on general mechanics has already reached its fourth edition. The second and third editions were issued under the superintendence of the author. Dr. Wien has had the advantage of the author's manuscript notes, found after his death, in preparing the volume for the fourth edition. No changes have, however, been made beyond the correction of printer's errors and the removal of slight obscurities. One of the best testimonies that we can give to the care and ability which Kirchhoff devoted to the original volume is to say that those who possess any one of the first three issues will not find it necessary to buy this last edition.

ERNEST W. BROWN.

Leçons élémentaires sur la théorie des formes et ses applications géometriques, a l'usage des candidats a l'agregation des sciences mathematiques. Par H. ANDOYER. Paris, Gauthier-Villars et Fils, 1898. 4to, 184 pp. Lithographed.

THIS title represents accurately the contents of the book. A restricted list of topics is adequately treated. Geometrical applications are plentiful but do not encroach upon nor obscure the purely algebraic theory. The treatment is perhaps elementary, but in style simplicity is less noticeable than brevity. The work as a whole is more nearly a syllabus than a textbook for the beginner, and as a syllabus it cannot fail to become widely known and valued.

Binary and ternary forms are introduced, but of binary forms only linear, bilinear, quadric, cubic, and quartic forms are discussed; and of ternary, only linear, bilinear, and quadric. The bilinear ternary form in cogredient variables I do not remember having seen in any earlier text, although Salmon's Higher plane curves gives a brief geometrical discussion of skew reciprocity; its inclusion here together with the form bilinear in contragredient variables must be commended by geometricians. Duality as a method stands certainly on a par with projectivity.

Two points of excellence are worthy of special mention. The first is that from the outset stem forms are assumed to contain several sets of variables; and this convention is observed in the case of each particular form, an unlimited number of sets of cogredient variables being adjoined. Of course this amplifies the complete system of each stem form, but the extension is easy, since no new types occur. The second novel merit is that the term *polar* is so defined as to include such operations as Aronhold's. If so-called variables are replaced by cogredient variables, the process is ordinarily called a polar operation, and M. Andoyer sees no reason why a different term should be needed when coefficients are replaced by cogrédient coefficients. The reason why the operation is invariant is the same in both cases. As illustrating the degree of elegance attained by M. Andoyer may be cited from § 3, Chapter I, the proof (susceptible of improvement, though not of simplification in form) that absolute invariants exist; and the entire § 2 of chapter III, which sets forth the relation of a homography to a binary bilinear form.

In a text prepared especially to emphasize geometrical applications, the purely algebraic side of any problem is naturally of only secondary importance. Here the student learns to think of invariance as based on reasons rather than on specific normal forms; it is not important for the beginner to reduce the canonizant, for example, to typical form, and it is important to see clearly that every eliminant of a set of equations must be an invariant, regardless of the notation used to express it. This principle leads to a preponderance of reasoning over reckoning, and the postponement of purely algebraic problems. While complete form systems are given for each special stem form, Gordan's theorem is simply stated without proof. Nor is there any mention of Hilbert's theorems (though on p. 101 it is stated that "Le théorem de Gordan subsiste dans le domaine ternaire,") nor of the enumeration problems solved by Sylvester and Deruyts. This marks the elementary character of the work, and leaves much to be looked for from the larger compend which, the preface tells us, the author has had in preparation already for some years.

HENRY S. WHITE.

Sur les lois de réciprocité. Par X. STOUFF, professeur à la Faculté des Sciences de Besançon. Paris, Hermann, 1898. 8vo, 31 pp.

THE laws of reciprocity have been the object of numerous mathematical researches, the chief of which are the memoirs of Jacobi, Eisenstein, and Kummer in *Crelle's Journal.* Stouff proposes to apply n-dimensional geometry to the subject following the examples of Minkowski's geometry of numbers.* At bottom the question of the laws of reciprocity appears to have a natural and close connection with the fuchsian polygons of Poincaré generalized for space of any number of dimensions. The intervention of these polygons appears implicitly in Gauss's memoir on biquad-

* Minkowski, Geometrie der Zahlen, Leipzig, Teubner, 1896.