SUMMER SEMESTER 2016 - HIGHER ANALYSIS II
LINEAR PARTIAL DIFFERENTIAL EQUATIONS

Lecture. Tuesday 11 - 1 pm and Thursday 1 - 3 pm, RUD 25, room 1.013
Recitation. Tuesday 1 - 3 pm, RUD 25, room 3.008
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Office hours. Monday 2 - 3 pm

Since this course is listed as a Basic Course of the Berlin Mathematical School, it will be held in English.

Contents. This course is dedicated to the study of the classical partial differential equations: the wave equation, the heat equation, the Schrödinger equation, and the Laplace equation. Initially we will consider simple problems for these equations and in a few cases we will obtain explicit formulas. Similar to ordinary differential equations, we will consider initial value problems and boundary value problems.

In this context it will be of importance to assess which problems can be solved and which not. Hence we will study power series solutions and existence and uniqueness theorems. Recall that ordinary differential equations with constant coefficients can be effectively solved by means of the Laplace transform. In the context of partial differential equations we will study the Fourier transform which will be a powerful tool for solving partial differential equations.

For every partial differential equation, there are a number of different problems. We may try to solve the equation in the full Euclidean space or in a bounded region. If an equation is solved in a bounded region, certain initial and/or boundary conditions need to be added. For the differential equations mentioned above, fundamental solutions will be developed. These will be useful when discussing the solution of initial value problems of boundary value problems.

Fundamental solutions force us to extend the concept of the function and the derivative and introduce so-called distributions. Finally we will consider partial differential equations with variable coefficients. In this context we will rely on functional analytic methods. We will understand that many differential equations have solutions which are not differentiable in the classical sense. Those solutions are called weak solutions.

Prerequisites. Analysis I,II, III, Linear Algebra I,II, Higher Analysis I (Functional analysis).

Recitation and Admission to the Final Exam. Every week there will be homework assignments posted on my home page. Some of the problems will be discussed during the recitation section. In order to gain admission to the final exam (7/21/2016 or 10/10/2016), you are asked to attend the recitation section and to present the solution of one homework problem on the black board.

Books. A course dedicated to this vast area of mathematics can only cover a small

selection of topics. For you studies I recommend the following books which I have relied on when preparing my lectures.

- F. John: Partial Differential Equations, Springer-Verlag, vierte Auflage 1982
- J. Rauch: Partial Differential Equations, Springer-Verlag 1991,
- M. Renardy and R. Rogers: An Introduction to Partial Differential Equations, Springer-Verlag 1993, zweite Auflage 2004
- B. Schweizer: Partielle Differentialgleichungen, Springer-Verlag 2013
- W. Strauss: Partial Differential Equations, J. Wiley & Sons, second edition 2008
- M. Taylor: Partial Differential Equations I, Springer 1996
- J. Wloka: Partielle Differentialgleichungen, Teubner 1980