

**Kunkel, Peter; Mehrmann, Volker**

**Differential-algebraic equations. Analysis and numerical solution.** (English) Zbl 1095.34004

Zürich: European Mathematical Society Publishing House (ISBN 3-03719-017-5/hbk). viii, 377 p. (2006).

The textbook is devoted to a systematic and detailed analysis of initial and boundary value problems for differential-algebraic equations (implicit differential equations, differential-algebraic systems, algebraic-differential systems, descriptor systems, singular systems) that are a widely accepted tool for modeling and simulation of constrained dynamical systems in numerous applications, such as mechanical multibody systems, electrical circuit simulation, chemical engineering, control theory, fluid dynamics and many others.

The analysis is developed from the theory of linear constant coefficient systems via linear variable coefficient systems to general nonlinear systems. Further sections on control problems, generalized inverses of differential-algebraic operators, generalized solutions, and differential equations on manifolds complement the theoretical treatment of initial value problems. Two major classes of numerical methods for differential-algebraic equations (Runge-Kutta and BDF methods) are discussed and analyzed with respect to convergence and order. A chapter is devoted to index reduction methods that allow the numerical treatment of general differential-algebraic equations. The analysis and numerical solution of boundary value problems for differential-algebraic equations is presented, including multiple shooting and collocation methods. A survey of current software packages for differential-algebraic equations completes the text.

The book is addressed to graduate students and researchers in mathematics, engineering and sciences, as well as practitioners in industry. A prerequisite is a standard course on the numerical solution of ordinary differential equations. Numerous examples and exercises make the book suitable as a course textbook or for self-study.

Reviewer: Georgii P. Razmyslovich (Minsk)

**MSC:**

- [34A09](#) Implicit ordinary differential equations, differential-algebraic equations
- [34A12](#) Initial value problems, existence, uniqueness, continuous dependence and continuation of solutions to ordinary differential equations
- [34B15](#) Nonlinear boundary value problems for ordinary differential equations
- [65L80](#) Numerical methods for differential-algebraic equations
- [65L06](#) Multistep, Runge-Kutta and extrapolation methods for ordinary differential equations
- [65-01](#) Introductory exposition (textbooks, tutorial papers, etc.) pertaining to numerical analysis
- [34-01](#) Introductory exposition (textbooks, tutorial papers, etc.) pertaining to ordinary differential equations

Cited in **4** Reviews  
Cited in **222** Documents

**Keywords:**

implicit equations; initial value problems; boundary value problems; methods for differential-algebraic equations

**Software:**

[NewtonLib](#); [GELDA](#); [GENDA](#); [MANPAK](#); [DASSL](#); [MBSSIM](#)