

Functions of Several Real Variables

2.1 Introduction

In Chapter 1 we studied the calculus of functions of a single real variable defined by $y = f(x)$. In this chapter we shall extend the concepts of functions of one variable to functions of two or more variables.

If to each point (x, y) of a certain part of the x - y plane, $x \in \mathbb{R}$, $y \in \mathbb{R}$ or $(x, y) \in \mathbb{R} \times \mathbb{R} = \mathbb{R}^2$, there corresponds a real value z according to some rule $f(x, y)$, then $f(x, y)$ is called a *real valued function of two variables* x and y and is written as

$$z = f(x, y), x \in \mathbb{R}, y \in \mathbb{R}, \text{ or } (x, y) \in \mathbb{R}^2, z \in \mathbb{R}. \quad (2.1)$$

We call x, y as the independent variables and z as the dependent variable.

In general, we define a real valued function of n variables as

$$z = f(x_1, x_2, \dots, x_n), (x_1, x_2, \dots, x_n) \in \mathbb{R}^n, z \in \mathbb{R} \quad (2.2)$$

where x_1, x_2, \dots, x_n are the n independent variables and z is the dependent variable. The point (x_1, x_2, \dots, x_n) is called an *n -tuple* and lies in an n -dimensional space. In this case, the function f maps \mathbb{R}^n into \mathbb{R} .

The function as defined by Eq. (2.2) is called an *explicit* function, whereas a function defined by $\phi(z, x_1, x_2, \dots, x_n) = 0$ is called an *implicit* function.

We shall discuss the calculus of the functions of two variables in detail and then generalize to the case of several variables.

2.2 Functions of Two Variables

Consider the function of two variables

$$z = f(x, y). \quad (2.3)$$

The set of points (x, y) in the x - y plane for which $f(x, y)$ is defined is called the *domain* of definition of the function and is denoted by D . This domain may be the entire x - y plane or a part of the x - y plane. The collection of the corresponding values of z is called the *range* of the function. The following are some examples

Functions Of Several Real Variables

Magar Mager



Functions Of Several Real Variables:

Functions Of Several Real Variables Martin Moskowitz, Fotios C Paliogiannis, 2011-04-29 This book begins with the basics of the geometry and topology of Euclidean space and continues with the main topics in the theory of functions of several real variables including limits continuity differentiation and integration All topics and in particular differentiation and integration are treated in depth and with mathematical rigor The classical theorems of differentiation and integration such as the Inverse and Implicit Function theorems Lagrange's multiplier rule Fubini's theorem the change of variables formula Green's Stokes and Gauss theorems are proved in detail and many of them with novel proofs The authors develop the theory in a logical sequence building one result upon the other enriching the development with numerous explanatory remarks and historical footnotes A number of well chosen illustrative examples and counter examples clarify matters and teach the reader how to apply these results and solve problems in mathematics the other sciences and economics Each of the chapters concludes with groups of exercises and problems many of them with detailed solutions while others with hints or final answers More advanced topics such as Morse's lemma Sard's theorem the Weierstrass approximation theorem the Fourier transform Vector fields on spheres Brouwer's fixed point theorem Whitney's embedding theorem Picard's theorem and Hermite polynomials are discussed in starred sections

Functions of Several Real Variables J. R. L. Webb, 1991 Aimed at second year undergraduates through to postgraduates studying mathematical analysis this textbook describes the theory of real analysis up to but excluding multiple integration It includes a study of differentiation culminating in the implicit function theorem

On the Differentiability of Functions of Several Real Variables James Serrin, 1961 **Several Real Variables** Shmuel Kantorovitz, 2016-02-09 This undergraduate textbook is based on lectures given by the author on the differential and integral calculus of functions of several real variables The book has a modern approach and includes topics such as The p norms on vector space and their equivalence The Weierstrass and Stone Weierstrass approximation theorems The differential as a linear functional Jacobians Hessians and Taylor's theorem in several variables The Implicit Function Theorem for a system of equations proved via Banach's Fixed Point Theorem Applications to Ordinary Differential Equations Line integrals and an introduction to surface integrals This book features numerous examples detailed proofs as well as exercises at the end of sections Many of the exercises have detailed solutions making the book suitable for self study Several Real Variables will be useful for undergraduate students in mathematics who have completed first courses in linear algebra and analysis of one real variable

Functions of several variables B. Craven, 2012-12-06 This book is aimed at mathematics students typically in the second year of a university course The first chapter however is suitable for first year students Differentiable functions are treated initially from the standpoint of approximating a curved surface locally by a flat surface This enables both geometric intuition and some elementary matrix algebra to be put to effective use In Chapter 2 the required theorems chain rule inverse and implicit function theorems etc are stated and proved for n variables concisely and rigorously Chapter 3 deals

with maxima and minima including problems with equality and inequality constraints The chapter includes criteria for discriminating between maxima minima and saddlepoints for constrained problems this material is relevant for applications but most textbooks omit it In Chapter 4 integration over areas volumes curves and surfaces is developed and both the change of variable formula and the Gauss Green Stokes set of theorems are obtained The integrals are defined with approximative sums expressed concisely by using step functions this preserves some geometrical and physical concept of what is happening Consequent on this the main ideas of the differential form approach are presented in a simple form which avoids much of the usual length and complexity Many examples and exercises are included

Mathematics for Engineers and Scientists, Sixth Edition Alan Jeffrey, 2004-08-10 Since its original publication in 1969 Mathematics for Engineers and Scientists has built a solid foundation in mathematics for legions of undergraduate science and engineering students It continues to do so but as the influence of computers has grown and syllabi have evolved once again the time has come for a new edition Thoroughly revised to meet the needs of today's curricula Mathematics for Engineers and Scientists Sixth Edition covers all of the topics typically introduced to first or second year engineering students from number systems functions and vectors to series differential equations and numerical analysis Among the most significant revisions to this edition are Simplified presentation of many topics and expanded explanations that further ease the comprehension of incoming engineering students A new chapter on double integrals Many more exercises applications and worked examples A new chapter introducing the MATLAB and Maple software packages Although designed as a textbook with problem sets in each chapter and selected answers at the end of the book Mathematics for Engineers and Scientists Sixth Edition serves equally well as a supplemental text and for self study The author strongly encourages readers to make use of computer algebra software to experiment with it and to learn more about mathematical functions and the operations that it can perform

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Holomorphic Functions and Integral Representations in Several Complex Variables R. Michael Range, 1998-06-26 The subject of this book is Complex Analysis in Several Variables This text begins at an elementary level with standard local results followed by a thorough discussion of the various fundamental concepts of complex convexity related to the remarkable extension properties of holomorphic functions in more than one variable It then continues with a comprehensive introduction to integral representations and concludes with complete proofs of substantial global results on domains of holomorphy and on strictly pseudoconvex domains in \mathbb{C}^n including for example Carathéodory's famous Mapping Theorem The most important new feature of this book is the systematic inclusion of many of the developments of the last 20 years which centered around integral representations and estimates for the Cauchy Riemann equations In particular integral representations are the principal tool used to develop the global theory in contrast to many earlier books on the subject which involved methods from commutative algebra and sheaf theory and or

partial differential equations I believe that this approach offers several advantages 1 it uses the several variable version of tools familiar to the analyst in one complex variable and therefore helps to bridge the often perceived gap between complex analysis in one and in several variables 2 it leads quite directly to deep global results without introducing a lot of new machinery and 3 concrete integral representations lend themselves to estimations therefore opening the door to applications not accessible by the earlier methods

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Theory and Applications of Differentiable Functions of Several Variables Sergei

Mikhailovich Nikol'skii, 1967

Handbook of Mathematics I.N. Bronshtein, K.A. Semendyayev, 2013-06-29 This guide book to mathematics contains in handbook form the fundamental working knowledge of mathematics which is needed as an everyday guide for working scientists and engineers as well as for students Easy to understand and convenient to use this guide book gives concisely the information necessary to evaluate most problems which occur in concrete applications

Complex

Analysis with MATHEMATICA® William T. Shaw, 2006-04-20 This book presents a way of learning complex analysis using Mathematica Includes CD with electronic version of the book

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Theory and Applications of Differentiable Functions of Several Variables, 1994 This book explores various topical trends in the theory of differentiable functions of several real variables and its applications Among the subjects covered are imbedding of various spaces of differentiable functions defined on sets in Euclidean space on a sphere and in a polydisc approximation of functions estimates for the norms of various integral operators in weighted space conditions for stabilization of a function to a polynomial sufficient conditions for multipliers construction of unconditional bases in anisotropic spaces existence of entire solutions for quasilinear equations and establishment of an asymptotic formula for the kernels of powers of the resolvent of

elliptic operators **Sharpening Mathematical Analysis Skills** Alina Sîntămărian, Ovidiu Furdui, 2021-10-25 This book gathers together a novel collection of problems in mathematical analysis that are challenging and worth studying They cover most of the classical topics of a course in mathematical analysis and include challenges presented with an increasing level of difficulty Problems are designed to encourage creativity and some of them were especially crafted to lead to open problems which might be of interest for students seeking motivation to get a start in research The sets of problems are comprised in Part I The exercises are arranged on topics many of them being preceded by supporting theory Content starts with limits series of real numbers and power series extending to derivatives and their applications partial derivatives and implicit functions Difficult problems have been structured in parts helping the reader to find a solution Challenges and open problems are scattered throughout the text being an invitation to discover new original methods for proving known results and establishing new ones The final two chapters offer ambitious readers splendid problems and two new proofs of a famous quadratic series involving harmonic numbers In Part II the reader will find solutions to the proposed exercises Undergraduate students in mathematics physics and engineering seeking to strengthen their skills in analysis will most benefit from this work along with instructors involved in math contests individuals who want to enrich and test their knowledge in analysis and anyone willing to explore the standard topics of mathematical analysis in ways that aren't commonly seen in regular textbooks Unilateral Variational Analysis In Banach Spaces (In 2 Parts) Lionel Thibault, 2023-02-14 The monograph provides a detailed and comprehensive presentation of the rich and beautiful theory of unilateral variational analysis in infinite dimensions It is divided into two volumes named Part I and Part II Starting with the convergence of sets and the semilimits and semicontinuities of multimappings the first volume develops the theories of tangent cones of subdifferentials of convexity and duality in locally convex spaces of extended mean value inequalities in absence of differentiability of metric regularity of constrained optimization problems The second volume is devoted to special classes of non smooth functions and sets It expands the theory of subsmooth functions and sets of semiconvex functions and multimappings of primal lower regular functions of singularities of non smooth mappings of prox regular functions and sets in general spaces of differentiability of projection mapping and others for prox regular sets Both volumes I and II contain for each chapter extensive comments covering related developments and historical comments Connected area fields of the material are optimization optimal control variational inequalities differential inclusions mechanics economics The book is intended for PhD students researchers and practitioners using unilateral variational analysis tools Advanced Mathematics for Engineers and Scientists Paul DuChateau, 2013-01-17 This book can be used as either a primary text or a supplemental reference for courses in applied mathematics Its core chapters are devoted to linear algebra calculus and ordinary differential equations Additional topics include partial differential equations and approximation methods Each chapter features an ample selection of solved problems These problems were chosen to illustrate not only how to solve various

algebraic and differential equations but also how to interpret the solutions in order to gain insight into the behavior of the system modeled by the equation In addition to the worked out problems numerous examples and exercises appear throughout the text

Theory of Functions of a Complex Variable A. I. Markushevich, 2013

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