MATHEMATICAL MONOGRAPHS. NO. 4. HYPERBOLIC FUNCTIONS

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JAMES MCMAHON

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Trieste

MATHEMATICAL MONOGRAPHS.

EDITED BY

MANSFIELD MERRIMAN AND ROBERT S. WOODWARD.

No. 4.

HYPERBOLIC FUNCTIONS.

BY

JAMES McMAHON,

PROFESSOR OF MATHEMATICS IN CORNELL UNIVERSITY.

FOURTH EDITION, ENLARGED.

FIRST THOUSAND.

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UNDER THE TITLE

HIGHER MATHEMATICS.

First Edition, September, 1896.
Second Edition, January, 1898.
Third Edition, August, 1900.
Fourth Edition, January, 1906.

ROBERT DRUMMOND, PRINTER, NEW YORK.

EDITORS' PREFACE.

THE volume called Higher Mathematics, the first edition of which was published in 1896, contained eleven chapters by eleven authors, each chapter being independent of the others, but all supposing the reader to have at least a mathematical training equivalent to that given in classical and engineering colleges. The publication of that volume is now discontinued and the chapters are issued in separate form. In these reissues it will generally be found that the monographs are enlarged by additional articles or appendices which either amplify the former presentation or record recent advances. This plan of publication has been arranged in order to meet the demand of teachers and the convenience of classes, but it is also thought that it may prove advantageous to readers in special lines of mathematical literature.

It is the intention of the publishers and editors to add other monographs to the series from time to time, if the call for the same seems to warrant it. Among the topics which are under consideration are those of elliptic functions, the theory of numbers, the group theory, the calculus of variations, and non-Euclidean geometry; possibly also monographs on branches of astronomy, mechanics, and mathematical physics may be included. It is the hope of the editors that this form of publication may tend to promote mathematical study and research over a wider field than that which the former volume has occupied.

December, 1905.

AUTHOR'S PREFACE.

This compendium of hyperbolic trigonometry was first published as a chapter in Merriman and Woodward's Higher Mathematics. There is reason to believe that it supplies a need, being adapted to two or three different types of readers. College students who have had elementary courses in trigonometry, analytic geometry, and differential and integral calculus, and who wish to know something of the hyperbolic trigonometry on account of its important and historic relations to each of those branches, will, it is hoped, find these relations presented in a simple and comprehensive way in the first half of the work. Readers who have some interest in imaginaries are then introduced to the more general trigonometry of the complex plane, where the circular and hyperbolic functions merge into one class of transcendents, the singly periodic functions, having either a real or a pure imaginary period. For those who also wish to view the subject in some of its practical relations, numerous applications have been selected so as to illustrate the various parts of the theory, and to show its use to the physicist and engineer, appropriate numerical tables being supplied for these purposes.

With all these things in mind, much thought has been given to the mode of approaching the subject, and to the presentation of fundamental notions, and it is hoped that some improvements are discernible. For instance, it has been customary to define the hyperbolic functions in relation to a sector of the rectangular hyperbola, and to take the initial radius of the sector coincident with the principal radius of the curve; in the present work, these and similar restrictions are discarded in the interest of analogy and generality, with a gain in symmetry and simplicity, and the functions are defined as certain characteristic ratios belonging to any sector of any hyperbola. Such definitions, in connection with the fruitful notion of correspondence of points on conics, lead to simple and general proofs of the addition-theorems, from which easily follow the conversion-formulas, the derivatives, the Maclaurin expansions, and the exponential expressions. The proofs are so arranged as to apply equally to the circular functions, regarded as the characteristic ratios belonging to any elliptic sector. For those, however, who may wish to start with the exponential expressions as the definitions of the hyperbolic functions, the appropriate order of procedure is indicated on page 25, and a direct mode of bringing such exponential definitions into geometrical relation with the hyperbolic sector is shown in the Appendix.

December, 1905.

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