

SHORTER NOTICES.

Bibliography of Quaternions and Allied Systems of Mathematics. By ALEXANDER MACFARLANE. University Press, Dublin, 1904.

THE International Catalogue of Scientific Literature places the following branches of mathematics under the head of universal algebra: (1) calculus of operations. (2) general theory of complex numbers. (3) quaternions. (4) Ausdehnungslehre and vector analysis. (5) matrices. (6) other special sorts of complex numbers. (7) algebra of logic.

The work under review contains a bibliography of topics 2, 3, 4, and 5. Titles in which vector ideas and methods are applied are also included. Although the subject of bilinear forms is not mentioned in the International Catalogue, Professor Macfarlane very properly includes certain titles in this field which deal with the theory of matrices. It is an extremely difficult matter to prepare a complete bibliography for a field as wide as Professor Macfarlane has chosen, and his approximation will be keenly appreciated, especially by those to whom large libraries are not accessible. The fields of quaternions and vector analysis seem to be carefully covered. In the allied branches of general theory of complex numbers and matrices the bibliography is not so complete, though most of the fundamental memoirs are noted. A partial list of omissions is appended, which contains among others important titles by Weierstrass, Frobenius, Molien and Dedekind.

CARTAN.

1897. "Sur les systèmes de nombres complexes." *Comptes Rendus*, page 1217.
 1897. "Sur les systèmes réels de nombres complexes." *Comptes Rendus*, page 1296.
 1898. "Les groupes bilinéaires et les systèmes de nombres complexes." *Annales de la Faculté des Sciences de Toulouse*, volume 12, page 81.

DEDEKIND.

1885. "Zur Theorie der aus n Haupteinheiten gebildeten complexen Grössen." *Göttinger Nachrichten*, page 141.

1887. "Erläuterungen zur Theorie der sogenannten allgemeinen complexen Grössen." *Göttinger Nachrichten*, page 1.

FROBENIUS.

1896. "Ueber die cogredienten Transformationen der bilinearen Formen." *Sitzungsberichte der Berliner Akademie*, page 7.

HAUSDORFF.

1900. "Zur Theorie der Systeme complexer Zahlen." *Leipziger Berichte*, page 43.

HAWKES.

1902. "Estimate of Peirce's Linear Associative Algebra." *American Journal of Mathematics*, volume 24, page 87.
 "On hypercomplex numbers." *Transactions of the American Mathematical Society*, volume 3, page 312.
 "Enumeration of non-quaternion number systems." *Mathematische Annalen*, volume 58, page 361.

HILBERT.

1896. "Zur Theorie der aus n Haupteinheiten gebildeten complexen Grössen." *Göttinger Nachrichten*, page 179.

JOLY.

1898. "The associative algebra applicable to hyperspace." *Proceedings of the Irish Academy*.

MOLIEN.

1892. "Ueber Systeme höherer complexer Zahlen." *Mathematische Annalen*, volume 41, page 83.
 1893. "Berichtigung zu dem Aufsatz: Ueber Systeme höherer complexer Zahlen." *Mathematische Annalen*, volume 42, page 308.

PIERCE.

1903. "Classification and properties of dual conical congruences." Dissertation, Zürich.

STUDY.

1890. "Ueber Systeme complexer Zahlen und ihre Anwendung in der Theorie der Transformationsgruppen." *Monatshefte für Mathematik*, page 283.

1898. "Beweis eines von Herrn Dedekind angegebenen Satzes." *Göttinger Nachrichten*, page 1.

TABER.

1892. "On a theorem of Sylvester's relating to non-degenerate matrices." *Proceedings of the American Academy*, page 46.
 "Note on the representation of orthogonal matrices." *Proceedings of the American Academy*, page 163.
1893. "On real orthogonal substitutions." *Proceedings of the American Academy*, page 212.
1894. "On the automorphic linear transformation of bilinear forms." *Proceedings of the American Academy*, page 178.
 "On orthogonal substitutions." *Bulletin of the New York Mathematical Society*, volume 3, page 251.
1897. "Notes on the theory of bilinear forms." *Bulletin of the American Mathematical Society*, volume 3, page 156.

WEIERSTRASS.

1884. "Zur Theorie der aus n Haupteinheiten gebildeten complexen Zahlen." *Göttinger Nachrichten*, page 395.

H. E. HAWKES.

An Elementary Text-book on the Differential and Integral Calculus. By WILLIAM H. ECHOLS. Professor of Mathematics in the University of Virginia. New York, Henry Holt and Company, 1902.

IN this book Professor Echols has made a commendable and, on the whole, a successful attempt to establish the principles of the differential and integral calculus with proper regard to modern ideas on the subject, pointing out carefully the limits under which the processes can be applied and giving examples of exceptional cases, such as Weierstrass's example of a continuous function which has no determinate derivative, and Pringsheim's example of a function for which Maclaurin's series is absolutely convergent and yet does not represent the function. One would like to see also, however, an example in which $\partial^2 z / \partial x \partial y$ and $\partial^2 z / \partial y \partial x$ are different — a case of peculiar interest in some of the applications.

The book is far more comprehensive than the usual text-books, and should therefore be useful for consultation by