accelerators, and the hybrid use of both concepts. – They can use methods to adapt conventional numerical algorithms to high-performance computing architectures as well as numerical methods designed for specialised architectures. You can assess the suitability of specialized HPC architectures for the implementation of given processes and have the programming competence to implement and evaluate efficient solvers of numerical problems.		
	Prerequisites: none		

4.	Compulsory Module: Applications of Scientific and High-Performance-Computing	h	ECTS-Credits
a.	**AG Applied HPC**	3	5
b.	**VO Case Studies of HPC**	2	2
c.	**VU Software Solutions in HPC**	2	3
d.	**VU Management and Visualisation of Simulation Data**	3	5
	Summe	**10**	**15**
	Learning Outcomes: – Students will be familiar with representative examples of applications of scientific computing in various disciplines as well as the subject-specific software used to process them and will be able to discuss both from the perspectives of the various disciplines. – They have the competence - independently and with original ambition - to elicit meaningful models for selected problems from the practice of scientific computing, to construct suitable simulations and to implement, execute and evaluate them efficiently on suitably selected hardware, and to critically evaluate the results obtained. – They have the skills to visualise simulation data in a professional and descriptive manner and to manage it according to the rules of good scientific practice. They are able to communicate, explain, and discuss findings obtained from simulations, useful visualisations, and prerequisites and limitations of the statements made.		
	Prerequisites: none		

§ 9 Examination regulations

(1) The performance of modules is evaluated by module examinations. Module examinations are examinations that serve to proof the knowledge and skills acquired in a module. The respective modules are competed by the positive evaluation of all parts of a module examination.

(2) The performance evaluation of the courses of the modules is effected by course examinations. Course examinations are
- examinations which serve to proof the knowledge and skills covered in one lecture in which course assessment is based on a single examination at the end of the course. The course instructor has to define and announce the examination method (written and/or oral) before the start of the course.
- examinations in courses with continuous performance assessment, where the evaluation is based on regular written or oral contributions of the participants. The course instructor has to define and announce the evaluation criteria before the start of the course.

(3) The course instructors have to inform the students in a suitable fashion about the targets, contents and methods of their courses as well as the contents, methods and evaluation criteria of the course examinations at the begin of each semester.

§ 10 Conclusion

The completion of the Extension Programme in Scientific Computing requires the conclusion of a regular study programme, which it expands. To document its completion, a certificate will be issued.

§ 11 Coming into force

This curriculum comes into force as of October 1st, 2022.