Attachment 1: Module Description

Compulsory Modules of Basic Education

Module Number	**Module Name**	**Responsible Lecturer**
CMS-SKL	Soft Skills	Prof. Dr. Björn Andres bjoern.andres@tu-dresden.de
Qualification Objectives	Students possess the scientific working methods and are familiar with the principles of good scientific practice. They know the DFG rules on good scientific practice and how these are implemented at TU Dresden. They are familiar with the basic of scientific working methods (epistemology according to Laplcae, literature research, presentation techniques, writing techniques). They can communicate expertly in the English language and independently write academic essays.	
Content	The module includes gaining or improving German and English language proficiency, or in other languages in exceptional cases. Language skills in German can be gained at any level of the European Framework of Reference for Languages. Language skills in English can be acquired at level C1 or higher of the European Framework of Reference for Languages. If a student proves that he or she already has a command of both German and English at level C1 or higher, courses in other languages are also permitted. In addition, the module includes compulsory training in good scientific practice, scientific ethics and scientific working methodology.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week and language courses amounting to 2 lecture hours per week, plus independent study. Language courses have to be chosen from the language education programme of Technische Universität Dresden (Catalogue of the Language and Culture Learning Center, LSK; TUDIAS Catalogue).	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	This module is a compulsory module, within the Master degree programme Computational Modelling and Simulation programme.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a 15 minute presentation in English and, if necessary, the language course qualification.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade results from the unweighted average of the graded work.	
Frequency of the Module	The module is offered each year during the winter semester.	
Workload	The total workload is 150 hours.	

Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-PRO	Research Project	Prof. Dr. Björn Andres bjoern.andres@tu-dresden.de
Qualification Objectives	The students master the practical application and transfer of acquired knowledge in an independent scientific project. They are able to identify a problem and divide it into steps that can be worked on independently. They can communicate autonomously about the project and find help when necessary. They are proficient in the scientific methods of computer modelling, in particular the design, implementation and validation of models and simulations. They are able to translate these simulations into a complex application problem.	
Content	The module includes a computer-aided modelling or simulation project on a topic of the student's choice in Computational Life Science, Computational Mathematics, Visual Computing, Computational Modelling in Energy Economics, Computational Engineering and Logical Modeling.	
Teaching and Learning Methods	The module includes a research project amounting to 12 lecture hours per week plus independent study.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	This module is a compulsory module, within the Master degree programme Computational Modelling and Simulation programme.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of completing a written project report of 120 hours and a 30 minute oral presentation in English.	
Credit Points and Grades	15 credit points can be earned by completing the module. The module grade is calculated from the weighted average of the graded work. The written project report is doubly weighted and the oral presentation is singly weighted.	
Frequency of the Module	The module is offered each year during the winter semester.	
Workload	The total workload is 450 hours.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-SEM	Literature Studies in Computational Modelling	Prof. Dr. Björn Andres bjoern.andres@tu-dresden.de
Qualification Objectives	Students will be able to independently develop the contents of scientific publications from at least two different fields of Computational Modelling and Simulation and present them to third parties in a comprehensible manner, and critically analyse the acquired knowledge. They are able to critically analyse and communicate the application of computational modelling methods in two different application areas and to recognise cross-application approaches.	
Content	Analysis and discussion of scientific publications on a topic of the student's choice in the fields of Computational Life Science, Computational Mathematics, Visual Computing, Computational Modelling in Energy Economics, Computational Engineering and Logical Modeling.	
Teaching and Learning Methods	The module includes seminars amounting to 4 lecture hours per week plus independent study. The courses are to be selected from the CMS-SEM catalogue to the specified extent; this will be announced as usual at the Faculty of Computer Science, at the beginning of each semester, including the language of the course.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	This module is a compulsory module, within the Master degree programme Computational Modelling and Simulation programme.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examination performances specified in the CMS-SEM catalogue.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module score is the unweighted average of the grades earned in the individual graded pieces of work.	
Frequency of the Module	The module is offered every summer semester.	
Workload	The total workload is 150 hours.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-COR-MLD	Machine Learning and Data Mining	Prof. Dr. Björn Andres bjoern.andres@tu-dresden.de
Qualification Objectives	Upon completing the module, students master the basics and handling of forward problems and inverse problems in computer-aided science. They intuitively comprehend the meaning and definition of these two problem formulations, as well as the relationship with generative and discriminative approaches in Statistics. They know the theoretical connections between these two formulations, as given by the Theorem of Bayes and the Euler-Lagrange equations. For forward problems, students know what verification and validation mean, and can apply these in practice. For inverse problems, students are familiar with the basics of machine learning, in particular supervised and unsupervised approaches, as well as the concepts of overfitting and cross validation.	
Content	Mathematical formulation of forward problems and inverse problems, generative and discriminative modelling approaches, Bayes theorem, Euler-Lagrange equations of optimisation, verification and validation of models and simulations, basics of machine learning, supervised learning, unsupervised learning, overfitting, cross validation, learning as an optimisation problem, basics of neural networks.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Knowledge in sequential computer programming, algorithms and data structures, analysis of functions of one and several variables, linear algebra (vector and matrix calculation), as well as probability calculation and Statistics at the Bachelor's level is required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	In the Computational Modelling and Simulation Master's programme, the module is one of ten compulsory elective modules (for students of Computational Life Science: nine), of which three must be chosen. This module fulfils the prerequisites for the CMS-EE-SCEE and CMS-EE-REEP modules.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a written examination lasting 90 minutes. If there are fewer than 10 students registered at the end of	

	the registration period, the written examination may be replaced by an oral examination as an individual examination lasting 30 minutes; if this is the case, this will be announced to the registered students at the end of the registration period.
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to the examination grade.
Frequency of the Module	The module is offered in each winter semester.
Workload	The total workload is 150 hours.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-COR-HPC	Parallel Programming and High-Performance Computing	Prof. Dr. Wolfgang Nagel wolfgang.nagel@tu-dresden.de
Qualification Objectives	Upon completing this module, the students will acquire the basics of parallel programming and high performance scientific computing.	
Content	The contents of the module include the design and architecture of numerical simulation codes, as well as computer programmes for data analysis. Furthermore, they include practical parts for the implementation of examples on existing HPC architectures in a high-level language with different parallelisation models such as e.g., MPI, multi-threading or CUDA.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Knowledge in sequential computer programming, algorithms and data structures, analysis of functions of one and several variables, linear algebra (vector and matrix calculation), as well as probability calculation and Statistics at the Bachelor's level is required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	In the Computational Modelling and Simulation Master's programme, the module is one of ten compulsory elective modules (for students of Computational Life Science: nine), of which three must be chosen. This module fulfils the prerequisites for the CMS-EE-SCEE and CMS-EE-REEP modules.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a 90-minute written test. If there are fewer than 10 students registered at the end of the registration period, the written examination may be replaced by an oral examination as an individual examination lasting 30 minutes; if this is the case, this will be announced, to the registered students at the end of the registration period.	
Credit Points and Grades	5 credit points can be earned by passing the module. The module grade corresponds to the examination grade.	

Frequency of the Module	The module is offered each year during the winter semester.
Workload	The total workload is 150 hours.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-COR-NUM	Basic Numerical Methods	Prof. Dr. Ivo Sbalzarini ivo.sbalzarini@tu-dresden.de
Qualification Objectives	Upon completing this module, the students will acquire the basics of numerical mathematics and numerical simulation methods. This includes the theoretical understanding of how a computer calculates with finite floating-point numbers and what kind of errors and inaccuracies may arise from these, and how to reduce or control them same. They will be familiar with basic numerical methods for numerical solutions and simulating mathematic models, linear algebra models, and ordinary and partial differential equations. They will be able to estimate the approximation errors of the methods and determine the algorithmic intensity, and will be able to implement these methods themselves, while adapting and optimising them for specific applications.	
Content	Floating point arithmetic, rounding errors, cancellation, numerical interpolation (Lagrange, Newton, Aitken-Neville, Hermite, Splines), numerical solutions of linear and non-linear equations and equation systems, Taylor developments, finite differences and their approximation errors, explicit and implicit time integrators, numerical stability, direct and iterative algorithms for matrix inversion, numerical integration (quadrature), discrete Fourier transformations, matrix decomposition (LU, QR, SVD), solution for the Poisson equation, fundamentals numerics of partial differential equations.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Knowledge in sequential computer programming, algorithms and data structures, analysis of functions of one and several variables, linear algebra (vector and matrix calculation), as well as probability calculation and Statistics at the Bachelor's level is required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	In the Computational Modelling and Simulation Master's programme, the module is one of ten compulsory elective modules (for students of Computational Life Science: nine), of which three must be chosen. This module fulfils the prerequisites for the module CMS-CE-CFD.	

Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a 90-minute written examination. If there are fewer than 10 students registered at the end of the registration period, the written examination may be replaced by an oral examination as an individual examination lasting 30 minutes; if this is the case, this will be announced to the registered students at the end of the registration period.
Credit Points and Grades	5 credit points can be earned by completing this module. The module grade corresponds to the examination grade.
Frequency of the Module	The module is offered each year during the winter semester.
Workload	The total workload is 150 hours.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-COR-SAP	Stochastics and Probability	Prof. Dr. Ivo Sbalzarini ivo.sbalzarini@tu-dresden.de
Qualification Objectives	Upon completing the module, the students master the basics of stochastic modelling and simulation. They are able to implement stochastic algorithms independently and formulate new ones.	
Content	Conditional probabilities, normal distributions, and scale-free distributions; transformation of random variables; simulation of pseudo and quasi random numbers; Markov chains and their matrix representation, mixing times; Monte Carlo Methods: Convergence, Law of Large Numbers, Variance Reduction, Rao-Blackwell, Importance Sampling, Markov Chains Monte-Carlo Using Metropolis-Hastings & Gibbs Samplers; Random processes and Brownian motion: properties in 1, 2, 3 and more dimensions, connection to the diffusion equation; Stochastic differential equations (SDEs): Nonlinear transformations of Brownian motion (Ito calculus), Ornstein-Uhlenbeck process and other solvable equations; Examples from population dynamics, genetics, protein kinetics, etc.; Numerical simulation of SDEs: strong and weak error, Euler-Maruyama scheme, Milstein scheme; Stochastic optimisation algorithms; exact stochastic simulation algorithms.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Knowledge in sequential computer programming, algorithms and data structures, analysis of functions of one and several variables, linear algebra (vector and matrix calculation), as well as probability calculation and Statistics at the Bachelor's level is required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	In the Computational Modelling and Simulation Master's programme, the module is one of ten compulsory elective modules (for students of Computational Life Science: nine), of which three must be chosen.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a 90-minute written examination. If there are fewer than 10 students registered at the end of the registration period, the written examination may be replaced by an oral examination as an individual examination lasting 30 minutes; if this is	

	the case, this will be announced to the registered students at the end of the registration period.
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to the examination grade.
Frequency of the Module	The module is offered each year during the winter semester.
Workload	The total workload is 150 hours.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-COR-VIZ	Data Visualisation	Prof. Dr. Stefan Gumhold stefan.gumhold@tu-dresden.de
Qualification Objectives	Upon completing this module, the students will acquire the basics and practices of scientific visualisation of measurement and experimental data, as well as simulation results. They know the basics of visual perception and their influence on the design of visualisations. Students can confidently specify data by dimension, feature types, and structure and select appropriate visual attributes for a given specification. They know the most important visualisation forms for 2-, 3- and multidimensional observation spaces, as well as for scalar, vectorial, tensor-valued and multidimensional features. They are able to select suitable techniques for the respective visualisation task. Students are familiar with basic presentation- and interaction techniques and can thoroughly implement them in an interactive visual analysis system. They know the most important visualisation frameworks, have gathered practical experience and are able to select these tasks appropriately.	
Content	The contents of the module are the basics of data visualisation, which deals with the mapping of data of different types on visual attributes, and builds on knowledge about the visual perception of humans.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Knowledge in sequential computer programming, algorithms and data structures, analysis of functions of one and several variables, basic techniques of data analysis and linear algebra (vector and matrix calculation) at the Bachelor's level is required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	In the Computational Modelling and Simulation Master's programme, the module is one of ten compulsory elective modules (for students of Computational Life Science: nine), of which three must be chosen.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a 90-minute written examination. If there are fewer than 10 registered students at the end of the	

	registration period, the written examination can be replaced by an oral examination as an individual examination lasting 30 minutes; if this is the case, this will be announced to the registered students at the end of the registration period.
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to the examination grade.
Frequency of the Module	The module is offered each year during the winter semester.
Workload	The total workload is 150 hours.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-COR-SED	Statistical Principles and Experimental Design	Prof. Dr. M.D. Ingo Röder ingo.roeder@tu-dresden.de
Qualification Objectives	Upon completing the module, the students master the methodical and practical basics of statistical data analysis and modelling, as well as the planning of experiments. They are able to describe and analyse data using statistical methods and interpret their results correctly. Furthermore, they gain the ability to plan experiments in such a way that a subsequent data evaluation in the context of the respective question is meaningful and efficient.	
Content	Content of the module include basic concepts of probability theory (e.g. random variables, distributions, limit sets), schools of statistical inference (e.g. frequentistic Bayesian, likelihood-based), estimation methods (e.g. point and interval estimators), principal and application of statistical tests (e.g. significance and fit test), term and application of statistical models (e.g. linear and generalised linear models), principles of experimental design (e.g. replication, randomisation, block formation), variance components and types, special designs (e.g. factorial designs, block designs), and aspects of sample size planning.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Basic knowledge in the fundamentals of probability theory, analysis of functions of one or more variables, linear algebra (vector and matrix calculus) as well as basic knowledge of computer programming at bachelor level are required. Students can prepare for the module with the following literature: Rohatgi & Saleh: An Introduction to Probability and Statistics, Wiley, 2001 Hefferon: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008; Tamás Rudas: Handbook of Probability: Theory and Applications, Sage Publications, Inc., 2008	
Usability	In the Computational Modelling and Simulation Master's programme, the module is one of ten compulsory elective modules (for students of Computational Life Science: nine), of which three must be chosen. However, it cannot be chosen as a compulsory elective module by students of the Track Computational Life Science as it is a compulsory module in this track.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The preliminary examination involves 9 practice tests of 12 (75%). The module examination itself consists of an examination paper lasting 90 minutes. If there are fewer than 10 students registered at the end of the registration period, the written examination can be replaced by an oral examination as individual examination lasting 30 minutes; if this is the case, this will be announced to the registered students at the end	

	of the registration period.
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to the examination grade.
Frequency of the Module	The module is offered each year during the winter semester.
Workload	The total workload is 150 hours.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-COR-DBM	Database Management	Prof. Dr. Wolfgang Lehner wolfgang.lehner@tu-dresden.de
Qualification Objectives	Upon completion of this module, students master the fundamental techniques for building transactional information systems. They will learn the core concepts of ER modelling and the relational database model including SQL and, in particular, master the central components of the database system architecture such as buffer management, recovery and the query optimiser.	
Content	Basics of database systems, SQL, database programming, database design, relational data models, ER diagrams, normal forms, database architecture, query optimisation, buffer management.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Fundamental knowledge in the basics of computer databases as well as fundamental knowledge of computer programming at bachelor level is required. Students can prepare for the module with the following literature: ▪ Lemahieu, W.; Broucke, S.V.; Baesens, B.: "Principles of Database Management", 2018 ▪ Elasmri, R.; Navathe, S.: "Fundamentals of Database Systems" (5th Edition) ▪ Ramakrishnan, R.; Gehrke, J.: "Database Management Systems". McGraw-Hill, 2002 ▪ Weikum, G.; Vossen, G.: „Transactional Information Systems". Morgan Kaufmann, 2001 ▪ J. Hoffer:, M. Prescott, H. Topi: „Modern Database Management" (9th Edition)	
Usability	In the Computational Modelling and Simulation Master's programme, the module is one of ten compulsory elective modules (for students of Computational Life Science: nine), of which three must be chosen.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a 90-minute written examination. If there are fewer than 10 students registered at the end of the registration period, the written examination can be replaced by an oral examination as an individual examination lasting 30 minutes; if this is the case, this will be announced to the registered students at the end of the registration period.	
Credit Points and Grades	5 credit points can be earned through completion of this module. The module grade corresponds to the examination grade.	
Frequency of the Module	The module is offered in each winter semester.	

Workload	The workload is 150 hours in total.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-COR-SSE	Scientific Software Engineering	Prof. Dr. Uwe Aßmann uwe.assmann@tu-dresden.de
Qualification Objectives	After completion of the module, students master fundamental methods, construction elements and notations for the systematic modelling, design and development of large object-orientated software systems of scientific computing with special emphasis on the aspect of reusing classes and frameworks. Graduates of this module have mastered the use of design patterns and their basis, role modelling. They are able to participate in the design and development of large software systems according to the consolidated state-of-the-art and to apply them in practical scenarios.	
Content	Classic design patterns in UML and programming languages for variability, expandability and reuse of components and software frameworks.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for participation	Fundamental knowledge of computer programming at Bachelor level is required: principle of object orientation, programming in Java, C#. Python, or C++, UML modelling (class diagrams, object diagrams, state machine diagrams, sequence diagrams). Students can prepare for the module with the following literature: Erich Gamma, Richard Helm, Ralph Johnson und John Vlissides. Design Patterns. Addison-Wesley Longman. The book of the so-called “Gang of Four (GOF)“. See also the website: http://st.inf.tu-dresden.de/teaching/dpf.	
Usability	In the Computational Modelling and Simulation Master's programme, the module is one of ten compulsory elective modules (for students of Computational Life Science: nine), of which three must be chosen.	
Requirements for the Awarding of Credit Points	The credit points are acquired if the module examination is passed. The module examination consists of a 90-minute written test. If there are less than 20 students registered at the end of the registration period, the written examination can be replaced by an oral examination lasting 15 minutes. The type of examination will be determined by the person responsible for the module at the end of the examination registration period and announced to the registered students at the end of the registration period.	
Credit points and grades	5 credit points can be earned through completion of the module. The module grade corresponds to the examination grade.	
Frequency of the module	The module is offered in each winter semester.	

Workload	The workload is 150 hours in total.
Duration of the Module	The module takes one semester to complete.

Modules in the Track Computational Life Science

Module Number	**Module Name**	**Responsible Lecturer**
CMS-CLS-ELG	Computational Life Science Basics	Prof. Dr. Ivo Sbalzarini ivo.sbalzarini@tu-dresden.de
Qualification Objectives	The students master the basic skills for the application of computer-aided modelling and simulation in the life sciences. They have in-depth knowledge of the application domain and are able to intuitively present simulation results. They have in-depth knowledge of the application domain and are able to intuitively present simulation results. They are familiar with concrete biological questions and have a solid command of the fundamentals of the application discipline and its technical vocabulary. They can evaluate biological data mathematically and learn testable models.	
Content	The content of the module can be chosen according to the student's focus: the basics of mechanics, the basics of automation, computer science methods for graphical representation and control of simulations, as well as flow simulation, biologically-orientated simulation and modelling methods, basics of machine learning and biomedical data sciences.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research project amounting to 8 lecture hours per week plus independent study. The courses are to be selected from the CMS-CMA-ELG catalogue to the specified extent; this will be announced as usual at the Faculty of Computer Science, at the beginning of each semester, including the language of the lecture, the necessary graded work and the weighting of the grades.	
Prerequisites for Participation	Knowledge in sequential computer programming, algorithms and data structures, analysis of functions of one and several variables, linear algebra (vector and matrix calculation), as well as probability calculation and Statistics at the Bachelor's level is required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	The module is a compulsory module for students of Computational Life Science in the Computational Modelling and Simulation Master degree programme.	

Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examinations specified in the CMS-CMA-ELG catalogue.
Credit Points and Grades	10 credit points can be earned through completing this module. The module grade results from the average of those for the graded work, weighted according to the catalogue CMS-CMA-ELG.
Frequency of the Module	The module is offered in each academic year, starting in the summer semester.
Workload	The workload is 300 hours in total.
Duration of the Module	The module takes two semesters to complete.

Module Number	Module Name	Responsible Lecturer
CMS-CLS-IBC	Introduction to Biochemistry	Prof. Dr. Simon Alberti simon.alberti@tu-dresden.de
Qualification Objectives	After completing the module, students will have knowledge of the basics of biochemistry, organic chemistry of biological molecules, their structure and their biosynthesis, primary metabolic networks, enzymology, gene expression, mutagenesis and the genetic architecture of selected biosyntheses. Students are able to explain nutrient and food-related meal planning and implement them independently.	
Content	The module includes the presentation of the most important macromolecules of the cell, its molecular building blocks, the biosynthesis and degradation of macromolecules. Furthermore, the module encompasses the flow of information in the cell from DNA to protein and methods for manipulating the genetic information.	
Teaching and Learning Methods	The module consists of lecture amounting to 2 lecture hours per week and practical amounting to 2 lecture hours per week, as well as independent study.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of Computational Life Science in the Computational Modelling and Simulation Master degree programme.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a written examination lasting 90 minutes and a practical training session lasting 24 hours. If there are fewer than 15 students registered at the end of the registration period, the written examination may be replaced by an oral examination as an individual test lasting 20 minutes; if this is the case, this will be announced to the registered students at the end of the registration period.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade is calculated from the weighted average of the graded work: The written examination resp. the oral examination is double weighted and the practical training session is single weighted.	
Frequency of the Module	The module is offered each year during the winter semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CLS-ABI	Applied Bioinformatics	Prof. Dr. Michael Schroeder michael.schroeder@tu-dresden.de
Qualification Objectives	At the end of this module, the students will acquire the methodological principles of the methodical basics of sequence analysis and other bioinformatic algorithms. They know essential algorithms and can classify them, analyse them and judge their goal-setting and efficiency.	
Content	The content of the module are the basics of sequence comparison. These include algorithms such as e.g., Levenshtein distance, dynamic programming, global and local alignment, substitution matrices, multiple sequence alignment and others.	
Teaching and Learning Methods	The module consists of lectures amounting to 2 lecture hours per week and exercises amounting to 2 lecture hours per week, as well as independent study.	
Prerequisites for Participation	Knowledge in sequential computer programming, linear algebra (vector and matrix calculation), as well as probability calculation and bachelor level statistics is required. Students can prepare for the module with the following literature: Schildt: C++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Alberts, Bray, Hopkin, Johnson, Roberts, Lewis: Essential Cell Biology, Taylor & Francis, 2013 Jaynes: Probability Theory: The Logic of Science, Cambridge University Press, 2003.	
Usability	The module is a compulsory module for students of Computational Life Science in the Computational Modelling and Simulation Master degree programme.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of an ungraded colloquium of 45 minutes.	
Credit Points and Grades	5 credit points can be earned through the module. The module grade corresponds to that of the graded work.	
Frequency of the Module	The module is offered in each summer semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CLS-ELV	Computational Life Science Advanced	Prof. Dr. Ivo Sbalzarini ivo.sbalzarini@tu-dresden.de
Qualification Objectives	After completing the module, students will have in-depth skills in the application of computer-aided modelling and simulation in life sciences, extended to complex spatio-temporal systems. They have in-depth knowledge of the application domain and are able to study mixed models using self-implemented simulation methods, model complex systems independently and test and validate the models. Students are familiar with the application domain to the extent that they can hold solution-oriented project discussions with partners from the life sciences.	
Content	The content of the module is optional, depending on the student's focus: biomechanics, particle methods, mathematical and computational biology, cognitive neurology, advanced biophysics, advanced machine learning, complex biological networks, multiphase simulation, advanced genomics, biological hydrodynamics.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research project amounting to 8 lecture hours per week and independent study. The courses are to be selected from the CMS-CMA-ELV catalogue to the specified extent; this will be announced as usual at the Faculty of Computer Science, at the beginning of each semester, including the language of the course, the necessary examination performances and the weighting of the grades.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of Computational Life Science in the Computational Modelling and Simulation Master degree program.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examinations specified in the CMS-CMA-ELG catalogue.	
Credit Points and Grades	10 credit points can be earned by completing the module. The module grade results from the average of those received for graded pieces of work, weighted according to the catalogue CMS-CMA-ELG.	
Frequency of the Module	The module is offered each academic year, starting in the winter semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CLS-TEA	Computational Life Science Teamproject	Prof. Dr. Ivo Sbalzarini ivo.sbalzarini@tu-dresden.de
Qualification Objectives	The students are able to work on a complex research focused project that requires competences from several areas of computational life science. The students are able to solve a larger, typical interdisciplinary task in a group of 2 – 4 persons in the field of Computational Life Science. The students master the literature research and the use of scientific information sources. They have in-depth professional competence as well as extensive methodological and social skills in project management and teamwork.	
Content	The content of the module are the interdisciplinary processing, application and communication of a work topic of the student's choice in the fields of biology, biochemistry, biophysics, biomechanics, bioinformatics, biometrics, numerical and statistical methods for the life sciences, mathematical and computational biology, cognitive neurology, computer science methods for the graphical representation and control of simulations, machine learning, biological networks, genomics, and flow simulation.	
Teaching and Learning Methods	Research project amounting to 8 lecture hours per week and independent study.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of Computational Life Science in the Computational Modelling and Simulation Master degree programme.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a group project report jointly written by the team in 70 hours and an oral presentation in English of 30 minutes.	
Credit Points and Grades	10 credit points can be achieved by completing the module. The module grade results from the unweighted average of the examination grades.	
Frequency of the Module	The module is offered in each summer semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CLS-MOS	Modelling and Simulation in Biology	Prof. Dr. Ivo Sbalzarini ivo.sbalzarini@tu-dresden.de
Qualification Objectives	After completing the module, the students master the modelling and simulation of biological systems in space and time. They are able to independently derive models of biological processes, formulate them mathematically and simulate them numerically in the computer. The corresponding simulation codes can be designed and implemented independently.	
Content	The content of the module includes: model scaling, dimensional analysis, dynamic system storage and flow modelling, spatiotemporal systems volume control model, vector analysis, conservative force, spatio-temporal finite-difference simulation, temporal system particle methods, application in diffusion, reaction diffusion, advection-diffusion, waves, flows and currents, PDEs.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week, plus independent study.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of Computational Life Science in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are earned if the module examination is passed. The module examination consists of a written examination of 120 minutes. If there are fewer than 10 students registered at the end of the registration period, the written examination can be replaced by an oral examination – as an individual examination lasting 30 minutes; if this is decided, the registered students will be informed of this change at the end of the registration period.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to the examination grade.	
Frequency of the Module	The module is offered each year during the summer semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Modules in the Track Computational Mathematics

Module Number	**Module Name**	**Responsible Lecturer**
CMS-CMA-ELG	Computational Mathematics Basics	Prof. Dr. Axel Voigt axel.voigt@tu-dresden.de
Qualification Objectives	The students master the basic competences for the application of computer-aided modelling and simulation in mathematics. They have in-depth knowledge of the application domain and are able to intuitively present simulation results. They have in-depth knowledge of the application domain and are able to intuitively present simulation results.	
Content	The content of the module depends on the student's main focus: Identification and processing of mathematical problems, interpretation and presentation of the results and formulation of the mathematical problem as a computer programme, applications from molecular modelling, biophysics or numerics, the mathematics of partial differential equations, object-oriented scientific programming.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research project amounting to 8 lecture hours per week and independent study. The courses are to be selected from the CMS-CMA-ELG catalogue to the specified extent; this will be announced as usual at the Faculty of Computer Science, at the beginning of each semester, in writing, including the language of the course, the necessary examinations and the weighting of the grades.	
Prerequisites for Participation	Knowledge at the Bachelor level is required in sequential computer programming, algorithms and data structures, analysis of functions of one and more variables, linear algebra (vector and matrix calculation) as well as probability calculus and statistics. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree programme computational Modelling and simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examinations specified in the CMS-CMA-ELG catalogue.	

Credit Points and Grades	The module allows one to earn 10 credit points. The module grade results from the average those of the graded work, weighted according to the catalogue CMS-CMA-ELG.
Frequency of the Module	The module is offered every academic year, starting in the winter semester.
Workload	The workload is 300 hours in total.
Duration of the Module	The module takes two semesters to complete.

Module Number	Module Name	Responsible Lecturer
CMS-CMA-FEM	Finite Element Methods	Prof. Dr. Axel Voigt axel.voigt@tu-dresden.de
Qualification Objectives	The students master the theory and practice of the finite element method (FEM) for the numerical solution of partial differential equations. The students have a systematic understanding of the theory of FEM, especially of convergence results. They have knowledge of algorithmic questions and implementation aspects in software, have basic knowledge and experience in the modelling of application-related problems, for example in the fields of fluid mechanics and materials science. In addition, the students are able to independently analyse specific problems of selected areas of application and to solve them with suitable FEM procedures.	
Content	The module content covers all essential aspects of the Finite Element Method, including the theory, the implementation and their applications. In particular, the following will be covered: Convergence and errors of finite element methods, mathematical formulation of the method, implementation on serial and parallel computers, algorithms for finite element situations, modelling using finite elements. Examples and applications are considered from the fields of fluid mechanics and materials science.	
Teaching and Learning Methods	Lecture amounting to 3 lecture hours per week and exercise amounting to 1 lecture hour per week, plus independent study.	
Prerequisites for Participation	Numerical Competences of Ordinary Differential Equations at Bachelor level (See, for example, Gerald, Wheatley: Applied Numerical Analysis (chapters 1-6), Pearson, 2003, or Ferziger: Numerical Methods for Engineering Application (Chapters 1-5), Wiley, 1998)	
Usability	The module is a compulsory module for students of the Computational Modelling and Simulation Master degree programme track Computational Mathematics. The module creates the prerequisites for the modules CMS-CMA-MODSEM and CMS-CMA-ELV2.	
Requirements for the Awarding of Credit Points	The credit points are earned if the module examination is passed. The module examination consists of a written examination of 120 minutes. If there are fewer than 10 students registered at the end of the registration period, the written examination can be replaced by an oral examination – as a group examination lasting 20 minutes in groups of 3; if this is the case, the registered students will be informed of this change at the end of the registration period. Examination preparation is a practical lasting 10 hours in total.	

Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to that of the graded work.
Frequency of the Module	The module is offered each year during the winter semester.
Workload	The workload is 150 hours in total.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-CMA-MODSEM	Modelling Case Studies	Prof. Dr. Axel Voigt axel.voigt@tu-dresden.de
Qualification Objectives	After completing the module, students master the mathematical modelling and treatment of problems from application areas, preferably by means of a description by partial differential equations. The students have a systematic understanding of how application problems can be formulated mathematically, suitably simplified and numerically treated. They are able to present their results comprehensibly even to non-mathematicians.	
Content	Content of the module are case studies to transfer mathematical modelling and simulation to specific application problems. In particular, this includes the formulation of the problem using partial differential equations, the analysis of the assumptions and approximations made, the design and implementation of suitable numerical solutions for the problem, the validation and verification of the solution, as well as the presentation and demonstration of the results to a non-specialist audience.	
Teaching and Learning Methods	The module includes seminars amounting to 4 lecture hours per week, research project amounting to 4 lecture hours per week and independent study.	
Requirements for participation	Competences on the partial differential equations are required, as they can be acquired in the module CMS-CMA-FEM.	
Usability	The module is a compulsory module in the Master degree programme Computational Modelling and Simulation for students of Computational Mathematics.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module exam consists of an oral presentation lasting 60 minutes.	
Credit points and Grades	10 credit points can be earned by completing the module. The module grade is determined by the examination grade.	
Frequency of the Module	The module is offered in each summer semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CMA-PROJ	Computational Mathematics Project	Prof. Dr. Axel Voigt axel.voigt@tu-dresden.de
Qualification Objectives	The students master the autonomous processing of a project with tasks from applications of mathematics in other areas, the investigation or improvement of algorithms and the generalization or specialization of mathematical results. The students are able to familiarize themselves with the task in a project group, to discuss possible ways and solutions and to define steps to fulfill the task, to acquire the necessary theoretical detailed knowledge and computational aids, to contribute their respective strengths to the project and the to use limited time resources efficiently.	
Content	The module includes the investigation or improvement of algorithms and the generalisation or specialisation of mathematical results. The content of the module includes the cross-disciplinary application and communication of mathematical solutions. In project groups, a concrete problem is established broken down into solvable sub-problems, the methods required for the solution are determined and implemented, and the solution is validated and presented.	
Teaching and Learning Methods	The module includes a seminar amounting to 2 lecture hours per week, research project amounting to 2 lecture hours per week, as well as independent study.	
Requirements for participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The performance credits are awarded if the module examination is passed. The module exam consists of an oral presentation lasting 20 minutes.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade is determined by the examination grade.	
Frequency of the module	The module is offered each year during the winter semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CMA-ELV1	Computational Mathematics Advanced	Prof. Dr. Axel Voigt axel.voigt@tu-dresden.de
Qualification Objectives	The students have in-depth competencies for the application of computer-aided modelling and simulation in mathematics. They know the application domain to the extent that they are able to study complex models by means of self-implemented simulation methods and to independently model mathematical relationships, to test and validate the models.	
Content	The content of the module deepens questions from the field of Computational Mathematics. These depend on the student's main focus: Application of mathematical problems in fluid mechanics, biology, biophysics, electronics or materials science, advanced topics in numerics of partial differential equations or scientific programming and arithmetic.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research project amounting to 8 lecture hours per week and independent study. The courses are to be selected from the CMS-CMA-ELV1 catalogue to the specified extent; this will be announced as usual at the Faculty of Computer Science, at the beginning of each semester, in writing, including the language of the course, the necessary examinations and the weighting of the grades.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examinations specified in the CMS-CMA-ELV1 catalogue.	
Credit Points and Grades	10 credit points can be earned through completing the module. The module grade is the average of the grades of examinations weighted according to the catalogue CMS-CMA-ELV1.	
Frequency of the Module	The module is offered each academic year, starting in the summer semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes two semesters to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CMA-ELV2	Computational Mathematics Applications	Prof. Dr. Axel Voigt axel.voigt@tu-dresden.de
Qualification Objectives	The students are able to transfer their acquired competencies of computational modelling and simulation in mathematics to the application domain. They are able to study complex models using self-implemented simulation methods and to model mathematical correlations independently and to test and validate the models. In particular, the students are able to grasp a complex mathematical problem independently in models and to explore it in communication with experts of the application domain computer supported.	
Content	The content of the module depends on the student's main focus: the transfer of knowledge into a research project, topics of mathematical biology, particle methods, mathematical programming.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research projects amounting to 8 lecture hours per week and independent study. The courses are to be selected from the CMS-CMA-ELV2 catalogue to the specified extent; this will be announced as usual at the Faculty of Computer Science, at the beginning of each semester, in writing, including the language of the course, the necessary examinations and the weighting of the grades.	
Prerequisites for Participation	The skills acquired in the CMS-CMA-FEM module are necessary.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examinations specified in the CMS-CMA-ELV2 catalogue.	
Credit Points and Grades	10 credit points can be earned through completing the module. The module grade is the average of the grades of examinations weighted according to the catalogue CMS-CMA-ELV2.	
Frequency of the Module	The module is offered each academic year, starting in the summer semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes two semesters to complete.	

Modules in the Track Visual Computing

Module Number	**Module Name**	**Responsible Lecturer**
CMS-VC-ELG	Visual Computing Basics	Prof. Dr. Stefan Gumhold stefan.gumhold@tu-dresden.de
Qualification Objectives	The students have the basic skills for the digital representation and processing of visual data. They have in-depth knowledge in two areas of Visual Computing and are able to apply and implement the methods taught therein.	
Content	The module covers the basics of digital representation and processing of visual data. Depending on the student's focus, this includes the basics of computer graphics, visualistics, computer vision, design and implementation of user interfaces, machine learning for image processing, applications from the fields of high-performance computing, computer-aided medicine and surgery.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research project amounting to 8 lecture hours per week. The courses are to be selected from the catalogue CMS-VC-ELG to the specified extent; this will be announced including the course language, the required graded work and weights of the grades at the beginning of the semester as usual at the Faculty of Computer Science.	
Prerequisites for Participation	Knowledge in sequential computer programming, algorithms and data structures, analysis of functions of one and several variables, linear algebra (vector and matrix calculation), as well as probability calculation and Statistics at Bachelor level are required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	The module is a compulsory module for students of Tracks Visual Computing in the Master's degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examinations specified in the CMS-VC-ELG catalogue.	
Credit Points and Grades	10 credit points can be earned by completing the module. The module grade results from the average of the graded work, weighted according to the catalogue CMS-VC-ELG.	

Frequency of the Module	The module is offered each year during the winter semester.
Workload	The workload is 300 hours in total.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-VC-ELV1	Visual Computing Advanced	Prof. Dr. Stefan Gumhold stefan.gumhold@tu-dresden.de
Qualification Objectives	Students have in-depth and specialized knowledge in the field of visual computing. They are able to select suitable solution methods for new tasks and develop existing methods.	
Contents	Contents of the module are in-depth questions from the field of Visual Computing. Depending on the student's focus, this includes: advanced topics in computer graphics and visual computing, as well as their solution using classical methods and procedures of machine learning, multimedia technology, advanced aspects of user interface design and human machine interaction, applications in the fields of life sciences and interactive information visualisation.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research project amounting to 12 lecture hours per week plus independent study. The courses are to be selected from the CMS-VC-ELV1 catalogue to the specified extent; this will be announced as usual at the Faculty of Computer Science, at the beginning of each semester, in writing, including the language of the course, the necessary examinations and the weighting of the grades.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the track Visual Computing in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examinations specified in the CMS-VC-ELV1 catalogue.	
Credit Points and Grades	15 credit points can be earned through completing the module. The module grade results from the average of the graded work, weighted according to the catalogue CMS-VC-ELV1.	
Frequency of the Module	The module is offered each academic year, starting in the summer semester.	
Workload	The workload is 450 hours in total.	
Duration of the Module	The module takes two semesters to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-VC-ELV2	Visual Computing Applications	Prof. Dr. Stefan Gumhold stefan.gumhold@tu-dresden.de
Qualification Objectives	The students have in-depth specialised and interdisciplinary knowledge in the field of visual computing. They are able to work on new, interdisciplinary tasks and to select suitable solution methods as well as to develop new solution methods.	
Contents	The contents of the module are research-related application problems of Visual Computing. Depending on the student's main focus, this covers: computer-aided surgery, biomedical image processing, interactive and immersive visualisation (virtual and augmented reality), and search and retrieval multimedia data.	
Teaching and Learning Methods	The module includes courses amounting to 12 lecture hours per week in total plus independent study. At least, lectures amounting to 2 lecture hours per week and exercises amounting to 2 lecture hours per week are to be selected from the CMS-VC-ELV2 catalogue. 8 lecture hours per week are to be freely chosen from the lectures, exercises, seminars, practical and research projects listed in the catalogue; this is announced - including the language of the course, the required examinations and weights of the grades - at the beginning of the semester as usual at the Faculty of Computer Science.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the track Visual Computing in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examinations specified in the CMS-VC-ELV2 catalogue.	
Credit Points and Grades	15 credit points can be earned by completing the module. The module grade results from the average of the graded work, weighted according to the catalogue CMS-VC-ELV2.	
Frequency of the Module	The module is offered each academic year, starting in the summer semester.	
Workload	The workload is 450 hours in total.	
Duration of the Module	The module takes two semesters to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-VC-TEA	Visual Computing Teamproject	Prof. Dr. Stefan Gumhold stefan.gumhold@tu-dresden.de
Qualification Objectives	Students are able to work on a complex, research-oriented project that requires competences from several areas of visual computing. The students are able to solve a larger, typically interdisciplinary task in the field of visual computing in a group of 2 – 4 people. The students master the literature research and the use of scientific information sources. They have in-depth expertise as well as extensive methodological and social skills in project management and teamwork.	
Content	The content of the module covers the interdisciplinary application and communication of a working topic in the fields of digital representation and processing of visual data.	
Teaching and Learning Methods	Research project amounting to 8 lecture hours per week plus independent study.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the track Visual Computing in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a group project report jointly written by the team in 70 hours and an oral presentation in English of 30 minutes.	
Credit Points and Grades	10 credit points can be earned by completing the module. The module grade results from the unweighted average of the graded work.	
Frequency of the Module	The module is offered in each summer semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Modules in the Track Computational Modelling in Energy Economics

Module Number	**Module Name**	**Responsible Lecturer**
CMS-EE-EPM	Electric Power Markets	Prof. Dr. Dominik Möst dominik.moest@tu-dresden.de
Qualification Objectives	The students know the basics and methods of the economic theory of the electricity sector. They are able to analyse the electrical sector from an economic perspective.	
Content	The module addresses techno-economic issues in the electricity industry. It includes methods, knowledge and interdependencies in the fields of energy market structures, techno-economic analysis as well as the modelling and optimization of energy systems and modelling of energy markets.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree programme Computational Modelling and Simulation. This module meets the requirements for the CMS-EE-SCEE, CMS-EE-LSEE and CMS-EE-REEP modules.	
Requirements for the Awarding of Credit Points	The credit points are earned if the module examination is passed. The module examination consists of a 90 minute written paper. If there are fewer than 10 students registered at the end of the registration period, the written examination can be replaced by an oral examination – as an individual examination lasting 45 minutes; if this is the case, the registered students will be informed of this at the end of the registration period.	
Credit Points and Grades	5 credit points can be earned through completing the module. The module grade corresponds to that of the graded work.	
Frequency of the Module	The module is offered each year during the winter semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-EE-EL1	Computational Modelling in Energy Economics Basics	Prof. Dr. Dominik Möst dominik.moest@tu-dresden.de
Qualification Objectives	The students master the basic skills for the application of computer-aided modelling and simulation in energy market modelling. You have in-depth knowledge of the application domain and are able to present simulation results intuitively. The students are familiar with concrete economic issues and know the basics of the application discipline as well as its technical vocabulary.	
Content	The content of the module depends on the student's main focus: numerical methods, computer methods for graphical representation and control of simulations, computer-aided simulation and advanced programming.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, practical and research project in amounting to 8 lecture hours per week plus independent study. The courses are to be selected from the catalogue CMS-EE-EL1 to the specified extent; this will be announced including the course language, the required graded work and weights of the grades at the beginning of the semester as is customary at the Faculty of Computer Science.	
Prerequisites for Participation	Knowledge in sequential computer programming, linear algebra (vector and matrix calculation) as well as probability calculation and bachelor level statistics are required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the examination services specified in the CMS-EE-EL1 catalogue.	
Credit Points and Grades	10 credit points can be earned by completing the module. The module grade is calculated from the weighted average of the graded work according to the CMS-EE-EL1 catalogue.	

Frequency of the Module	The module is offered every academic year, starting in the winter semester.
Workload	The workload is 300 hours in total.
Duration of the Module	The module takes two semesters to complete.

Module Number	Module Name	Responsible Lecturer
CMS-EE-SCEE	Case Studies in Energy Economics	Prof. Dr. Dominik Möst dominik.moest@tu-dresden.de
Qualification Objectives	After completing this module, students will be able to independently answer complex questions of energy and risk management or resource economics and to create and apply their own concepts for integrating economic aspects into decisions. In addition, the students are able to work in teams, they master literature research and the use of scientific information sources.	
Content	The module addresses current techno-economic issues in the energy industry. It covers the modelling of commodity markets, the mapping and modelling of uncertainties in the energy industry and the economic modelling of electricity networks.	
Teaching and Learning Methods	The module includes seminars amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Knowledge and competencies are expected as they can be acquired in the modules CMS-EE-EPM, CMS-COR-HPC and CMS-COR-MLD.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a seminar paper lasting 60 hours and an oral presentation lasting 30 minutes.	
Credit Points and Grades	10 credit points can be earned through completion of the module. The module grade is calculated from the unweighted average of the graded work.	
Frequency of the Module	The module is offered in each summer semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-EE-LSEE	Literature Studies in Energy Economics	Prof. Dr. Dominik Möst dominik.moest@tu-dresden.de
Qualification Objectives	The students can independently search and evaluate the scientific literature in the field of the energy industry and present the results comprehensively.	
Content	The module addresses in-depth techno-economic issues in the energy industry, in-depth modelling of commodity markets, in-depth mapping and modelling of uncertainties in the energy industry and in-depth economic modelling of electricity networks.	
Teaching and Learning Methods	The module includes seminars amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	The knowledge and skills acquired in the CMS-EE-EPM module are assumed.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a seminar paper lasting 90 hours and an ungraded oral presentation of 30 minutes.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade is calculated from the unweighted average of the graded work, taking into account § 12 paragraph 1 sentence 5 of the Examination Regulations.	
Frequency of the Module	The module is offered in each winter semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-EE-REEP	Resource Economics and Environmental Policy	Prof. Dr. Dominik Möst dominik.moest@tu-dresden.de
Qualification Objectives	The students know and master the theory of exhaustible resources. They are able to answer questions about market and price structures on raw material markets and to apply and critically reflect on optimisation methods in the energy industry.	
Content	The module covers the basics of resource economics and environmental policy. These include current and applied theories and models of the subject areas, such as the hotel rule. The module also covers the basics of environmental policy tax instruments.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week, research project amounting to 2 lecture hours per week plus self-study.	
Prerequisites for Participation	The knowledge and skills to be acquired in the modules CMS-EE-EPM, CMS-COR-HPC and CMS-COR-MLD are required.	
Usability	The module is a compulsory module for students of the track Computational Modelling in Energy Economics in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of a written examination of 90 minutes and a project report of 150 hours.	
Credit Points and Grades	10 credit points can be earned through completing this module. The module grade is calculated from the weighted average of the graded work. The written examination is doubly weighted and the oral examination is weighted normally.	
Frequency of the Module	The module is offered each year during the summer semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-EE-EL2	Computational Modelling in Energy Economics Advanced	Prof. Dr. Dominik Möst dominik.moest@tu-dresden.de
Qualification Objectives	The students have in-depth skills in the application of computer-aided modelling and simulation in energy market modelling, extended to complex techno-economic systems. They know the application domain to the extent that they are able to study models using self-implemented simulation methods, to model complex market economy processes independently and to test and validate the models. You can independently conduct project discussions with partners from the economic sciences.	
Contents	The content of the module depends on the student's main focus: in-depth knowledge of numerical methods, supplementary computer science methods for graphical representation and control of simulations, computer-aided simulation and advanced programming.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research project amounting to 8 lecture hours per week plus independent study. The courses are to be selected from the catalogue CMS-EE-EL2 to the specified extent; this will be announced including the course language, the required graded work and weights of the grades at the beginning of the semester as is customary at the Faculty of Computer Science.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the track computational mathematics in the Master degree program Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the tasks specified in the CMS-EE-EL2 catalogue.	
Credit Points and Grades	10 credit points. The module grade is calculated from the weighted average of the graded work according to the CMS-EE-EL2 catalogue.	
Frequency of the Module	The module is offered each academic year, starting in the summer semester.	
Workload	The workload is 300 hours in total.	
Duration of the Module	The module takes two semesters to complete.	

Modules in the Track Computational Engineering

Module Number	Module Name	**Responsible Lecturer**
CMS-CE-FEM	Engineering Finite Element Methods	Prof. Dr. Michael Beitelschmidt michael.beitelschmidt@tu-dresden.de
Qualification Objectives	The students are familiar with the mathematical basics and have mastered the practical application and engineering work with the Finite Element Method (FEM) for the numerical solution of partial differential equations. They are well-versed in algorithms and implementation aspects in software, can investigate convergence empirically, have basic knowledge and experience in modelling application-related problems, for example in the fields of fluid mechanics and continuum mechanics. In addition, students are able to independently analyse concrete problems of selected aspects of engineering and solve them with suitable FEM methods.	
Contents	The module covers the mathematical basics, aspects of implementation as well as the practical application of the Finite Element Method for engineering problems. This includes in particular the implementation and application of the method. Convergence and errors of Finite Element Methods, mathematical formulation of the method, and modelling using finite elements are also covered. Examples and applications from fluid mechanics and materials science.	
Teaching and Learning Methods	Lecture amounting to 3 lecture hours per week, exercise amounting to 1 lecture hours per week plus independent study.	
Prerequisites for Participation	Kompetenzen zur Numerik gewöhnlicher Differentialgleichungen (vgl. z.B. Ferziger: Numerical Methods for Engineering Application (chapters 1-5), Wiley, 1998)	
Usability	This is a compulsory module for students of the track Computational Engineering in the master programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are earned if the module examination is passed. The module examination consists of a written examination of 120 minutes. If there are fewer than 10 students registered at the end of the registration period, the written examination can be replaced by an oral examination – as a group examination – with up to 3 students lasting 20 minutes; if this is the case, this will be announced to the registered students at the end of the registration period. Preliminary examination work lasts 10 hours.	
Credit Points and Grades	5 credit points can be earned through completing the module. The module grade corresponds to that of the graded work.	
Frequency of the Module	The module is offered each year during the winter semester.	

Workload	The workload is 150 hours in total.
Duration of the Module	The module takes one semester to complete.

Module Number	Module Name	Responsible Lecturer
CMS-CE-EL1	Computational Engineering Basics	Prof. Dr. Michael Beitelschmidt michael.beitelschmidt@tu-dresden.de
Qualification Objectives	The students master the basic skills for the application of computer-aided modelling and simulation in the engineering sciences. You have in-depth knowledge of the application domain and are able to present simulation results intuitively. The students know concrete constructive questions and know the basics of the application discipline as well as its technical vocabulary.	
Content	The content of the course depends on the student's main focus: the basics of mechanics, the basics of automation, computer science methods for graphical representation and control of simulations, flow simulation.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, tutorials, practical and research project amounting to 8 lecture hours per week plus independent study. The courses must be selected from the CMS-CE-EL1 catalogue to the specified extent; this will be announced at the beginning of the semester, as is customary at the Faculty of Computer Science, including the language of the course, the graded work required in each case and the weights of the grades.	
Prerequisites for Participation	Knowledge in sequential computer programming, algorithms and data structures, analysis of functions of one and several variables, linear algebra (vector and matrix calculation), as well as probability calculation and Statistics at the Bachelor's level is required. With the following literature, students can prepare for the module: Harel: Algorithmics - The Spirit of Computing, Addison-Wesley, 2004 Schildt: C ++ from the ground up, McGraw-Hill, 2003 Abelson, Hal; Sussman, Gerald Jay: Structure and Interpretation of Computer Programs. MIT Press, 1985; Cormen, Leiserson, Rivest & Stein: Introduction to Algorithms, 2nd Edition, MIT Press 2001; Lax, Terrell: Multivariable Calculus with Applications (Undergraduate Texts in Mathematics), Springer, 2018 Hefferon, Jim: Linear Algebra, http://joshua.smcvt.edu/linearalgebra/, 2008.	
Usability	The module is a compulsory module for students of the Computational Engineering track in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the tasks specified in the CMS-CE-EL1 catalogue.	
Credit Points and Grades	10 credit points can be earned through completing the module. The module grade is calculated from the weighted average of the graded work according to the CMS-CE-EL1 catalogue.	

Frequency of the Module	The module is offered each academic year, starting in the summer semester.
Workload	The workload is 300 hours in total.
Duration of the Module	The module takes two semesters to complete.

Module Number	Module Name	Responsible Lecturer
CMS-CE-AT	Advanced Topics in Finite Element Analysis	Prof. Dr. Markus Kästner markus.kaestner@tu-dresden.de
Qualification Objectives	The students have sound knowledge and skills for numerical solutions of coupled field problems taking into account geometric and material non-linearities.	
Contents	The module covers the Finite Element Method for non-linear material behaviour under consideration of finite deformation: continuum mechanical modelling, discretisation of the weak from and its linearization as well as further aspects and applications, e.g. adaptive and iso-geometric discretisations, modelling of coupled field problems, and multi-scale modelling approaches.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Bachelor-level knowledge of linear algebra, numerics of differential equations, discrete structures and technical mechanics is required.	
Usability	The module is a compulsory module for students of the Computational Engineering track in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are earned if the module examination is passed. The module examination consists of a written examination of 120 minutes. If there are fewer than 25 students registered at the end of the registration period, the written examination can be replaced by an oral examination – as an individual examination – lasting 20 minutes; if this is the case, the registered students will be informed of this at the end of the registration period.	
Credit Points and Grades	5 credit points can be earned through completing the module. The module grade corresponds to that of the graded work.	
Frequency of the Module	The module is offered in each summer semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CE-MBD	Multibody Dynamics	Prof. Dr. Michael Beitelschmidt michael.beitelschmidt@tu-dresden.de
Qualification Objectives	The students understand the method of multi-body system simulation in order to calculate large movements of mechanical systems of rigid bodies in the time domain. The students master the methodology of setting up the motion equations of multi-body systems as well as their computational implementation for simple special cases. The students know the different algorithms of multi-body simulation, which are used in commercial programmes.	
Contents	Contents are kinematics and kinetics of rigid bodies, description of joints and bindings, the algorithms for setting up the equations of motion as well as solution methods.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the Computational Engineering track in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are earned if the module examination is passed. The module examination consists of a written final examination of 120 minutes.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to the grade of the examination performance.	
Frequency of the Module	The module is offered in each summer semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CE-MP	Multifield Problems	Prof. Dr. Thomas Wallmersperger thomas.wallmersperger@tu-dresden.de
Qualification Objectives	The students master the basics for the investigation and calculation of multi-functional structures and structural elements and the fundamental relationships for the mathematical description of mechanical, thermal and electrical phenomena in deformable materials. Students are able to describe and calculate active structures.	
Content	The content of the module covers the behaviour and formulations for different active materials and the calculation of "real" applications of multifunctional structures, basic equations of continuum mechanics and their extension to other physical phenomena as well as the modelling of field problems that couple different physical phenomena.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Knowledge of linear algebra, numerics of differential equations, discrete structures and technical mechanics is required.	
Usability	The module is a compulsory module for students of the Computational Engineering track in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are earned if the module examination is passed. The module examination consists of a written examination of 120 minutes. If there are fewer than 15 students registered at the end of the registration period, the written examination can be replaced by an oral examination – as an individual examination – lasting 30 minutes; if this is the case, this will be announced to the registered students at the end of the registration period.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to that of the graded work.	
Frequency of the Module	The module is offered in each summer semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CE-CFD	Computational Fluid Dynamics	Prof. Dr. Jochen Fröhlich jochen.froehlich@tu-dresden.de
Qualification Objectives	The students master basic discretisation methods for the partial differential equations of fluid mechanics. They are able to create and apply these algorithms, analyse their central properties and validate them using suitable tests.	
Content	The module includes the classification of differential equations, algorithms of finite differences and finite volumes, analysis of the numerical properties of the methods in terms of convergence, consistency and stability. Furthermore, solution methods for resulting systems of equations and selected applications are part of the module.	
Teaching and Learning Methods	The module includes lectures amounting to 2 lecture hours per week, exercises amounting to 2 lecture hours per week plus independent study.	
Prerequisites for Participation	Basics of mathematics (analysis), basics of numerics as they can be acquired in the module CMS-COR-NUM, basics of fluid mechanics (conservation equations, similarity indicators)	
Usability	The module is a compulsory module for students of the Computational Engineering track in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are earned if the module examination is passed. The module examination consists of a written examination of 120 minutes. If there are fewer than 10 students are registered at the end of the registration period, the written examination can be replaced by an oral examination – as an individual examination – lasting 20 minutes; if this is the case, this will be announced to the registered students at the end of the registration period.	
Credit Points and Grades	5 credit points can be earned by completing the module. The module grade corresponds to that of the graded work.	
Frequency of the Module	The module is offered in each winter semester.	
Workload	The workload is 150 hours in total.	
Duration of the Module	The module takes one semester to complete.	

Module Number	Module Name	Responsible Lecturer
CMS-CE-EL2	Computational Engineering Advanced	Prof. Dr. Michael Beitelschmidt michael.beitelschmidt@tu-dresden.de
Qualification Objectives	After completing the module, students will have in-depth skills in the application of computer-aided modelling and simulation in engineering sciences, extended to complex spatio-temporal systems. You have in-depth knowledge of the application domain and are able to study mixed models using self-implemented simulation methods, model complex systems independently and test and validate the models. Students are familiar with the application domain to the extent that they can hold solution-oriented project discussions with partners from the engineering sciences.	
Contents	The content of the module depends on the student's main focus: in-depth aspects of mechanics, in-depth aspects of automation, in-depth aspects of computer science methods for graphical representation and control of simulations, flow simulation.	
Teaching and Learning Methods	The module includes lecture, exercise, seminar, practical and research project amounting to 12 lecture hours per week plus independent study. The courses must be selected from the CMS-CE-EL2 catalogue to the specified extent; this will be announced at the beginning of the semester, as is customary at the Faculty of Computer Science, including the language of the course, the graded work required in each case and the weights of the grades.	
Prerequisites for Participation	No previous specialist knowledge is required.	
Usability	The module is a compulsory module for students of the Computational Engineering track in the Master degree programme Computational Modelling and Simulation.	
Requirements for the Awarding of Credit Points	The credit points are awarded if the module examination is passed. The module examination consists of the tasks specified in the CMS-CE-EL2 catalogue.	
Credit Points and Grades	15 credit points can be earned by completing the module. The module grade is calculated from the weighted average of the graded work according to the CMS-CE-EL2 catalogue.	
Frequency of the Module	The module is offered each academic year, starting in the summer semester.	
Workload	The workload is 450 hours in total.	
Duration of the Module	The module takes two semesters to complete.	

Modules in the Track Applied Artificial Intelligence

Module Name	**Computer Vision**
Module Number	CMS-AAI-CV
Responsible Lecturer	Prof. Dr. Björn Andres bjoern.andres@tu-dresden.de
Qualification Objectives	Students know and understand the concept of color space. They know and understand the problem of tone mapping and are able to implement and apply a tone mapping algorithm independently. They know and understand elementary linear and nonlinear operations of image analysis and are able to implement and apply them independently. Students are familiar with the problem of image classification and understand its mathematical formulation. They are familiar with the structure of convolutional neural networks (CNNs) and the U-Net architecture and understand how to apply them to the problem of image classification. They are familiar with the problems of segmentation and semantic segmentation of images, as well as object recognition, object tracking and key-point matching, and understand their mathematical formulation. They understand heuristic algorithms for these problems and are able to implement them independently. They are able to present technical results in English.
Content	The module covers color spaces and tone mapping, elementary operations of image analysis (linear operations, smoothing and edge detection, nonlinear operations, in particular bilateral filters and morphological filters), classification (logistic regression, CNN and U-Net), segmentation (seeded region growing algorithm, correlation clustering), semantic segmentation, object recognition, object tracking, as well as key-point matching and applications (registration, 3D reconstruction).
Teaching and Learning Methods	The module comprises lecture amounting to 2 lecture hours per week, exercise amounting to 2 lecture hours per week plus independent study.
Prerequisites for Participation	Prerequisites are knowledge of sequential computer programming of algorithms and data structures, analysis of functions of one and several variables, as well as linear algebra, in particular vector and matrix calculation. Useful reading for this module: Kurt Mehlhorn, Peter Sanders. Algorithms and Data Structures. Springer Berlin Heidelberg 2008. ISBN: 978-3-540-77977-3. DOI: 10.1007/978-3-540-77978-0 Konrad Königsberger. Analysis 1. Springer Berlin Heidelberg 2004. ISBN: 978-3-540-40371-5. DOI: 10.1007/978-3-642-18490-1 Konrad Königsberger. Analysis 2. Springer Berlin Heidelberg 2013. ISBN: 978-3-662-05699-3. DOI: 10.1007-3-3-662-3- 8 Gerd Fischer. Linear Algebra Springer Spektrum Wiesbaden 2014. ISBN: 978-3-658-03945-5. DOI 10.1007/978-3-658-03945-5

	Ulrich Krengel. Einführung in die Wahrscheinlichkeitstheorie und Statistik. Vieweg+Teubner Wiesbaden 2013. ISBN: 978-3-322-93581-6. DOI: 10.1007/978-3-322-93581-6 Lutz Priese, Katrin Erk. Theoretische Informatik. Springer Berlin Heidelberg 2018. ISBN: 978-3-662-57408-9. DOI: 10.1007/978-3-662-57409-6
Usability	The module is a compulsory module in the Master's degree program in Computational Modeling and Simulation for students in the Applied Artificial Intelligence track.
Requirements for the Awarding of Credit Points	Credit points are awarded upon passing the module examination. The module examination comprises a 90-minute written test.
Credit Points and Grades	The module is worth 5 credit points. The module grade corresponds to the grade of the examined assessment.
Frequency of the Module	The module is offered each winter semester.
Workload	The workload comprises 150 hours in total.
Duration of the Module	The module runs for the duration of one semester.

Module Name	**Robot Learning**
Module Number	CMS-AAI-RL
Responsible Lecturer	Prof. Dr. Roberto Calandra roberto.calandra@tu-dresden.de
Qualification Objectives	Students acquire in-depth knowledge of machine learning methods in the field of robotics and are able to apply machine learning methods in the field of robotics independently. They are able to describe machine learning problems in the field of robotics mathematically, implement algorithms to solve these problems themselves and empirically and quantitatively examine the application of these algorithms in the context of specific applications.
Content	This module covers the fundamentals of classical control theory, methods of machine learning in the field of robotics (optimization, supervised learning for robotics, reinforcement learning), and problems and applications of machine learning methods in the field of robotics (navigation, manipulation, locomotion, multi-agent systems).
Teaching and Learning Methods	The module comprises lecture amounting to 2 lecture hours per week, exercise amounting to 2 lecture hours per week plus independent study
Prerequisites for Participation	No special knowledge or abilities are required.
Usability	The module is a compulsory module in the Master's degree program in Computational Modeling and Simulation for students in the Applied Artificial Intelligence track.
Requirements for the Awarding of Credit Points	Credit points are awarded upon passing the module examination. The module examination comprises a 90-minute written test.
Credit Points and Grades	The module is worth 5 credit points. The module grade corresponds to the grade of the examined assessment.
Frequency of the Module	The module is offered each year in the summer semester.
Workload	The workload comprises 150 hours in total.
Duration of the Module	The module runs for the duration of one semester.

Module Name	**Touch Sensing and Processing**
Module Number	CMS-AAI-TSP
Responsible Lecturer	Prof. Dr. Roberto Calandra roberto.calandra@tu-dresden.de
Qualification Objectives	Students acquire in-depth knowledge of touch sensing and touch processing techniques. They are able to independently implement these techniques in an algorithmic way. They are able to apply these algorithms in practice to specific touch-sensing hardware and to specific problems and are able to empirically and quantitatively examine the algorithms in relation to the application.
Content	The module covers the basics of the psychology of touch, touch-sensing hardware, touch simulation, touch sensing, touch processing, touch-based control, applications of touch sensing, touch processing and touch-based control.
Teaching and Learning Methods	The module comprises lecture amounting to 2 lecture hours per week, exercise amounting to 2 lecture hours per week plus independent study.
Prerequisites for Participation	No prior knowledge is required.
Usability	The module is a compulsory module in the Master's degree program in Computational Modeling and Simulation for students in the Applied Artificial Intelligence track.
Requirements for the Awarding of Credit Points	Credit points are awarded upon passing the module examination. The module examination comprises a 90-minute written test.
Credit Points and Grades	The module is worth 5 credit points. The module grade corresponds to the grade of the examined assessment.
Frequency of the Module	The module is offered each winter semester.
Workload	The workload comprises 150hours in total.
Duration of the Module	The module runs for the duration of one semester.

Module Name	**Digital Circuit Technology**
Module Number	CMS-AAI-DCT
Responsible Lecturer	Prof. Dr.-Ing. habil. Ch. G. Mayr christian.mayr@tu-dresden.de
Qualification Objectives	Students know how digital circuits work and understand the basic design principles of digital circuits. Based on their knowledge of the component models of active semiconductors, they are familiar with the systematic design and analysis of digital and mixed-signal basic circuits. They also understand the architectural and system concepts of complex digital systems. Students are familiar with the special features of nanoscale CMOS technologies, methods for reducing power dissipation (low-power circuit technology), measures for increasing the processing speed in high-speed circuits and interfaces, and the consideration of statistical influences of manufacturing technologies.
Content	The module covers analysis, dimensioning and optimization of digital combinational and sequential basic elements on the basis of current semiconductor technologies (CMOS, BiCMOS, etc.), design of complex logic functions in the form of arithmetic-logic circuits (e.g. ALUs, shifters, multipliers), state machines (finite state machines), flip-flops and oscillator circuits, digital architecture and system concepts such as register transfer logic, memory architectures (DRAM, SRAM, EPROM) and mixed-signal circuits (ADC, DAC, interfaces) as well as the methodology of designing complex digital and mixed-signal systems (behavioral description, optimization, validation).
Teaching and learning methods	The module comprises lecture amounting to 2 lecture hours per week, exercise amounting to 2 lecture hours per week plus independent study.
Prerequisites for Participation	No prior knowledge is required.
Usability	The module is a compulsory module in the Master's degree program in Computational Modeling and Simulation for students in the Applied Artificial Intelligence track.
Requirements for the Awarding of Credit Points	Credit points are awarded upon passing the module examination. The module examination comprises a 120-minute written test.
Credit Points and Grades	The module is worth 5 credit points. The module grade corresponds to the grade of the examined assessment.
Frequency of the Module	The module is offered each winter semester.
Workload	The workload comprises 150 hours in total.
Duration of the Module	The module runs for the duration of one semester.

Module Name	**Deep Neural Network Hardware**
Module Number	CMS-AAI-DNNH
Responsible Lecturer	Prof. Dr.-Ing. habil. Christian Mayr christian.mayr@tu-dresden.de
Qualification Objectives	After completing the module, students should have a solid understanding of the key design decisions for DNN accelerators. They are able to select or design an accelerator for a given application. They know and understand the necessary steps for executing DNNs on hardware accelerators, as well as common optimization methods for DNN accelerators.
Content	The module covers the design of hardware accelerators for artificial neural networks – deep neural networks (DNN) – from architectures to arithmetic building blocks, hardware/software co-designs for DNN accelerators, the steps required to execute DNNs on hardware accelerators, and current optimization methods and novel approaches for DNN accelerators.
Teaching and Learning Methods	The module comprises lecture amounting to 2 lecture hours per week, exercise amounting to 2 lecture hours per week plus independent study.
Prerequisites for Participation	No special knowledge or abilities are needed.
Usability	The module is a compulsory module in the Master's degree program in Computational Modeling and Simulation for students in the Applied Artificial Intelligence track.
Requirements for the Awarding of Credit Points	Credit points are awarded upon passing the module examination. The module examination comprises a 90-minute written test.
Credit Points and Grades	The module is worth 5 credit points. The module grade corresponds to the grade of the examined assessment.
Frequency of the Module	The module is offered each year in the summer semester.
Workload	The workload comprises 150 hours in total.
Duration of the Module	The module runs for the duration of one semester.

Module Name	**Advanced Applied Artificial Intelligence**
Module Number	CMS-AAI-AV
Responsible Lecturer	Prof. Dr. Björn Andres bjoern.andres@tu-dresden.de
Qualification Objectives	Students acquire in-depth skills in developing methods and principles of machine learning and artificial intelligence in the context of a system consisting of hardware and software.
Content	The module covers special problems, methods, structures and algorithms of artificial intelligence that go beyond the content of the CMS-COR modules, optionally, depending on the focus of the from the areas of machine learning, machine learning hardware, computer vision, computer vision optics and electronics, image processing in medicine, robotics, robotics in medicine, hardware-software co-design, symbolic, logic-based and explainable artificial intelligence, data science, databases or high-performance computing.
Teaching and Learning Methods	The module comprises lecture, exercise, seminar, tutorials, practical and research project amounting to 4 lecture hours per week and self-study. The courses are to be selected from the CMS-AAI-AV catalogue in the specified scope; this catalogue, including the language of instruction, the required examination performance and the weight of the grades, will be announced at the beginning of the semester in the customary at the faculty.
Prerequisites for Participation	No special knowledge or abilities are needed.
Usability	The module is a compulsory module in the Master's degree program in Computational Modeling and Simulation for students in the Applied Artificial Intelligence track.
Requirements for the Awarding of Credit Points	Credit points are awarded upon passing the module examination. The module examination consists of the examinations specified in the CMS-AAI-AV catalogue.
Credit Points and Grades	The module is worth 5 credit points. The module grade is calculated from the weighted average of the grades of the examined assessments according to the CMS-AAI-AP catalogue.
Frequency of the Module	The module is offered each year in the summer semester.
Workload	The workload comprises 150 hours in total.
Duration of the Module	The module runs for the duration of one semester.

Module Name	**Applications of Applied Artificial Intelligence**
Module Number	CMS-AAI-AP
Responsible Lecturer	Prof. Dr.-Ing. habil. Christian Mayr christian.mayr@tu-dresden.de
Qualification Objectives	Students acquire advanced skills in applying the methods and principles of machine learning and artificial intelligence in an application domain. They have in-depth knowledge in the application domain and are able to independently implement models and algorithms for an application and to empirically analyze and validate them quantitatively with regard to the application. They can conduct solution-oriented project discussions with partners from the application domain.
Content	The module covers special applications of artificial intelligence models and algorithms that go beyond the content of the CMS-COR modules. Students can choose their area of specialization according to their interests: Computer vision, computer vision optics and electronics, medical image processing, robotics, robotics in medicine, hardware-software co-design, data science, databases or high-performance computing.
Teaching and Learning Methods	The module comprises lecture, exercise, seminar, tutorials, practical and research project amounting to 8 lecture hours per week and independent study. The courses are to be selected from the CMS-AAI-AP catalogue in the specified scope; this catalogue, including the language of instruction, the required examination performance and the weight of the grades, will be announced at the beginning of the semester in the customary manner.
Prerequisites for Participation	No special knowledge or abilities are needed.
Usability	The module is a compulsory module in the Master's degree program in Computational Modeling and Simulation for students in the Applied Artificial Intelligence track.
Requirements for the Awarding of Credit Points	Credit points are awarded upon passing the module examination. The module examination consists of the examinations specified in the CMS-AAI-AP catalogue.
Credit Points and Grades	The module is worth 10 credit points. The module grade is calculated from the weighted average of the grades of the examined assessments according to the CMS-AAI-AP catalogue.
Frequency of the Module	The module is offered each winter semester.
Workload	The workload comprises 300 hours in total.
Duration of the Module	The module runs for the duration of one semester.

Module Name	**Applied Artificial Intelligence Team Project**
Module Number	CMS-AAI-TEA
Responsible Lecturer	Prof. Dr. Björn Andres bjoern.andres@tu-dresden.de
Qualification Objectives	Students are able to work on a complex research-related project that requires skills from several areas of applied artificial intelligence. As part of a group of 2 to 4 students, they are able to solve a larger, typically interdisciplinary task in the field of applied artificial intelligence. Students are proficient in literature research and the use of scientific information sources. They have in-depth expertise as well as extensive methodological and social skills in relation to project management and teamwork.
Content	The module covers the interdisciplinary processing, application and communication of a topic of the students' choice from the fields of machine learning, machine learning hardware, computer vision, computer vision optics and electronics, medical image processing, robotics, robotics in medicine, hardware-software co-design, symbolic, logic-based and explainable artificial intelligence, data science, databases or high-performance computing.
Teaching and Learning Methods	The module comprises a research project amounting to 8 lecture hours per week plus independent study.
Prerequisites for Participation	No special knowledge or abilities are needed.
Usability	The module is a compulsory module in the Master's degree program in Computational Modeling and Simulation for students in the Applied Artificial Intelligence track.
Requirements for the Awarding of Credit Points	Credit points are awarded upon passing the module examination. The module examination comprises a project assignment of 70 hours and a presentation of 30 minutes.
Credit Points and Grades	The module is worth 10 credit points. The module grade is calculated from the unweighted average grade of the examined assessments.
Frequency of the Module	The module is offered each year in the summer semester.
Workload	The workload comprises 300 hours in total.
Duration of the Module	The module runs for the duration of one semester.