groups or 'areas', and a junior engineer has charge over each group. A group is divided into 'districts', each of which is under the charge of two attendants, who work in two shifts—one from 7 A.M. to 3 P.M., and the other from 3 P.M. to 11 P.M. The morning period is best for shutting down the plant for cleaning purposes. During the evening shift the attendant visits each sub-station in turn, carefully inspecting it, and at the right times switching on the apparatus required for the peak load demand. Special care has to be exercised, for there is much greater risk of something going wrong than in a manually operated station. Cleanliness of the station plant is of vital importance, and the attendant is responsible for seeing that labourers allotted to him run no risks. Automatic control can now be supplied to almost every type of converting and transforming plant, and hence considerable economies are effected by saving operators' wages.

Pure Mathematics.

- (1) *A Course of Pure Mathematics*. By Prof. G. H. Hardy. Fifth edition. Pp. xii + 455. (Cambridge: At the University Press, 1928.) 12s. 6d. net.
- (2) *The Elementary Differential Geometry of Plane Curves*. By R. H. Fowler. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 20.) Second edition. Pp. ix + 105. (Cambridge: At the University Press, 1929.) 6s. net.
- (3) *An Elementary Treatise on Differential Equations and their Applications*. By Prof. H. T. H. Piaggio. (Bell's Mathematical Series: Advanced Section.) Pp. xviii + 256 + xxvii. (London: G. Bell and Sons, Ltd., 1928.) 12s. net.

THE technical use of the term 'limit' in mathematics retains much of the original meaning of the Latin *limes*, a boundary line, from which it is derived. The notion of limit is also a boundary in another sense, for it marks the frontier between elementary and higher mathematics, where the adjectives must not be taken as necessarily synonymous with easy and difficult. The student who arrives at this frontier has before him an important choice of routes. One route leads to an introduction of limits by an appeal to geometrical intuition by means of which, if the illustrations are judiciously chosen and if the language is sufficiently vague, most of the theorems of the calculus can be deduced with a generality which is almost embarrassing. Advance by this route may seem to be

rapid, but the cost is a mistrust of mathematical processes which appear to lead to paradoxical results. The other route proceeds to a somewhat longer but rigorous building of foundations on a secure arithmetical basis. The start may be fairly arduous but the reward is a feeling of security founded on understanding. That there is an increasing tendency to realise the value of the more rigorous treatment of foundations is evidenced by the above three books, for (1) is in its fifth edition, while (2) and (3) are in their second.

(1) No introduction to the theory of functions of a real variable can dispense with a discussion of the domain of that variable—the real numbers of the arithmetic continuum. Prof. Hardy leads the student by easy stages through the concept of real number to functions of a continuous variable and so to the differential and integral calculus. Illustrations are freely given and a wide selection of examples. The book is interesting to read and places the elements of the subject on a secure basis for further advance. An appendix to the new edition explains the symbols O , o , $\sim$.

(2) A rigorous treatment of elementary plane differential geometry (curvature, contact, envelopes, singular points, asymptotes), with occasional excursions into three dimensions. It is a pity that Mr. Fowler did not incorporate Neville's revised theory of envelopes which is based on a new definition of characteristic points, the scope of which is indicated in the preface. It would have been kinder to include definitions of symbols such as O and $\sim$, instead of referring the reader elsewhere. The value of this book lies in giving a treatment of geometry in English on the lines of several French works, for example, Goursat's "Cours d'analyse".

(3) This is a really good book, which should appeal to all who embark on the study of ordinary and partial differential equations. The mathematical equipment demanded is not extensive and the subject is treated in a sane and exact manner, with copious illustrations. The chapters on numerical approximation and integration in series are very well written. The examples, which are numerous, contain many important results. In the new edition, a long chapter has been added, introducing among other things a brief note on Schrödinger's wave equation and some recent work of Remes on numerical approximation.

These three books together form a most suitable introductory course on the analytical side of pure mathematics.

L. M. MILNE-THOMSON.