INTERNATIONAL PROGRAM (MASTER)

CLASSES: SUMMER SEMESTER 2010

1556 Homogeneous and Symmetric Spaces
Lecture: 4 h, 8 credit points
Tue 09:45-11:15 AOC 101 Geb 30.45, Thu 08:00-09:30 Oberer HS Geb 10.91
Tutorial: 2 h, 2 credit points
Thu 15:45-17:15 HS 93 Geb 10.81
Prof. Enrico Leuzinger

1563 Nonlinear Schroedinger Equations: Dynamical Aspects
Lecture: 2 h, 4 credit points
Mon 14:00-15:30 1C-03 Geb 5.20
Prof. Roland Schnaubelt

1564 Spectral Theory
Lecture: 4 h, 8 credit points
Mon 08:00-09:30 NH Geb 20.40, Wed 09:45-11:15 Nusselt Geb 10.23
Tutorial: 2h, 2 credit points
Wed 15:45-17:15 SR 1 Geb 1.85
Prof. Roland Schnaubelt

1575 Boundary and Eigenvalue Problems
Lecture: 4 h, 8 credit points
Mo 09:45-11:15 1C-04 Geb 5.20, Wed 14:00-15:30 1C-03 Geb 05.20
Tutorial: 2 h, 2 credit points
Thu 14:00-15:30 HS 102 Geb 10.50
Prof. Wolfgang Reichel

1579 Computer-assisted Proofs for Partial Differential Equations
Lecture: 2 h, 4 credit points
Fr 11:30-13:00 SR 1 Geb 01.85
Tutorial: 1 h, 1 credit points
Fr 08:00-09:30 SR 1 Geb. 01.85 - fortnightly, from Apr 16
Prof. Michael Plum

1590 Stochastic Processes
Lecture: 4 h, 8 credit points
Tue 08:00-09:30 HS II (R005) Geb 30.41, Wed 08:00-09:30 NH Geb 20.40
Tutorial: 2 h, 2 credit points
Fr 14:00-15:30 NH Geb 20.40
Prof. Nicole Bäuerle

1606 Adaptive Finite Element Methods
Lecture: 2 h, 4 credit points
Mon 11:30-13:00 1C-04 Geb 05.20
Prof. Willy Dörfler

1608 Numerical Methods for Maxwell's Equations
Lecture: 2 h, 4 credit points
Fr 09:45-11:15 1C-04 Geb 05.20
Prof. Tobias Jahnke

1735 Seminar: Calculus of Variations
Tue 15:45-17:15 SR 2 Geb 01.85
Prof. Michael Plum and Prof. Wolfgang Reichel

1738 Seminar: Partial Differential Equations
Thu 09:45-11:15 R 214 Geb 11.40
Prof. Matthias Kurzke

1752 Seminar: Computational Fluid Dynamics
Wed 11:30-13:00 1C-04 Geb 05.20
Prof. Vincent Heuveline

1754 Seminar: Engineering Mathematics and Computing
NN
Prof. Vincent Heuveline

Time-table for lectures

	Monday	Tuesday	Wednesday	Thursday	Friday
08:00-09:30	Spec. Theory	Stoch. Proc.	Stoch. Proc.	H+S Spaces	
09:45-11:15	BEP	H+S Spaces	Spec. Theory		Maxwell
11:30-13:00	Fin. Element				Comp-Ass Proofs
14:00-15:30	Schröd.		BEP		
15:45-17:15					

GERMAN CLASSES

Optional German language classes should be attended in the late afternoon and evening.

CLASSES: SUMMER SEMESTER 2010

1556 Homogeneous and Symmetric Spaces

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Thu 15:45-17:15 HS 93 Geb 10.81
Prof. Enrico Leuzinger

Contents:
Group actions, Lie groups and Lie algebras, homogeneous Riemannian manifolds, symmetric spaces, locally symmetric spaces.

Prerequisites:
A course in Riemannian geometry.

References:
S. Helgason, Differential Geometry, Lie Groups and Symmetric Spaces, Academic Press 1978.

1563 Nonlinear Schroedinger Equations: Dynamical Aspects

Lecture: 2 h, 4 credit points
Mon 14:00-15:30 1C-03 Geb 5.20
Prof. Roland Schnaubelt

Will be completed.

1564 Spectral Theory

Lecture: 4 h, 8 credit points
Mon 08:00-09:30 NH Geb 20.40, Wed 09:45-11:15 Nusselt Geb 10.23
Tutorial: 2h, 2 credit points
Wed 15:45-17:15 SR 1 Geb 1.85
Prof. Roland Schnaubelt

Contents:
The spectrum of a linear operator on a Banach space generalizes the concept of an eigenvalue of a matrix. In Banach spaces spectral theoretic methods play an equally important role as the eigenvalue theory im finite dimensions. These methods are used everywhere in analysis and its applications.
At the beginning we discuss the basic properties of the spectrum. In view of the applications

on differential operators this is not only done for bounded operators, but also for a certain class of unbounded linear operators, the so-called closed operators. To treat differential operators on L^p spaces, we introduce weak derivative in the L^p setting and Sobolev spaces. One can develop a detailed spectral theory for two main classes of operators. We first deal with compact operators, where the spectrum determined by the eigenvalues to a large extent. In this context we also prove the so-called Fredholm alternative, which has important applications e.g. to integral equations. Then we study (possibly only closed) self adjoint operators on Hilbert spaces. For such operators the spectral theorem is a far reaching extension of the diagonalisation of hermitian matrices. Finally, we treat the functional calculi for self adjoint, bounded and sectorial operators.

Prerequisites: Functional analysis

References:
H.W. Alt: Lineare Funktionalanalysis. Springer.
J.B. Conway: A Course in Functional Analysis. Springer.
N. Dunford, J.T. Schwartz: Linear Operators. Part I: General Theory. Wiley.
T Kato: Perturbation Theory of Linear Operators. Springer.
A.E. Taylor, D.C. Lay: Introduction to Functional Analysis. Wiley.
D. Werner: Funktionalanalysis. Springer.

1575 Boundary and Eigenvalue Problems
Lecture: 4 h, 8 credit points
Mo 09:45-11:15 1C-04 Geb 5.20, Wed 14:00-15:30 1C-03 Geb 05.20
Tutorial: 2 h, 2 credit points
Thu 14:00-15:30 HS 102 Geb 10.50
Prof. Wolfgang Reichel

Contents:
The course consists of topics on linear elliptic partial differential equations, where the differential equations are coupled with boundary conditions. Boundary value problems of such kind appear e.g. in modeling of reaction-, convection- and diffusion processes. Special cases of boundary value problems are so called eigenvalue problems, which appear e.g. in quantum mechanics or in vibrations of elastic materials. If time permits we will also investigate basic properties of time-dependent problems (parabolic initial-boundary value problems) like the heat equation, which models heat conduction.
In the course I will cover results on existence of weak solutions in Sobolev spaces, estimates of such solutions together with qualitative and regularity properties.

1. Motivation & examples
2. Weak derivatives and Sobolev spaces

   Poincaré and Sobolev inequalities, imbedding theorems

3. Elliptic boundary value problems

   Maximum and comparison principles, existence results, Fredholm alternative

   Regularity properties of solutions

4. Elliptic eigenvalue problem

   Eigenvalues, eigenfunctions, completeness, variational characterization

5. Parabolic initial-boundary value problems

Audience:
Mathematicians, physicists, engineers

Prerequisites:
Analysis I–III (or similar lectures), basics in functional analysis.

References:
L.C. Evans: Partial Differential Equations, American Mathematical Society 1998
Gilbarg & Trudinger: Elliptic Partial Differential Equations of Second Order, Springer 1998
Renardy & Rogers: An Introduction to Partial Differential Equations, Springer 1992
Walter Strauss: Partial Differential Equations – An Introduction, John Wiley 1992
Gerald B. Foland: Introduction to Partial Differential Equations, Princeton University Press, 1995

1579 Computer-assisted Proofs for Partial Differential Equations
Lecture: 2 h, 4 credit points
Fr 11:30-13:00 SR 1 Geb 01.85
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Prof. Michael Plum

Contents:
Many boundary value problems for semilinear elliptic partial differential equations allow very stable numerical computations of approximate solutions, but are still lacking analytical existence proofs. In the lecture course, methods are presented which exploit the knowledge of a “good” numerical approximate solution, in order to provide a rigorous proof of existence of an exact solution close to the approximate one. The essence of such methods are fixed-point arguments which take all numerical errors into account, and thus give mathematical proofs which are not “worse” than any purely analytical ones.

Prerequisites:
Knowledge about elliptic boundary value problems and in functional analysis.

References:
M. Plum, Existence and Multiplicity Proofs for Semilinear Elliptic Boundary Value Problems by Computer Assistance. DMV Jahresbericht: JB 110, Band (2008), Heft 1, 19-54.

1590 Stochastic Processes

Lecture: 4 h, 8 credit points
Tue 08:00-09:30 HS II (R005) Geb 30.41, Wed 08:00-09:30 NH Geb 20.40
Tutorial: 2 h, 2 credit points
Fr 14:00-15:30 NH Geb 20.40
Prof. Nicole Bäuerle

Contents:
In the first part of the lecture we consider Markov chains in discrete- and continuous-time. These kind of prcesses are often taken as models for the random evolution of systems in various areas like e.g. telecommunication, production planning, biology and physics. The aim is to show some convergence results which describe the long-term behavior of these systems. In the second part of the lecture we discuss in detail the Brownian motion, in particular its existence, path properties, the reflexion principle and the strong Markov property.

Prerequisites:
Some knowledge of probability theory is required.

References:
Bremaud, P. (1999): Markov Chains: Gibbs Fields, Monte Carlo Simulation and Queues. Springer, New York.
Karatzas, I. and S. Shreve (1991): Brownian motion and stochastic calculus. Springer, New York.
Resnick, S. (1992): Adventures in Stochastic Processes. Birkhäuser, Boston.
Ross, S. (1996): Stochastic Processes. Wiley, New York.

1606 Adaptive Finite Element Methods

Lecture: 2 h, 4 credit points
Mon 11:30-13:00 1C-04 Geb 05.20
Prof. Willy Dörfler

Contents:
It is not advisable to use numerical simulations without control of the (problemdependent) error. For example, in the calculation of the statics of a building, all displacements, forces and stresses should satisfy tolerances that guarantee the elastic behaviour of the used material which is the base of the modelling.
We discuss methods to compute, together with the solution, estimates for various kinds of error measures. Moreover, this error estimation also allows to adapt the whole numerical algorithm to the solution and this can result in tremendous savings in the simulation. It can be proved for model problems, that such algorithms are of optimal complexity. We treat stationary and time-dependent problems.

Prerequisites:
Knowledge in Finite Element Methods and basics in the theory of elliptic and parabolic partial differential equations.

By request, the lecture is given in english.

1608 Numerical Methods for Maxwell's Equations

Lecture: 2 h, 4 credit points
Fr 09:45-11:15 1C-04 Geb 05.20
Prof. Tobias Jahnke

Contents:

The classical theory of electromagnetism is based on a system of coupled partial differential equations derived by James Clerk Maxwell about 150 years ago. These equations describe the interaction between the electric and magnetic fields, the electric and magnetic flux densities, and the electric and magnetic current densities. Solving Maxwell's equations numerically is challenging problem which appears in many different situations such as, e.g., the cellphone radiation interacting with a human head, or the simulation of a photonic crystal waveguide switch.

In this lecture numerical methods for the time-dependent Maxwell equations will be derived and analyzed. The course will mainly focus on the issue of time-integration. Finite-difference time-domain methods such as the famous Yee scheme will be discussed and compared with alternative approaches such as exponential integrators.

Prerequisites:

The lecture will be given in English. It is intended for students in mathematics, physics and other sciences with basics in ordinary and partial differential equations and the corresponding numerical methods. Knowledge about Maxwell's equations is not yet required because a short introduction to these equations will be provided in the first chapter.

References:

Matthew N. O. Sadiku: Numerical techniques in electromagnetics. 2. ed., Boca Raton, Fla.: CRC Press, 2001.

Allen Taflove and Susan C. Hagness: Computational electrodynamics: the finite-difference time-domain method. 3. ed., Boston: Artech House, 2005.

More references will be given in the lecture.