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Partial differential equations: theory and technique, George F. Carrier and Carl E. Pearson, Academic Press, New York, San Francisco, London, 1976, ix + 320 pp., $16.50.

In the introduction to his lecture notes on *Methods of mathematical physics*, K. O. Friedrichs observes that most of the fundamental problems of analysis have their origins in physics and that, of these problems, a high percentage are concerned with differential equations. As he points out, the fundamental laws on which problems in the sciences are based are formulated in terms of partial differential equations, which express relations between physical quantities in arbitrarily small neighborhoods of points in space and time. It is the task of the mathematician to deduce from the relations in the small a picture of the phenomenon in the large. A book on partial differential equations will always deal with some aspects of this broad picture. The portions of the picture which are presented and the fineness of focus on specific areas will depend on the tastes of the author and on the clientele toward which the book is aimed.

As in most areas of mathematics the precise boundaries of the subject of partial differential equations are impossible to define. The subject spills over into almost all other fields of mathematics and the tools from many other areas of mathematics are now widely used in partial differential equations. This was not always the case. In the early part of this century the subject was much more precisely defined and much more closely related to physics. The field itself is, of course, a very old one, and the first systematic treatments of the subject date back almost a century. The impact of the books of Riemann, Weber, Frank and von Mises, Courant and Hilbert, Webster and others is mentioned in Gårding's review of the book of E. T. Copson, Bull. Amer. Math. Soc. **82** (1976), 521–523.

The subject of partial differential equations is now so broad that a comprehensive treatment of the subject is impossible. Because the author can include only a small portion of the subject in a book, and because authors' tastes differ, texts on partial differential equations vary considerably in content, style, focus and level. There are books which are aimed at the users of mathematics and those intended for students and researchers in mathematics. Some are written in modern terminology making use of the tools of modern analysis, while others are done in the more classical style, often with a more physically motivated approach.

Those books intended for the users of mathematics usually concentrate on methods of solving or approximating the types of problems which arise from classical physics. Some will devote little if any attention to questions of existence and regularity of solution. At the other extreme is the book on partial differential equations which concentrates almost exclusively on the questions of existence and uniqueness of solution (in the appropriate space dictated by the equation, the data, and the geometry), and to the study of regularity and other qualitative properties of the solution. The problem is regarded as solved once one has proved that the problem is well posed. Such books may ignore completely the connections with–and interpretations in–other disciplines. Most textbooks in partial differential equations fall somewhere between these two extremes, and this considerable variety in content and style in books on partial differential equations is certainly desirable.

The book of Carrier and Pearson is clearly intended for the users of mathematics, and specific examples are drawn principally from classical physics and from the authors' own areas of research, i.e., fluid and gas dynamics. The avowed aim of the book is the development of perspective and acquisition of practical technique. It presents more or less classical results, making no use of the tools of modern analysis; however, it does include quite a lot of material not usually included in a text at this level. The mathematics is within the reach of an advanced mathematics undergraduate, but today's mathematics undergraduate is not likely to have the knowledge of special functions, continuum mechanics, etc. needed to fully appreciate the applications. A number of interesting problems appear at the ends of the chapters, and the authors claim that the reader who evades the problems will miss 72% of the value of the book.

The problems treated in this text, as in the case of most books on partial differential equations, fall into the special category of well-posed problems. As pointed out by John in the book of Bers, John and Schechter, well-posed problems by no means exhaust the subject of partial differential equations. He observes that one may think of the solution of a well-posed problem as predicating the outcome of an experiment for a given arrangement of apparatus. The determination of what arrangement will produce a desired effect or what arrangement led to certain observed effects will correspond in general to a much more difficult mathematical problem, a problem that may not be well posed. In partial differential equations one may in fact not know, for a given equation, what classes of initial and/or boundary value problems are well posed, i.e., he may not know what apparatus to use.

A substantial percentage of interesting and important physical problems must of necessity be modeled as improperly posed mathematical problems, but since improperly posed problems can rarely be handled by standard analytical methods, such problems are largely ignored in books on partial differential equations.

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Topological transformation groups 1: *A categorical approach*, J. de Vries, Mathematical Centre Tracts, no. 65, Mathematisch Centrum, Amsterdam, 1975, v + 249 pp.

In this review, I will rapidly trace some stability concepts from their physical origins, along a path of increasing abstraction, into varieties of compact transformation groups. Much of the work already done (including de Vries' book) represents secondary technical research for which the primary investigations are still wanting.

I wish to thank Murray Eisenberg for helpful criticism and for the Markus and Palis references.

1. From differential equations to continuous flows. A 'nice' autonomous differential equation

$$\dot{x} = f(x), \qquad x \in X \subset \mathbf{R}^n,$$

admits unique solutions $\pi(x, t)$ with $\pi(x, 0) = x$, which are global in the sense that π is defined on $X \times \mathbf{R}$. If we refer only to the facts that X is a topological space and that $\pi: X \times \mathbf{R} \to X$ is a continuous action on X by the topological group $\mathbf{R}$ of reals, we may still discuss some of the qualitative dynamical properties of the system. This is where 'topological dynamics' comes from.