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BOOK REVIEWS

S. KAKAÇ and Y. YENER, **Heat Conduction**. Middle East Technical University, Ankara (1979). 431 pp.

THIS BOOK by S. Kakaç and Y. Yener is based on a special series of lectures on heat conduction theory which has been read for the last fifteen years to the students of Mechanical Engineering Department of the Middle East Technical University in Ankara. It contains 9 chapters and 4 appendices.

The first chapter deals with the basic concepts and laws of the heat transfer theory. Chapter 2 is devoted to derivation of the heat conduction equation, statement of the initial and boundary conditions. The third chapter contains the solution of one-dimensional stationary heat conduction problems for differently shaped bodies with and without internal heat sources; it also considers in detail the finned heat transfer surfaces. Chapter 4 describes the mathematical apparatus required for the solution of heat conduction problems: orthogonal functions, Fourier series, integral transforms. Chapters 5 and 6 are devoted to the solution of stationary and non-stationary one-dimensional and spatial and heat conduction problems by separation of the variables. Chapter 7 describes the methods of integral Fourier and Hankel transformations, while Chapter 8, the Laplace transformation method. Finally, Chapter 9 is devoted to the solution of heat conduction problems by numerical methods. In particular, the network methods for the solution of boundary-value problems of heat conduction theory are covered here to a quite satisfactory extent for a textbook.

The advantage of the book is the large number of examples showing the solution of applied engineering problems. Moreover, the end of each chapter is furnished with problems that permit a better assimilation of the theory and serve to illustrate its application in engineering practice.

Unfortunately, the book lacks an important class of problems in the heat conduction theory such as the problems with moving boundaries, as well as the method of sources and sinks which is used to solve the problems with unsteady state temperatures.

A. B. BARTMAN
V. G. LEITSINA
N. V. PAVLYUKEVICH

M. N. OŽIŞIK, **Heat Conduction**, John Wiley, New York (1980). 687 pp.

THE PRAGMATISM of the present-day scientific and technological concepts is best evidenced by an astounding expansion of the heat conduction theory methods in most diversified problems of technology and engineering physics. The simplicity of the fundamental principle, a readily comprehensible mathematical formalism and its computational advantages have made thermal calculations an attractive tool for carrying out investigations in a wide gamut of sciences — from microbiology to the physics of fusion plasmas. And as a natural consequence of evolution of the universal role of thermophysics one witnesses changes in the bank of publications in the heat conduction theory. Among new contributions promising reasonable dividends is the monograph *Heat Conduction* by M. N. Ožişik.

The monograph combines the qualities of a good textbook for students, postgraduates and young investigators, a convenient handbook for specialists willing to modify the mathematical tools they use and, finally, a certain historical review of the works which have been carried out since publication of the well known monographs by H. S. Carslaw and J. C. Jeager, and A. V. Luikov.

The structure of the book is consistent in basic outline, with the equilibrium set up between the methods which are used for the solution of heat conduction problems. Almost half of the book (7 out of 15 chapters) is devoted to the classical heat conduction methods (separation of the variables, Duhamel theorem, Green's function, Laplace technique for non-stationary problems). Compared to the monographs by H. S. Carslaw/J. C. Jeager and A. V. Luikov, an experienced reader will spot hardly any substantially new results here, but will find pleasure in looking over the material compiled with great pedagogical skill. We would recommend this part of the book, supplied, by the way, with first-class illustrations and useful problems, as an excellent textbook for beginners.

It might be as well to point out a distinctive attribute of these chapters. A survey of the large number of publications in the field of heat conduction clearly reveals either the pressure of the classical books of H. S. Carslaw/J. C. Jeager and A. V. Luikov or an extreme 'thermal voluntarism'. In this respect, the book by M. N. Ožişik advocates a different style, which dates back to the classical works on general mathematical methods of theoretical physics, i.e. the style of the well known monograph by P. M. Morse and H. Feshbach *Methods of Theoretical Physics*. This shows up very clearly in the chapters on separation of variables, but is also perceptible throughout the whole book. Such specific restoration of the heat conduction theory in the 'abode of physics' is only welcome. Although 'thermal modelling' is a relatively independent outcome of manifold branches of science and technology, its genesis owes much to the methodological concepts of physics. Only abiding by this standpoint, one can avoid *a priori* mistakes and, in harmony with the perspective trends on physics, develop the studies on heat conduction.

Chapters 8–15 deal with the current achievements of the theory (the simplest models of transport in composite media, approximate and non-linear methods, transport with a change of phase, anisotropic media, etc.). The content of these chapters is valuable for a very clear presentation of new fundamental possibilities in heat conduction problems. Primarily, this is transference in anisotropic media, which is set out in Ch. 15 in such a non-trivial form that deserves the keenest attention. This chapter will introduce the reader to new and interesting aspects of a very important and difficult problem.

In Ch. 8 the reader will find a very economical treatment of the technique of generalized orthogonal expansions for the analysis of heat conduction in composite media. And whilst the author confines his attention to a one-dimensional problem, the mathematics of the chapter contains the required methodological apparatus which can be successfully applied in more complex situations. It should be noted in general that what is attractive about this book is that the author does not 'overload the ship' and in each section considers simple, but principal and most important, aspects of mathematical methods providing the reader with a working knowledge of the subject.

A tribute to the engineering methods of studying the thermal physics problems is paid in Ch. 9 devoted to approximate analytical methods. We are not sure that this area will see any outstanding achievements in the nearest future and therefore approve of the author who prepares the reader of this chapter to a thorough assimilation of all which has been done by the classics as well as of the current literature authors.

A number of subsequent chapters invite some critical comments. Thus, Ch. 10, notable for the largest list of references cited, ignores the Soviet publications and, in the first place, the works by B. Ya. Lyubov and G. A. Grinberg which are of fundamental importance for the problems with phase changes. This chapter, exclusive of Lyubov's equations for the interface coordinate (B. Ya. Lyubov *Theory of Crystallization in Large Volumes*. Nauka Press, 1975) or Grinberg's relations for asymmetric cases of the Stefan problem (*J. Engng Phys.*, 1974), lacks comprehensiveness.

In Ch. 11 on non-linear problems, the author, in addition to a traditional coverage of the Boltzmann–Kirchhoff-type approaches, similarity etc., has made an interesting attempt to call attention to the analysis of non-linear boundary conditions (radiation of boundary surfaces), but has not cited the available methods of solution of the non-linear integral equation (11-109), for example, the works by American authors, J. B. Keller, R. A. Handelsmann, W. E. Olmstead, and analogous Soviet works by A. B. Bartman and T. L. Perelman (*Proc. Int. Heat Transf. Conf., Versailles*, 1970; *Tokyo*, 1974) (see also I. J. Kumar, *Proc. R. Soc.*, 1971) on asymptotic solution of this and similar type of equations in the theory of transport.

An otherwise very useful Ch. 12 on numerical methods of solution unfortunately does not contain references to the well known works of A. N. Tikhonov, A. A. Samarsky and their disciples who have largely contributed to the development of the difference methods for solving the complex linear and non-linear heat conduction problems. First of all this relates to A. N. Tikhonov and A. A. Samarsky's well known course of lectures *Equations of Mathematical Physics*, which contains some non-traditional approaches to the heat conduction problems.

Chapters 13 and 14 are an excellent essay on the general technique and special applications of general integral transforms with a perfect selection of problems. We wish only to note that in the Soviet Union the Sturm–Liouville-type expansions at the final interval have been generalized in the works by G. A. Grinberg in 1940's and are referred to as the 'Grinberg methods' (see G. A. Grinberg *Selected Problems of Electric and Magnetic Phenomena*, Izd. Akad. Nauk SSSR, 1948 or A. S. Galitsyn and A. N. Zhukovsky *Integral Transforms and Special Functions in Heat Conduction Problems*, Naukova Dumka Press, Kiev, 1977).

The book ends with Ch. 15, which has already been praised above, and with several appendices having practical importance.

In concluding this review, we wish to emphasize that the author has written a timely and up-to-date book on the fundamentals of heat conduction theory.

O. G. Martynenko
R. I. Soloukhin