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★**Nodal discontinuous Galerkin methods.**
Algorithms, analysis, and applications.
Texts in Applied Mathematics, 54.
Springer, New York, 2008. xiv+500 pp. \$59.95.
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Among the numerical methods for solving PDEs, the discontinuous Galerkin finite element method (DG-FEM) is attractive for its flexibility in handling complex geometry and hp-adaptivity. The method provides discontinuous approximations with a Galerkin approach element by element, through properly chosen numerical fluxes (or numerical traces) at the element interfaces. The local nature of the method allows a high degree of parallelizability. The main weakness of the method is the larger number of unknowns in the discrete system compared to the standard Galerkin method. The first DG-FEM was introduced in the early 1970s. Since the 1990s, research on the method has experienced a phenomenal growth. The method has been successfully used in solving a wide variety of problems in fluid dynamics, solid mechanics, and other physical sciences.

The book under review presents basic ideas, theoretical analysis, MATLAB implementation and applications of the DG-FEM. The main body of the book consists of ten chapters. The first chapter starts with an introduction of the method for a one-dimensional scalar conservation law, with a comparison of the method with three other popular numerical methods: the finite difference method, the finite volume method, the (standard) finite element method. The section on a brief historical account of the method provides an extensive list of application areas. The representative references quoted are useful for any reader interested in applying the method in a particular area. This chapter also includes a description of the contents of the following chapters. Chapters 2 to 4 provide the basics of the method, mostly in the context of the numerical solution of a linear one-dimensional scalar conservation law. In particular, Chapter 2 discusses the construction of the method; Chapter 3 is devoted to the implementation of the method, including several MATLAB codes; Chapter 4 focuses on theoretical insights on the performance of the method, with results on convergence, error estimation, stability, and dispersive properties. The remaining chapters give extensions of the basics of the method to more complicated situations: one-dimensional nonlinear conservation laws in Chapter 5; two-dimensional conservation laws in Chapter 6; equations with higher-order spatial derivatives, including the heat equation, convection-diffusion equation, elliptic equations, incompressible and compressible Navier-Stokes equations, in Chapter 7; eigenvalue problems for the Laplacian operator and the Maxwell system in Chapter 8; isoparametric curvilinear elements and nonconforming discretizations in Chapter 9; and equations with three spatial variables in Chapter 10. There are three appendices, one on the computation of Jacobi polynomials and their extension to simplexes, one on a MATLAB-based mesh generator, and an overview of the codes used in the book.

This book provides comprehensive coverage of the major aspects of the DG-FEM, from derivation, analysis and implementation of the method to simulation of application problems. It is a highly valuable volume in the literature on the DG-FEM. It is also suitable as a textbook for a graduate-level course for students in computational and applied mathematics, physics and engineering.

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