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Book reviews

Transport Phenomena: Equations and Numerical Solutions
Estéban Saatdjian (Ed.); John Wiley & Sons Ltd., 2000, 414 pp., £ 55.00 (hardback), ISBN 0-471-62230-3

Transport phenomena is an old, but fascinating subject. Estéban Saatdjian has presented an excellent introduction in this book, which is not as theoretical as the title implies. In fact, after the introduction of the basic governing equations in Chapter 1, there are six more chapters dealing with the physical implications, empirical models and applications. The text is particularly geared towards heat transfer analysis with four chapters devoted to this topic. Classical aspects of fluid mechanics and mass transfer are introduced in two separate chapters. The text is followed by an introduction (three chapters) to numerical methods with the emphasis on solving heat transfer problems. It covers the materials in a manner that is suitable for beginners in the field: with simple examples and basic equations and difficult problems. One does not need to have a strong mathematical background to follow the equations and their derivations. The book can be used as a heat transfer text for software engineers.

Unfortunately, the majority of the text refers only to literature that is 10 or more years old. Only a couple of references in natural convection, turbulent flow and numerical methods are recent publications or conference presentations. Therefore, some of the views do not reflect the current status in the field.

Despite its lack of recent literature, the text is well written and well reflects the classical aspects of the field, especially in heat transfer. It includes a broad and thorough coverage of conduction, forced (laminar and turbulent) and natural convection, and of radiation heat transfer. In fluid mechanics, a simple and short introduction on the mass conservation equations and the momentum conservation (or Navier–Stokes) equations is presented. A couple of pages are even devoted to Darcy's law and Brinkman's equation for creeping flows in porous media. (Here a typo is found after the Brinkman's equation (1.13) on page 19 of the text: "This equation is often used when the flow rate through the porous medium is high and inertial effects are important." should read as, "*This equation (like Darcy's law) is often used when the flow rate through the porous medium is low and inertial effects are negligible.*") There is a short introduction to turbulent flows with the simple two-equation k-ϵ model. The coverage of mass transfer is weak. Nevertheless, molecular diffusion and convective mass transfer are introduced (although the sections on multi-component mixtures, simultaneous heat and mass transfer, interface mass transfer are not suitable for the introduction). Expressions for estimating the transport coefficients are also included.

The second part of the text deals with numerical methods. The classic recipes for solving heat transfer and other problems can be helpful for engineers wishing to learn numerical methods. However, reader beware! While the simple approach used to describe the methods is a strong point of the text, the theoretical background on the finite volume method appears to be weak.

The author has mixed the requirements for a conformal method (the function value, and even the fluxes, must be single valued on the control volume boundary) with the consistency/stability requirements for the numerical solution of the discrete equation. One can be assured that the resultant discrete equation from a conformal method is consistent with the original differential equation. However, a non-conformal method does not automatically imply inconsistency. A very simple example,

$$\frac{\mathrm{d}}{\mathrm{d}x}\left(\lambda\frac{\mathrm{d}T}{\mathrm{d}x}\right) + S = 0 \tag{1}$$

was used to introduce the finite volume method. The author discussed the final discrete equation in the form

$$a_\mathrm{P} T_\mathrm{P} = \sum_{i=1}^{N} a_i T_i + \bar{S}\,\Delta x \tag{2}$$

where a_i are positive coefficients resulting from the discretization of Eq. (1) and $\bar{S}$ corresponds to the value of S in Eq. (1). Based on Eqs. (1) and (2), the author seems to have generalized the following basic rules for the finite volume code (Section 10.2, p. 312):

1. The fluxes across the same face (i.e. at the interface of two adjacent finite volumes) must take the same value.
2. The coefficients a_i must all have the same sign.
3. When the source term is approximated as a linear function $\bar{S} = S_\mathrm{C} + S_\mathrm{P} T_\mathrm{P}$, the coefficient S_P must be either negative or equal to zero.

The basic rule 1 is essentially a conformity argument. Rule 2 is automatic if low-order schemes are used and one is prevented from using high-order schemes. Rule 3 is not related to rule 2 as the author thinks. When S_P is positive, it does not mean that $a_P - S_P\Delta x$ will possess a different sign than a_P. For this example, the requirement for a_P being negative is due to the numerical stability requirement when the discrete equation is to be solved using a Gauss–Seidel method.

In Section 10.6, the author presented the discretization of an advection term. Using the basic rule 2, the author ruled out the possibility of using a "central difference" scheme. Therefore, an "upwind method" must be used. However, the simple "upwind" used may not satisfy the conformity requirements as the function value may take two different values at the common interface between two adjacent finite volumes. Since the author did not discuss the conformity directly, this point is missed in the text. As the low-order ("upwind") scheme is not accurate, higher order schemes should be preferred. However, the author did not check the QUICK scheme against the rule 2, which would have readily lead to its rejection. This shows that the theory presented is not accurate. Other inconsistencies with this rule can be found elsewhere in the book.

It is not clear whether some of the data presented in the text were regenerated or taken from the literature. For example, the data in the table on the Lennard–Jones potential and collision diameter (Table D.1, p. 362) are not consistent with the trusted sources (e.g. [1]). As the table is not credited to any sources, one has no way of knowing its accuracy. Quite a few figures are poorly presented: the lines were too thick and the overall quality is not up to the standards of a normal text.

Overall, I feel the book is easy to follow. I will recommend the book to software engineers who wish to learn some fundamental aspects of transport phenomena, particularly heat transfer.

Reference

[1] E.L. Cussler, Diffusion: Mass Transfer in Fluid Systems, 2nd Edition, Cambridge University Press, Cambridge, 1997.

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Writing for Science and Engineering
Heather Silyn-Roberts, Butterworths, Heinemann, 2000, 281 pp., £14.99, paperback, ISBN 0-7506-4636-5

As you might hope from the title, I found this book very readable. It is a comprehensive "manual" of how to write every conceivable form of technical document, from e-mails to theses. As the author says, it is almost a recipe book, but that is apparently what the target readership (postgraduate students) wants. It also makes it easy to find what you are looking for and avoids a lot of padding.

After two chapters on the general structure and elements of a document, there are 11 chapters dealing with specific types of documents. The book concludes with chapters on referencing, editorial conventions, revising and proof-reading, problems of style and giving presentations to audiences of various sizes. There are appendices on SI units, grammar and style manuals.

The book is liberally sprinkled with helpful hints and checklists. I liked the suggestion early in the book for how to get over the problem of getting started. The author says just start with the section that gives you the least problems, which is why I always start writing reviews with the book title!

The chapter on "Problems of style" looks particularly useful, and includes a very illuminating section on the distorted passive. This is a construction that we are so used to seeing in technical writing that we do not pay it any attention, but when you see the example in the book, "Dropping of the slipper was carried out by Cinderella", the absurdity is clear.

I was not quite so happy with the advice a couple of pages later to "just use instinct — it usually works". We are inundated with so much poor grammar these days that I am not at all sure that instinct is reliable any more and that is exactly why we need this type of book.

I also disagree with the advice at the end of the chapter on presentations not to use "cartoons, cute pictures or clipart". As a distinguished colleague once said to me, "You can be serious without having to be solemn".

However, I was delighted to find someone else who hates the "striptease system", whereby more and more of an overhead slide is revealed by sliding a piece of paper down it. As the author says, it is unappealing and can be irritating. Slides should be designed in such a way that the whole content can be shown. My own experience is that slides revealed by this technique usually contain too much information anyway!

Appendix 3 lists a number of style manuals for specific disciplines. I was disappointed to find that, with one exception, these are all American.

I would strongly recommend this book to anyone interested in producing written documents. I would not have thought that it need be restricted to postgraduates, but would also be suitable for (senior) undergraduates and as a useful refresher for almost anyone engaged in technical writing.

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