independence proof for the continuum hypothesis, which shows clearly that toposes are usefully considered to be "Heyting-valued models" of set theory; and finally, there is an appendix on Penon's locally internal categories.

The book is throughout clear and precise, with an interesting historical introduction and plenty of helpful remarks and illustrations. Further developments are indicated in over a hundred exercises, and there are excellent bibliographies (usefully including references to Mathematical Reviews) and indices of definitions, notations and names. And just as the significance of the subject is as an attitude rather than as a technique, so the importance of the book is not as an assembly of original or unpublished ideas in topos theory but as a coherent account, essential reading for any topos theorist wishing to understand and master his subject, and an excellent introduction for everyone else; it is not likely to be superseded by a better work for some years. I regret the shortage, occasionally, of examples to bring the theory down to earth—for example, of object classifiers, or of coherent toposes; and of applications of results such as Barr's theorem; the inexperienced reader will probably find the exercises rather hard. But on balance I am very happy with the level of treatment: it would be hard, in a more leisurely introduction, to give such a good idea of the scope, depth, and interest of this increasingly important subject.

R. DYCKHOFF

JORDAN, D. W. and SMITH, P., *Nonlinear Ordinary Differential Equations* (Oxford Applied Mathematics and Computing Series), 360 pp, £12·00 (hard cover).

The aim of this book is to provide an undergraduate text dealing with the techniques used to obtain exact or approximate solutions of ordinary differential equations. This topic is excellently motivated, wherever possible, by elementary dynamical situations giving a physical background to the mathematical theory. The reader is then left with a clear intuitive picture of what would otherwise be a purely abstract concept.

The book starts with the conventional phase plane analysis and then spends several chapters on perturbation methods. This extensive study covers the various techniques of singular perturbation theory, averaging, forced oscillations, harmonic and subharmonic response and differential equations with periodic coefficients. The book also covers Liapunov stability and has a section on existence of periodic solutions. A large number of these topics would not be out of place in a postgraduate course. However the authors have skilfully managed to introduce everything at an elementary level so that no final year undergraduate student should feel that the underlying principles are beyond him. This does not imply that the authors deal lightly with such topics—on the contrary, one is led through quite complicated mathematical detail with expert care. The text is also backed up by very good figures and many illustrative and instructive examples, some worked and some left as exercises. These have clearly been culled from many years of searching for new questions to complement the course of lectures from which the book has been developed.

The book is mainly methods oriented, the aim being to explain the mathematics behind the various techniques involved. This it does very well. It also covers some theorems regarding existence and uniqueness which is in any case rather limited in this sphere of mathematics. It does not however deal with some of the more difficult aspects—for example, error estimation for the various approximations. Some of these aspects have been covered in great detail by other authors and are probably best left out of a book of this nature.

J. G. BYATT-SMITH

PETRICH, MARIO, *Lectures in Semigroups* (Wiley, 1977), 164 pp.

If this text were handed to me without the author's name I should have had no difficulty in guessing correctly who had written it. The style is unmistakeable. To coin a new adjective, it is truly "petrich": minimally encyclopaedic (which, alas, naturally implies the adjective "dreich"). It is most certainly not an elementary text and reading it is not an easy task, the wealth of material that it contains rendering it difficult to digest quickly. Nevertheless, it will be enjoyed by a happy, albeit small, group of readers; for a considerable amount of material of Eastern European and Russian origin is presented here in English for the first time. The first chapter is introductory and the author begins Chapter II with the notion of a band (a semigroup in which $x^2 = x$ for all x).

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