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BOOK REVIEW

Analytical Methods for Heat Transfer and Fluid Flow. By B. Weigand. Springer, 2004. 258 pp. ISBN 3 540 22247 2. £54.

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The intention of the author of this modest little book is to provide a guide for analytic methods for the solution of heat transfer problems. Explicitly, 'the main intent of this book is to show the usefulness of analytical methods, in a world, which focuses more and more on numerical methods' (the punctuation is that of the author). This might sound like an introduction to a high level perturbation methods book, but in fact the text is aimed at engineers, and engages with its subject at an elementary level, appropriate to first or second year undergraduates.

The book consists of six chapters comprising some 200 pages, together with four appendices of a further 45 pages. A list of symbols is provided at the start, some 200 references are cited, and there is a shortish index. Five or six problems are given at the end of each chapter.

The first chapter is a very brief introduction, setting the scene with the analytic solution of the heat conduction equation for the annual variation of the soil temperature profile. The second chapter is basic undergraduate material on the classification of second order partial differential equations, and the method of separation of variables. Chapter 3 addresses the engineering problem of the determination of wall heat flux for turbulent flow in a heated pipe or channel. The model is the advective-diffusive heat equation, but with a velocity which is determined from an eddy diffusive turbulent flow model, and the thermal conductivity is also of eddy diffusive form. The equation for temperature T is thus linear, and if axial heat conduction is ignored when the Péclet number is large, separation of variables leads to a Fourier series solution in terms of eigenfunctions of an ordinary Sturm–Liouville system. This chapter therefore discusses such systems, and then applies the results to various specific problems, and includes comparison of the theoretically derived profiles of Nusselt number with axial distance down tube to experimental results.

Chapter 4 addresses the issue of computing the eigenfunctions for the higher eigenvalues, a problem which becomes of increasing numerical awkwardness. The method to use is the WKB method, but the application of the method is challenged by singularities at the wall and near the centreline. A modified method due to Sleicher, Notter & Crippen in 1970 is described which gives good results, and applications to several different problems are given. Chapter 5 extends the solution methods of the earlier chapters (via separation of variables and eigenfunction expansions) to problems where the Péclet number is of $O(1)$ or is small. The final chapter 6 considers the issue of nonlinearity. Here the book moves away from pipe flows and considers viscous and thermal boundary layers, and shows how to find similarity solutions for these. The first two appendices describe fully developed turbulent flow profiles in pipes. The third appendix describes numerical methods for solution of eigenvalue problems, and gives reference to a web page where Fortran codes may be found. The final appendix elaborates the methods of chapter 5.

The author intends his book for graduate students and engineers. It is not really suitable as a course text, although one might teach an engineering graduate course on heat transfer partly from it. It will mainly serve as a reference for those interested in technical heat transfer calculations. It is somewhat similar in style and scope to Levich's book *Physicochemical Hydrodynamics* (Prentice Hall, 1962) or Schlichting's book *Boundary Layer Theory* (McGraw Hill, 1960), but is much less ambitious than those two books.

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