Applying Rolle's theorem to the first of these formulæ we see that between two consecutive positive (or negative) roots of $J_n(x)$ lies at least one root of $J_{n+1}(x)$; and from the second we see in the same way that between two successive positive (or negative) roots of $J_{n+1}(x)$ lies at least one root of $J_n(x)$. Thus the theorem is proved.

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SHORTER NOTICES.

Introductory Course in Differential Equations for Students in Classical and Engineering Colleges. By D. A. MURRAY, PH.D., Instructor in Mathematics in Cornell University. New York, Longmans, Green, and Co., 1897. Small 8vo, pp. xv+234.

It is the aim of this work as announced in its preface, "to give a brief exposition of some of the devices employed in solving differential equations." As is becoming in a book of elementary character written with this practical end in view, no attempt is made to develop the general theory of differential equations. At the same time, the discussion of the more important cases of "solvable" equations is adequate, and the appended notes contain among other points of theoretical interest a demonstration of the "existence theorem,"—a novel feature in a treatise on differential equations, written in English.

On the whole, the book seems to be an excellent practical introduction to differential equations, containing a well proportioned and suitable treatment of most of the topics which the student needs in his first course in the subject, and of these only, a good variety of exercises, and enough historical and bibliographical notes to suggest further reading.

On the other hand it must be said that the style is not especially attractive and that certain of the discussions are not wholly satisfactory. It will suffice to cite the sections on the symbolic treatment of the linear equation with constant coefficients, which would be clearer were it shown at the outset that the operator D as there involved obeys the fundamental laws of algebra; the chapter on singular solutions, in which it is not noticed that the p-discriminant is in the general case not a singular solution but a locus of cusps; and the demonstration in note H that the necessary condition of integrability of $Pdx + Qdy + Rdz = 0$ is also sufficient.

It is unfortunate, by the way, that Boole's simple and direct demonstration of this last theorem (Differential Equations, p. 276) should not have been reproduced in the more recent text-books of the subject.

H. B. FINE.

Elements of Theoretical Physics. By DR. C. CHRISTIANSEN, Professor of Physics in the University of Copenhagen. Translated into English by W. F. MAGIE, PH.D., Professor of Physics in Princeton University. London, Macmillan and Co.; New York, The Macmillan Company; 1897. 8vo, pp. xii + 339. Price, $3.25.

This work by Professor Christiansen aims to give, within the limits of a single octavo volume, a survey of the whole field of mathematical physics. We realize, with the translator, that there is need of a book which will enable us to get a bird's-eye view, as it were, of the whole subject, showing the interrelations of its various branches, and using a consistent notation. The task set himself by the author in attempting to condense his survey into such a narrow compass is a most difficult one and, bearing that in mind, the measure of success which he has achieved is very gratifying. It is doubtful, however, whether in this country there is any considerable body of readers to whom this book will be of much use. It is not sufficiently comprehensive to be used as a reference book by one who has worked much in the subject, and it is too condensed and too barren of illustration and detail to be consulted with profit by the beginner.

Professor Christiansen makes no pretence of giving the various theorems in their most general form, but deals with a great many special examples and problems, and always with those of great practical importance. For example, there is no general treatment of sound, but the vibration of strings is discussed as an example of elasticity. In the chapter on thermodynamics we find Planck's equations, and the following section is given up to a discussion of their application to the subject of dissociation; but that is all we find on thermodynamic potential. The first chapter, "General theory of motion," is by far the best in the book, and can be recommended to any one wishing a digest of that subject.

This volume cannot but suffer from a comparison with Voigt's two volumes upon the same subject which appeared somewhat later. Although Voigt's aim is that of Christiansen, he has succeeded where the latter has failed, mainly,