UNIVERSITÄT BAYREUTH

INTERNATIONAL OFFICE

General Overview of English-Taught Courses at the University of Bayreuth

Available during Summer Semester 2024

An overview for Winter Semester 2024/25 is expected to be available as of 01.10.2024

Mathematics, Physics and Computer Science

Number	Course Title	Duration	Type	ECTS / Credits	Module Description
00576	Current Topics in Complex Systems	2	Sem		
10110	Introduction to the iterative methods of numerics	5	Lec & Tut	8	Only a fraction of the mathematical problems that arise in practice can be solved analytically, the majority cannot be solved with paper and pencil. For example, not even the pendulum motion of a thin rod can be specified in a closed form. Another example results from Abel-Ruffini's theorem. According to this theorem, there is no closed-form formula for eigenvalue problems of dimension 5 or greater. In order to solve such simple problems, iterative numerical methods are essential. For more complex problems, the computer is used as an aid to implement the corresponding numerical methods. Topics covered: - Iterative methods for solving large-dimensional linear systems of equations (classical iteration methods, CG, GMRES methods, preconditioners) - Numerical methods for eigenvalue problems (QR, Lanczos methods, etc.), singular value decomposition and other topics such as - Nonlinear equations and optimisation - Approximation theory
10214	Modelling, simulation and optimisation with ordinary differential equations	6	Lec & Tut	10	Mathematical modelling of application problems with ordinary differential equations (e.g. population dynamics, epidemiology, mechanics, ...) Numerical methods for initial value problems of ordinary differential equations (convergence theory, one-step method, step size control, stiff differential equations) Optimisation with ordinary differential equations (formulation, discretisation, reformulation as a non-linear optimisation problem) It is planned that modelling will be dealt with on one day of the week and simulation on the other. Optimisation will be covered in both parts.
10234	Mathematical Modelling for Climate and Environment	6	Lec & Tut	5 /10	The course is planned to be conducted in two parts: -- Part 1 in Bayreuth during regular lecture times in the Summer Semester; this part will include guest lectures by experts in various areas of climate science -- Part 2 will consist of either an excursion (ca. one week) to the Alfred-Wegener-Institute for Polar and Marine Research in Bremerhaven (after the end of the regular lecture period) or a series of guest lectures on additional topics connected to the course Course topics: -- Physical principles, mathematical models, and numerical methods in climate and environmental sciences -- Earth system: Main components, driving forces, scales, feedbacks -- Hierarchy of climate models, regional and global focus -- Environmental modelling: Main applications and problem settings Description: The course introduces the main physical concepts and mathematical descriptions underlying modern climate and environmental models including formulating and interpreting the systems of ordinary and partial differential equations for the main components of the Earth system (ocean, atmosphere, land cover, subsurface, ice sheet, etc.) and interactions between them. Additionally, the course covers some basics of analytical and numerical solution methods for different types of climate and environmental problems and offers theoretical and programming assignments aiming to give the first hands-on experience with the introduced techniques.
10235	Fast Methods for Differential and Integral Equations	6	Lec & Tut	10	Numerical analysis of optimal complexity solvers for the treatment of boundary value problems; efficient treatment of parameter-dependent problems: - subspace correction methods - hierarchical bases and BPX preconditioners - geometric and algebraic multigrid methods (convergence and implementation aspects) - reduced bases methods - analysis of hierarchical matrices
10302	Mathematical Data Science	3	Lec & Tut	5	
10309	Methods of artificial intelligence in control theory	3	Lec & Tut	5	The lecture provides an introduction to the method of reinforcement learning. On the one hand, this includes the mathematical foundations of the method and the description of algorithm variants. On the other hand, the method of deep reinforcement learning is discussed in particular and it is analysed when deep neural networks represent an advantageous approximation architecture.
10602	Modelling Sem A Presentation	2	Adv. Sem	8	Students receive real-world projects and work (in small groups) their way into them. The Sem is divided into two parts: Presentation and Written Report. Presentation part: Each group prepares a presentation for its subject (duration: 30 - 60 minutes) and talks about it in front of the plenum.
10603	Modelling Sem A Report	2	Adv. Sem	8	Students receive real-world projects and work (in small groups) their way into them. The Sem is divided into two parts: Presentation and Written Report. Report: Each group prepares and distributes a report (at least 10 pages) using a scientific text system.
10604	Modelling Sem B Presentation	2	Adv. Sem	8	Students receive real-world projects and work (in small groups) their way into them. The Sem is divided into two parts: Presentation and Written Report. Presentation part: Each group prepares a presentation for its subject (duration: 30 - 60 minutes) and talks about it in front of the plenum.
10605	Modelling Sem B Report	2	Adv. Sem	8	Students receive real-world projects and work (in small groups) their way into them. The Sem is divided into two parts: Presentation and Written Report. Report: Each group prepares and distributes a report (at least 10 pages) using a scientific text system.
10609	Scientific Computing	3	Adv. Sem		Sem accompanying the ESG Scientific Computing

Number	Course Title	Duration	Type	ECTS / Credits	Module Description
10610	Preliminary course Scientific Computing	2	Lec & Tut		- Analytical concepts: normalised spaces, convergence, closed and compact sets, Banach and Hilbert spaces, Lp-spaces - Numerical methods: Interpolation, quadrature rules, LU and QR decomposition, conjugate gradient methods - Programming in C/C++: Implementation of CG with std::vector and BLAS; compiling, debugging and linking from the Linux command line and via cmake/make
10611	Modelling with differential equations	3	Lec & Tut	4	For students of the Elite Graduate Program Scientific Computing, this course consists of the lecture "Modelling, Simulation and Optimisation with Ordinary Differential Equations". Further information can be found at https://my.uni-bayreuth.de/cmlife/s/courses/Ly91YnRAY21jby9hcGkvY291cnNlcy8zMzk5MjA/overview or https://elearning.uni-bayreuth.de/course/view.php?id=40730
10809	Mathematical specialisations for economics	4	Lec & Tut	6	Mathematical methods from linear algebra, analysis and optimisation for economic and business management issues are deepened.
12003	Information Visualisation	2	Lec	5	Specific visualization types and data types (e.g. multi-dimensional, graphs, hierarchies and trees, time series, text-related, etc.) Interaction with information visualizations Presentation, integration and evaluation of information visualizations Practical implementation of information visualisations (e.g. with Python, web-based and other frameworks) Introduction to Information Visualization (e.g. motivation, examples, core concepts) Specific visualization types and data types (e.g. multi-dimensional, graphs, hierarchies and trees, time series, text-related, etc.) Interaction with information visualizations Presentation, integration and evaluation of information visualizations Practical implementation of information visualizations (e.g. Python, web-based and other frameworks)
12013	Intelligent User Interfaces	2	Lec	5	Introduction to Intelligent User Interfaces (e.g. motivation, examples, core concepts) - HCI + AI recap/ preparations (e.g. basic concepts; practical prototyping with Python (backend, AI, algorithms) and JS/HTML/CSS (user interface, interaction)) - Recommender systems (e.g. movie recommendations) - Conversational user interfaces (e.g. chatbots, voice assistants) - Interaction with text (e.g. personalised keyboards, text suggestions, language modelling) - User/input modelling and adaptive UIs (e.g. touch, pointing, typing, menus) - Computational UI design and evaluation (e.g. layout optimisation) -N1007 Broader perspective (e.g. explainable AI, ethics)_x000D_
12015	Intelligent User Interfaces	2	Tut		
12016	Information Visualisation	2	Tut		
12108	Event Processing (INF 222)	3	Lec	5	
12119	Programming, Data Analysis and Deep Learning in Python	2	Lec	5	The Python programming language, data types, control structures, functions, object-orientated programming, debugging. Algorithms: Recursion, dynamic programming, Newton's method. Arithmetic with matrices: Linear algebra with NumPy, matrix factorisations, eigenvectors and eigenvalues, diagonalisation, SVD, least squares method, pseudo inverse. Data analysis: pandas, clustering, plotting. Neural networks and deep learning.
12200	Data Analysis II	2	Lec	8	Data visualisation, machine learning, ontologies, NoSQL, distributed computing concepts (MapReduce, Hadoop, etc.)
12220	Foundations of Semi-structured Data	2	Lec	5	Data on the web is present in many different forms. The most widespread formats are tabular (csv), tree-structured (XML, JSON), and graph-structured (RDF, knowledge graphs, property graphs). Tabular data is "similar in spirit" to relational databases, which is treated in depth in DBIS 1. This lecture focuses on foundational aspects of the other data models, namely tree- and graph structured data.
14054	Advanced Physical Computing (PBWP6)	2	Lec	3 /5	
14055	Advanced Physical Computing (PBWP6)	2	Tut	5	
14056	Advanced Physical Computing (PBWP6)	0.5	Crs		
14057	Soft matter spectroscopy OS1+OS2	4	Lec	6 /9 /12 /15	The aim of this course is to give you an overview of the basics and applications of modern optical spectroscopy methods, in particular spectroscopy of soft matter, i.e. molecules and polymers. We will discuss 13 exemplary experiments. First, I will present the basics in the script and in overview videos. Then you will apply this to 'real' measurements, analyse them and interpret the results. In the live sessions, we will clarify open questions and discuss your solutions to the tasks.
14077	Crystallography in solid state physics	4	Lec & Tut	6 /9 /12 /15	Part 1: see Synchrotron and the X-ray free electron laser (15064) Part 2: Structure factor and electron density The phase problem and methods for structure solution Refinement methods Part 1 can be chosen as a course on synchrotron radiation; Part 2 for the entire module.

Number	Course Title	Duration	Type	ECTS / Credits	Module Description
14087	Methods of molecular simulation	4	Lec & Tut	15	In this course the wide range of modern simulation methods for the investigation of potential energy surfaces of different systems will be presented. These techniques allow e.g. the treatment of finite temperatures or other ensemble effects, or provide explicit dynamical information over micro- to macroscopic time scales. Methods for the search of minima and transition states, molecular dynamics, (kinetic) Monte Carlo, as well as techniques for the calculation of free energies will be discussed. The focus of the lecture is on the discussion of basic concepts, applications and limitations of the methods with the aim of providing an overview of the field rather than detailed technical knowledge.
14250	Advanced Concepts and Current Topics in Biological Physics (B1: Modelling and design of protein structures)	1	Lec & Tut	10	Lecturers from the elite study programme "Biological Physics". Time and place by arrangement with the students.
14252	Advanced Concepts and Current Topics in Biological Physics (B3: Techniques in Molecular Biology: Recent Revolutions in Research)	1	Lec & Tut	10	Lecturers from the elite study programme "Biological Physics". Time and place by arrangement with the students.
14253	Advanced Concepts and Current Topics in Biological Physics (B4:Visualisation of cell organelles: dynamics and ultrastructure)	1	Lec & Tut	10	
14260	Advanced Concepts and Current Topics in Biological Physics (P1: Biofluid simulations)	1	Lec & Tut	10	
14262	Advanced Concepts and Current Topics in Biological Physics (P3: Single-molecule techniques in Biophysics)	1	Lec & Tut	10	Lecturers from the elite study programme "Biological Physics". Time and place by arrangement with the students.
14264	Advanced Concepts and Current Topics in Biological Physics (P5: Calculating excitations in molecular systems)	1	Lec & Tut	10	Topic as part of the course Advanced Concepts and Current Topics in the elite study programme "Biological Physics". Block course after prior registration. Time and place to be announced.
14265	Advanced Concepts and Current Topics in Biological Physics (P6: Quantifying transport and binding events in living organisms)	1	Lec & Tut	10	
14270	Interdisciplinary Practical Exercise Course Biological Physics	6	Crs	12	Internship as part of the elite study programme "Biological Physics". Time and place by arrangement.
14361	Physics colloquium	2	Coll		
15020	Material physics	4	Lec	6 /9	The course gives an insight into the relationship between physical properties of solids and their structure and symmetry. Tensor properties of crystals of ranks zero through four will be considered.
15032	Review of Current Scientific Literature	2	Lec	6 /9 /12 /15	
15064	Synchrotron radiation and the X-ray free-electron laser	2	Lec	6 /9 /12 /15	Construction and operation of a synchrotron; the free electron laser (FEL); properties of synchrotron radiation and radiation from an X-ray laser; applications in biological physics and solid-state physics.
15140	Modern crystallographic methods	2	Sem		

Key/Abbreviations:

Adv.Sem	Advanced seminar
Crs	Course
Coll	Colloquium
ECTS	Credit Points
Lab	Lab course
Lec	Lecture
Pro	Project
Sem	Seminar
Tut	Tutorial

Please check availability of your chosen subject/course by contacting the respective faculty.
You can find contact details at **www.uni-bayreuth.de/en/study**

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