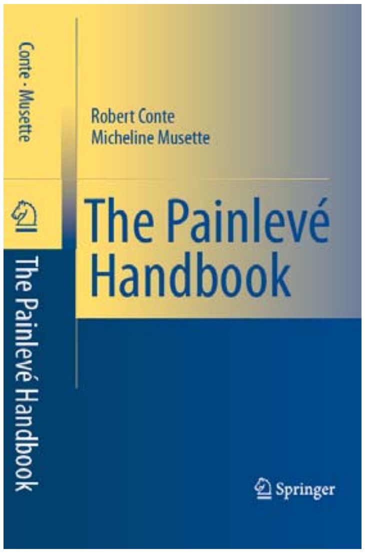

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The Painlevé Handbook

Nonlinear differential or difference equations are encountered not only in mathematics, but also in many areas of physics (evolution equations, propagation of a signal in an optical fiber), chemistry (reaction-diffusion systems), and biology (competition of species). This book introduces the reader to methods allowing one to build explicit solutions to these equations. A prerequisite task is to investigate whether the chances of success are high or low, and this can be achieved without any a priori knowledge of the solutions, with a powerful algorithm presented in detail called the Painlevé test. If the equation under study passes the Painlevé test, the equation is presumed integrable. If on the contrary the test fails, the system is nonintegrable or even chaotic, but it may still be possible to find solutions. The examples chosen to illustrate these methods are mostly taken from physics. These include on the integrable side the nonlinear Schrödinger equation (continuous and discrete), the Korteweg-de Vries equation, the Hénon-Heiles Hamiltonians, on the nonintegrable side the complex Ginzburg-Landau equation (encountered in optical fibers, turbulence, etc), the Kuramoto-Sivashinsky equation (phase turbulence), the Kolmogorov-Petrovski-Piskunov equation (KPP, a reaction-diffusion model), the Lorenz model of atmospheric circulation and the Bianchi IX cosmological model. Written at a graduate level, the book contains tutorial text as well as detailed examples and the state of the art on some current research.

Contents: From the contents 1. Introduction. 2. Singularity structure in the complex plane, the Painlevé test. 3. Integrating ordinary differential equations. 4. Painlevé property and Painlevé test for partial differential equations. 5. From the test to explicit solutions of PDEs. 6. Quartic Hénon-Heiles Hamiltonian. 7. Discrete nonlinear equations. 8. FAQ (Frequently asked questions). A. The classical results of Painlevé and followers. B. Brief presentation of the elliptic functions. C. Basic introduction to the Nevanlinna theory. D. More on the Painlevé transcendents. E. The bilinear operator of Hirota. F. Algorithm for computing the Laurent series.

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