Elliptic Functions: Complex Variables

Introduction

So far we have studied the elliptic functions of real variables, i.e. we consider the u in $\operatorname{sn}(u, k)$ to be a real number and have so far found that they have properties similar to the circular functions (for example they are bounded and periodic). However their real nature and power is exhibited only when we go in the realm of complex numbers and study them as functions of complex variables.

As an example of the power of complex variables, we can see the contrast between real variables and complex variables by looking at the behavior of circular functions and exponential functions. If we limit ourselves to the real variables the functions $\sin x$ and $\cos x$ have nothing to do with the exponential function $\exp(x)$ but as soon as we meet the complex variables we have the remarkable equation $\exp(ix) = \cos x + i \sin x$ and this puts the circular, exponential and logarithmic functions on the same footing.

We will not be discussing the deep methods of complex function theory, but we will rather find some peculiar properties of the elliptic functions when considered as functions of a complex variable. To that end we need to extend the definition of the elliptic functions to the domain of complex arguments. A simple method of defining $\operatorname{sn}(x + iy, k)$ could be define $\operatorname{sn}(iy, k)$ first and then use the addition formulas to define $\operatorname{sn}(x + iy, k)$. This brings us to the now famous Jacobi's Imaginary Transformation.

Jacobi's Imaginary Transformation

We need to recast our definitions in a slightly different form as follows:

$$u = F(\phi, k) = \int_0^\phi \frac{d\theta}{\sqrt{1 - k^2 \sin^2 \theta}}$$
$$= 2 \int_0^s \frac{dt}{\sqrt{1 + 2(1 - 2k^2)t^2 + t^4}}$$

where $\sin \phi = 2s/(1 + s^2)$.

Thus we have $\operatorname{sn}(u, k) = 2s/(1 + s^2)$ where s and u are related by the integral above. And after some manipulation we have

$$\operatorname{cn}(u, k) = \frac{1 - s^2}{1 + s^2}$$
$$\operatorname{dn}(u, k) = \frac{\sqrt{1 + 2(1 - 2k^2)s^2 + s^4}}{1 + s^2}$$

If we substitute $t = ix$ in the above integral formally and do some manipulation we get

$$iu = 2 \int_0^{is} \frac{dx}{\sqrt{1 + 2(1 - 2k'^2)x^2 + x^4}}$$

Elliptic Functions With Complex Arguemen

Walter Gautschi

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 Elliptic Functions for Complex Arguments Henry E. Fettis,James C. Caslin,1967 **Elliptic Functions with Complex Arguments** Francis Martin Henderson,1960 **Elliptic Functions with Complex Arguments** ,1960

 Elliptic Functions for Complex Arguments Henry E. Fettis,1967 The Jacobian elliptic functions sn w cn w dn w are tabulated to five decimals in the complex w u iv plane as functions of the nome q 005 005 4 for u K 0 1 1 and v K 0 1 1 where q e to the minus pi K K power and K and K are complete elliptic integrals with moduli k and k square root of l sq k respectively *ELLIPTIC FUNCTIONS WITH COMPLEX ARGUMENTS* F. M. HENDERSON,1957 *Lectures on the Theory of Elliptic Functions* Harris Hancock,1910 **An Atlas of Functions** Keith B. Oldham,Jan Myland,Jerome Spanier,2010-07-15 This book comprehensively covers several hundred functions or function families In chapters that progress by degree of complexity it starts with simple integer valued functions then moves on to polynomials Bessel hypergeometric and hundreds more **The Elementary Properties of the Elliptic Functions, with Examples** Alfred Cardew Dixon,1894 On the Direct Numerical Calculation of Elliptic Functions and Integrals Louis Vessot King,1924

 Handbook of Mathematical Functions Milton Abramowitz,Irene A. Stegun,1965-01-01 An extensive summary of mathematical functions that occur in physical and engineering problems **The Quarterly Journal of Pure and Applied Mathematics** ,1887 **The Mathematical-Function Computation Handbook** Nelson H.F. Beebe,2017-08-20 This highly comprehensive handbook provides a substantial advance in the computation of elementary and special functions of mathematics extending the function coverage of major programming languages well beyond their international standards including full support for decimal floating point arithmetic Written with clarity and focusing on the C language the work pays extensive attention to little understood aspects of floating point and integer arithmetic and to software portability as well as to important historical architectures It extends support to a future 256 bit floating point format offering 70 decimal digits of precision Select Topics and Features references an exceptionally useful author maintained MathCW website containing source code for the book s software compiled libraries for numerous systems pre built C compilers and other related materials offers a unique approach to covering mathematical function computation using decimal arithmetic provides extremely versatile appendices for interfaces to numerous other languages Ada C C Fortran Java and Pascal presupposes only basic familiarity with computer programming in a common language as well as early level algebra supplies a library that readily adapts for existing scripting languages with minimal effort supports both binary and decimal arithmetic in up to 10 different floating point formats covers a significant portion with highly accurate implementations of the U S National Institute of Standards and Technology s 10 year project to codify mathematical functions This highly practical text reference is an invaluable tool for advanced undergraduates recording many lessons of the intermingled history of computer hardw are and software numerical algorithms and mathematics In addition professional numerical analysts and others will find the

handbook of real interest and utility because it builds on research by the mathematical software community over the last four decades   Guide to Available Mathematical Software Ronald F. Boisvert,Sally E. Howe,David K. Kahaner,1984

Proceedings of the London Mathematical Society ,1889 Papers presented to J E Littlewood on his 80th birthday issued as 3d ser v 14 A 1965   *Quarterly Journal of Pure and Applied Mathematics* ,1886   **Mathematics of Computation 1943-1993: A Half-Century of Computational Mathematics** Walter Gautschi,1994 Proceedings of an International Conference held in Vancouver B C August 1993 to commemorate the 50th anniversary of the founding of the journal Mathematics of Computation It consisted of a Symposium on Numerical Analysis and a Minisymposium of Computational Number Theory This proceedings contains 14 invited papers including two not presented at the conference an historical essay on integer factorization and a paper on componentwise perturbation bounds in linear algebra The invited papers present surveys on the various subdisciplines covered by Mathematics of Computation in a historical perspective and in a language accessible to a wide audience The 46 contributed papers address contemporary specialized work Annotation copyright by Book News Inc Portland OR   *Elliptic Functions* Komaravolu Chandrasekharan,2012-12-06 This book has grown out of a course of lectures on elliptic functions given in German at the Swiss Federal Institute of Technology Zurich during the summer semester of 1982 Its aim is to give some idea of the theory of elliptic functions and of its close connexion with theta functions and modular functions and to show how it provides an analytic approach to the solution of some classical problems in the theory of numbers It comprises eleven chapters The first seven are function theoretic and the next four concern arithmetical applications There are Notes at the end of every chapter which contain references to the literature comments on the text and on the ramifications old and new of the problems dealt with some of them extending into cognate fields The treatment is self contained and makes no special demand on the reader s knowledge beyond the elements of complex analysis in one variable and of group theory   **Theory of Functions of a Complex Variable** Andrew Russell Forsyth,1900 This book is a collection of treaties and memoirs exploring the growing field of theory of functions   **Five Studies in Mathematics** Eric Temple Bell,Allen Fuller Carpenter,Robert Édouard Moritz,Lewis Irving Neikirk,Roy Martin Winger,1926   University of Washington Publications in Mathematics ,1926

Unveiling the Magic of Words: A Report on "**Elliptic Functions With Complex Arguemen**"

In a global defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their power to kindle emotions, provoke contemplation, and ignite transformative change is actually awe-inspiring. Enter the realm of "**Elliptic Functions With Complex Arguemen**," a mesmerizing literary masterpiece penned by way of a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve into the book is central themes, examine its distinctive writing style, and assess its profound effect on the souls of its readers.

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