

CHAPTER III

SINGULAR INTEGRAL EQUATIONS

3.1 INTRODUCTION

An integral equation is called a singular integral equation if one or both limits of integration become infinite, or if the kernel $K(x, t)$ of the equation becomes infinite at one or more points in the interval of integration. In other words, the integral equation of the first kind

$$f(x) = \lambda \int_{\alpha(x)}^{\beta(x)} K(x, t) u(t) dt \quad (1)$$

or the integral equation of the second kind

$$u(x) = f(x) + \lambda \int_{\alpha(x)}^{\beta(x)} K(x, t) u(t) dt \quad (2)$$

is called singular if the lower limit $\alpha(x)$, the upper limit $\beta(x)$ or both limits of integration are infinite. Moreover, the equations (1) or (2) is also called a singular integral equation if the kernel $K(x, t)$ becomes infinite at one or more points in the domain of integration.

Examples of the first style of singular integral equations are:

$$u(x) = 1 + e^{-x} - \int_0^{\infty} u(t) dt \quad (3)$$

$$F(\lambda) = \int_{-\infty}^{\infty} e^{-i\lambda x} u(x) dx \quad (4)$$

$$L[u(x)] = \int_0^{\infty} e^{-\lambda x} u(x) dx \quad (5)$$

Examples of the second style of singular integral equations are given by

$$x^2 \pm \int_0^x \frac{1}{\sqrt{x-t}} u(t) dt \quad (6)$$

$$x = \int_0^x \frac{1}{(x-t)^\alpha} u(t) dt, 0 < \alpha < 1 \quad (7)$$

$$u(x) = 1 + 2\sqrt{x} - \int_0^x \frac{1}{\sqrt{x-t}} u(t) dt \quad (8)$$

3.2 ABEL'S PROBLEM

Abel in 1823 investigated the motion of a particle that slides down along a smooth unknown curve, in a vertical plane, under the influence of the gravitational field. It is assumed that the particle starts from a point P, with vertical elevation x , slides along the unknown curve, to the lowest point O on the curve where the vertical distance is $x=0$. The total time of descent T from the highest point to the lowest point on the curve is given in advance, and dependent on the elevation x , hence expressed by

$$T = h(x) \quad (9)$$

Assuming that the curve between the points P and O has an arclength s , then the velocity at a point Q on the curve, between P and O, given by

$$\frac{ds}{dt} = \sqrt{2g(x-t)} \quad (10)$$

where t is a variable coordinate defines the vertical distance of the point Q, and g is a constant defines the acceleration of gravity. Integrating both sides of (10) gives

Singular Integral Equations

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Singular Integral Equations:

Singular Integral Equations and Discrete Vortices I. K. Lifanov, 2018-11-05 No detailed description available for Singular Integral Equations and Discrete Vortices *Singular Integral Equations* Ricardo Estrada, Ram P. Kanwal, 2000 This work focuses on the distributional solutions of singular integral equations progressing from basic concepts of the classical theory to the more difficult two dimensional problems *Singular Integral Operators* Solomon G. Mikhlin, Siegfried Prößdorf, 1987 The present edition differs from the original German one mainly in the following additional material weighted norm inequalities for maximal functions and singular operators 12 Chap XI polysingular integral operators and pseudo differential operators 7 8 Chap XII and spline approximation methods for solving singular integral equations 4 Chap XVII Furthermore we added two subsections on polynomial approximation methods for singular integral equations over an interval or with discontinuous coefficients Nos 3 6 and 3 7 Chap XVII In many places we incorporated new results which in the vast majority are from the last five years after publishing the German edition note that the references are enlarged by about 150 new titles S G Mikhlin wrote 7 8 Chap XII and the other additions were drawn up by S Prossdorf We wish to express our deepest gratitude to Dr A Bottcher and Dr R Lehmann who together translated the text into English carefully and with remarkable expertise

Singular Integral Equations E.G. Ladopoulos, 2013-03-09 The present book deals with the finite part singular integral equations the multidimensional singular integral equations and the non linear singular integral equations which are currently used in many fields of engineering mechanics with applied character like elasticity plasticity thermoelastoplasticity viscoelasticity viscoplasticity fracture mechanics structural analysis fluid mechanics aerodynamics and elastodynamics These types of singular integral equations form the latest high technology on the solution of very important problems of solid and fluid mechanics and therefore special attention should be given by the reader of the present book who is interested for the new technology of the twentieth one century Chapter 1 is devoted with a historical report and an extended outline of References for the finite part singular integral equations the multidimensional singular integral equations and the non linear singular integral equations Chapter 2 provides a finite part singular integral representation analysis in L_p spaces and in general Hilbert spaces In the same Chapter are investigated all possible approximation methods for the numerical evaluation of the finite part singular integral equations as closed form solutions for the above type of integral equations are available only in simple cases Also Chapter 2 provides further a generalization of the well known Sokhotski Plemelj formulae and the Nother theorems for the case of a finite part singular integral equation **Singular Integral Equations** N. I.

Muskhelishvili, J. R. M. Radok, 2008-01-01 This high level treatment considers one dimensional singular integral equations involving Cauchy principal values covering Hilbert and Riemann Hilbert problems Dirichlet problems inversion formulas for arcs more 1992 edition *Multidimensional Singular Integrals and Integral Equations* S. G. Mikhlin, 2014-07-10 Multidimensional Singular Integrals and Integral Equations presents the results of the theory of

multidimensional singular integrals and of equations containing such integrals Emphasis is on singular integrals taken over Euclidean space or in the closed manifold of Liapounov and equations containing such integrals This volume is comprised of eight chapters and begins with an overview of some theorems on linear equations in Banach spaces followed by a discussion on the simplest properties of multidimensional singular integrals Subsequent chapters deal with compounding of singular integrals properties of the symbol with particular reference to Fourier transform of a kernel and the symbol of a singular operator singular integrals in L_p spaces and singular integral equations The differentiation of integrals with a weak singularity is also considered along with the rule for the multiplication of the symbols in the general case The final chapter describes several applications of multidimensional singular integral equations to boundary problems in mathematical physics This book will be of interest to mathematicians and students of mathematics

Applied Singular Integral Equations B. N. Mandal, A. Chakrabarti, 2016-04-19 The book is devoted to varieties of linear singular integral equations with special emphasis on their methods of solution It introduces the singular integral equations and their applications to researchers as well as graduate students of this fascinating and growing branch of applied mathematics

Systems of Singular Integral Equations Nikolai Petrovich Vekua, 1967

Multidimensional Weakly Singular Integral Equations Gennadi Vainikko, 1993-07-29 The final aim of the book is to construct effective discretization methods to solve multidimensional weakly singular integral equations of the second kind on a region of R^n e g equations arising in the radiation transfer theory To this end the smoothness of the solution is examined proposing sharp estimates of the growth of the derivatives of the solution near the boundary G The superconvergence effect of collocation methods at the collocation points is established This is a book for graduate students and researchers in the fields of analysis integral equations mathematical physics and numerical methods No special knowledge beyond standard undergraduate courses is assumed

Singular Integrals and Singular Integral Equations with a Cauchy Kernel and the Method of Symmetric Pairing Erwin H. Bareiss, Charles P. Neuman, 1965 The method of symmetric pairing combined with midpoint integration is introduced for the numerical evaluation of Hilbert transforms and the Kramers Kronig relations and singular integral equations with a Cauchy kernel The method for use on high speed computers is simple reliable and inexpensive Numerical examples are presented

The Enigmatic Realm of **Singular Integral Equations**: Unleashing the Language is Inner Magic

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