Page 365. In formulæ (268) read $f_u = \bar{f}_u \cdot \cos^2 \alpha =$ etc.

Page 393. In the first term on the right-hand side of formula (298) in the denominator read $n_k - 1$ instead of $n_{k-1}$.

Page 414. In the second and third equations on this page, read $\Delta \dfrac{n \cdot \delta u}{u\mathbf{u}}$ instead of $\Delta \dfrac{n \cdot \delta u}{u}$.

Page 414. In the fifth equation on this page, insert a minus sign before $d_{k-1}$.

Page 439. In the second term of formula (323), read $\bar{R}_m'$ instead of $R_m'$.

Page 461. In the third formula on this page, on the right-hand side, insert a multiplication-dot before the expression in brackets.

Page 462. At the top of this page, strike out the first line, and insert in place thereof the following:

If we neglect the terms of the 3d order, the direction-cosines of the incident ray may be regarded as 1, $b/n$, $c/n$; so that the approximate equations of the incident ray $BH$ are:

Page 462. In the denominator of the fraction on the right-hand side of the equation in the 6th line read $n^2(y_h^2 + z_h^2)$ instead of $y_h^2 + z_h^2$.

Page 465. In the last expression in the last term of the first of equations (355) read $\mathbf{J}_k^3$ instead of $\mathbf{J}_k$.

Page 465. In the second of equations (355) in the first term on the right-hand side read $(\mathbf{y}_1^2 + \mathbf{z}_1^2)\mathbf{z}_1$ in place of $(\mathbf{y}_1^2 + \mathbf{z}_1^2)\mathbf{y}_1$; and after the + sign before the last term insert $\frac{1}{2}$.

Page 467. In the second of equations (357), in the numerator of the fraction in the first term on the right-hand side read $(\mathbf{y}_1^2 + \mathbf{z}_1^2)\mathbf{z}_1$ instead of $(\mathbf{y}_1^2 + \mathbf{z}_1^2)\mathbf{y}_1$.

Page 604. §122. Read Chap. I instead of Chap. II.

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# SHORTER NOTICES.

*A Treatise on the Analytic Geometry of Three Dimensions.* By GEORGE SALMON, late Provost of Trinity College, Dublin. Fifth edition, revised by R. A. P. ROGERS, Fellow of Trinity College, Dublin. Volume 1. London, Longmans, Green and Company, 1912. 8vo. xxii+470 pages, and two plates.

THE first edition of Salmon's Geometry of Three Dimensions was published in 1865. It formed the closing volume of an extensive treatise on algebraic geometry, two volumes of which were concerned with plane geometry, while the third contained a development and interpretation of the theory of linear transformations, from the standpoint of invariants, then just becoming known.

While many of the facts were known before, the point of view was a new one, and the great mass of material was successfully moulded into a systematic treatment. Extensive use was made of various chapters of algebra, but the algebraic processes are always kept in the background, and a full explanation of the geometric meaning of every step was given.

Many of the foundations are not carefully laid, and a somewhat curious mixture of rigorous logic and of appeal to the intuition are found side by side. One great difficulty in the choice of material was happily overcome by the author by assuming that the reader was familiar with the contents of each of the earlier volumes of the treatise. In this way considerable use could be made of determinants, linear transformations, projective systems, and invariants by presupposing theorems stated elsewhere. A student who has approached the subject through these preparatory steps will have but little difficulty in following the argument.

These books have been translated into many of the languages of Europe, and have run through several editions. In the meantime more comprehensive treatises on the subject matter of any one of the parts taken separately have appeared, and new contributions have greatly extended the boundaries, yet for a general orientation into the field of analytic geometry these volumes have remained the standard work, and have also served as a model of style and of presentation to most writers on geometry. The second edition appeared in 1869, the main additions being a consideration of Clebsch's researches on algebraic curves, and of Cayley's contributions to the theory of ruled surfaces. The third edition followed five years later (1874), having been prepared with the assistance of Professor Cayley. Two innovations in this edition are the introduction of the Plücker line coordinates and the Gauss coordinates of points on a surface; the appendix on quaternions, which appeared in the preceding edition, was omitted. The fourth edition was issued in 1882, under the supervision of Mr. Cathcart. Professor Salmon had in the meantime almost entirely withdrawn from mathematics. Since 1866 he had been Regius professor of divinity in Trinity College, Dublin, and the duties of his new office left him less and less leisure to continue his earlier studies in geometry. The fourth edition contains fewer changes than the preceding ones, scarcely taking into account the advances that had been made on the continent during the eight years since the last preceding one was published.

Counting the translations, the volume on three dimensions has run through fourteen editions, the preparation of which has been participated in by a dozen different persons.

Under these circumstances, it is a significant fact that thirty years after the last English edition appeared, in a time of unprecedented activity in cultivating new territory in geometry, and of compiling systematic treatises on the same general plan, it is still felt that a new edition can be best presented by preserving all the characteristic features of the preceding ones, only adding such material as is necessary to have the development conform to the present point of view.

In November, 1910, the Board of Trinity College, Dublin, authorized the preparation of a fifth edition along these lines, and appointed Mr. Rogers, Fellow, to undertake the task. In order to accomplish this purpose the size of the large volume had to be still further increased, and it was decided to divide it into two. The present volume contains the first 12 chapters, and the number of pages of subject matter has increased from 382 to 455; it also contains two photographic plates of models of quadric surfaces.

The first two chapters contain no essential changes. The concept of surface is introduced as the totality of triads of numbers which satisfy one given equation. A curve is defined as the totality of triads satisfying two. It is stated that three surfaces meet in a finite number of points, no mention being made in this place of those surfaces which have a partial intersection in common, but attention is called to the fact that algebraic equations are to be understood.

The transition from rectangular to tetrahedral coordinates is still hopelessly abrupt; a few sentences inserted from time to time have made the new presentation more logical, but have scarcely lessened the difficulty.

An article is added at the end of Chapter V, expressing the analytic classification of quadrics in terms of invariants, but it is not complete; a number of assumptions are made, only part of which are explicitly mentioned.

In Chapter VII a few explanatory sentences are introduced, which make the discussion less abrupt; the idea of projectivity is made more prominent, and treated more systematically. At the end of the chapter two articles are added, one on projective coordinates, collineations, and reciprocation, and the other on the projective theory of distance and angle. In the former, any tetrahedron and any unit point are shown to fix a system, and the coordinates are interpreted as anharmonic ratios, thus justifying the name projective coordinates. Projection is defined as a (1, 1) correspondence between the elements of any two entities, when the correspondence is defined by a system of linear equations with a non-vanishing determinant. In the second added article the projective theory of distance and angle are treated, thus justifying the earlier classification of quadrics. The discussion is also outlined for non-euclidean space, but the treatment is so brief that it can hardly be of assistance to the reader.

The chapter on confocal quadrics contains three added notes which connect the theory of confocal surfaces with that of poles and polars with regard to the absolute circle, and a number of proofs are simplified by means of duality. Use is made of the contents of these articles when discussing invariants and covariants of a system of quadrics. No other changes are made in this later chapter.

In the first part of the chapter on curves and developables, a considerable number of problems on curves defined by parametric equations, mostly concerning curves of order 3 or 4, is added. This excellent treatment of the projective properties of algebraic curves, the extension of Plücker's numbers to space curves, and the illustrations by means of curves of orders 3 and 4 is still standard, forty years after its first appearance.

In the second part of this chapter the Codazzi formulas and the Frenet formulas have been added, and Staude's construction of confocal quadrics is treated in fairly full outline.

This volume is provided with an index of subject matter and with a list of authors cited.

VIRGIL SNYDER.

*Oeuvres de Charles Hermite.* Publiées sous les auspices de l'Académie des Sciences par EMILE PICARD. Vol. III. Paris, Gauthier-Villars, 1912. 8vo. 522 pp.

A REVIEW of the first two volumes of Hermite's works has been given in volume 13, pages 182–190, and volume 16, pages 370–377 of this BULLETIN. The thirty-nine memoirs which make up the present volume belong to the years 1872–1880. A fourth volume will contain the remaining papers and bring the work to a close.