This book introduces the theory and application of multigrid methods for the fast numerical solution of linear and weakly nonlinear elliptic PDE. No previous exposure to numerical discretization methods is assumed. All that is required of the reader is curiosity and some basic knowledge of matrix theory and the theory of finite-dimensional vector spaces. An axiomatic, mostly-matrix-based approach is used in the book, both as a way of presenting the theory in a natural and simple setting, and as a means for translating the theory into practical codes. It deviates a little from the matrix-based-approach in the presentation of the framework for nonlinear problems in the latter part of the book. That nonlinear analysis, based on subspace decompositions, represents an area of current research. In fact, the book takes the reader all the way from the basics and simple implementation issues to the front lines of multigrid research. Coding the multigrid method is notoriously difficult. The current book, which contains several sample codes in the finite element and cell-centered finite difference frameworks, will train the interested reader in the construction of sophisticated, efficient multigrid codes using the simple but powerful MATLAB© programming environment.

- Provides basic axiomatic convergence theory of multigrid methods for linear and weakly nonlinear problems.
- Builds a bridge between the simple application of the basic theory and the research front for nonlinear methods.
- Includes sample codes in MATLAB© designed to help students learn to implement notoriously complicated multigrid and multi-level recursive algorithms.

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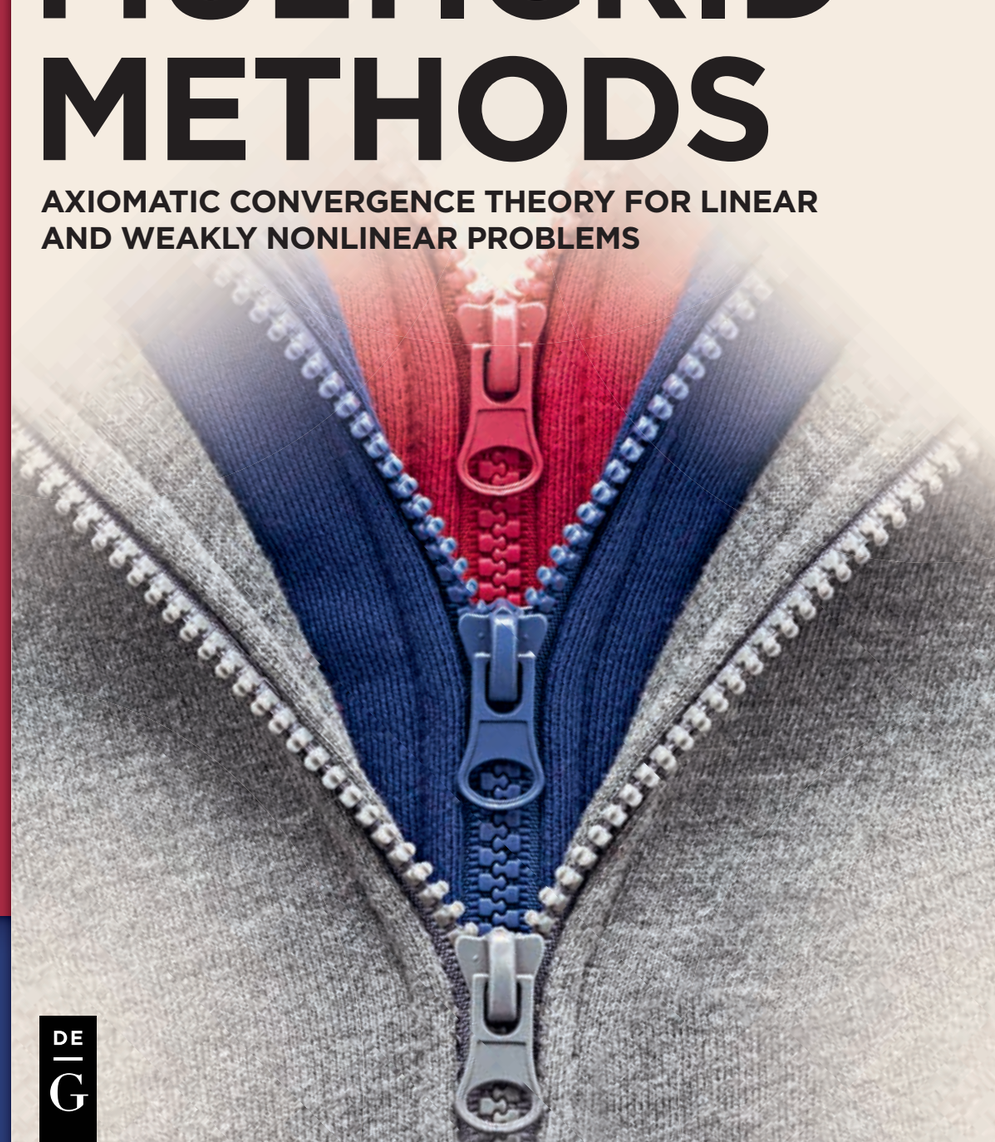
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