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BOOK REVIEW

A Practical Guide to Boundary Element Methods With the Software Library BEMLIB. By C. Pozrikidis. CRC Press, 2002. 440 pp. ISBN 1584 883235. $99.95 (hardback)

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Since the term 'practical guide' could be parsed a number of different ways, it's worth noting that the author intends a pragmatic introduction to the subject of boundary element methods (BEM), for an audience of, in his words, "professionals, researchers, and students in various branches of computational science and engineering". Theory consists mostly of key integral identities and manipulations – there are no stated theorems in the text – while the algorithmic discussion is somewhat more detailed. There is a clear preference for flow-based applications, electrostatics being given a few pages in an appendix as well. For a text that starts with a section of "Frequently asked questions" in lieu of a traditional introduction, the writing is surprisingly dry, even bland.

The text is split neatly into two halves, nearly equal in length. The first part consists of seven chapters describing the integral equations, discretizations, and algorithmic details of the BEM, plus exercises of widely varying complexity. The idea is to start simple and carry a core set of principles through an increasingly complex setting. Thus, Chapter 1 is about Laplace's equation in one dimension. While it is consistent with the author's aims, I found the presence of this eight-page chapter to be a bit pedantic. In Chapter 2 the development begins in earnest with Laplace's equation in two dimensions. Here one finds spare but serviceable descriptions of Green's identities, delta and Green's functions, direct and indirect integral representations, and more advanced topics such as interfaces, corners, and hypersingular integrals. The explanations are fine as far as they go, but the fast pace leaves little room for luxuries in the exposition – for instance, the distinction between Fredholm equations of the first and second kind is never even defined, much less explained.

In Chapter 3 we first encounter the BEM, for Laplace's equation in two dimensions. There are detailed recipes for discretizing the boundary and unknown function by both low-order and high-order methods. Regular Gauss–Legendre and singular quadrature are covered. While the collocation method is preferred, the Galerkin method is presented as well. The information in this chapter is detailed enough to put actual implementations within reach.

Chapters 4 and 5 do for Laplace's equation in three dimensions what Chapters 2 and 3 did for two dimensions. The parallel structure of the text pays off well here, and there are appropriate additional topics such as axisymmetric domains. Both flat and curved triangles are covered in the geometric discretization.

Chapter 6 is devoted to complications beyond Laplace's equation: forcing terms, nonlinearity, and time dependence. Convection–diffusion problems are used throughout this chapter to illustrate methods of particular solutions, dual reciprocity, fixed point iteration, and space–time, Laplace transform, and time discretizations. Chapter 7 is devoted to viscous flow and is perhaps the book's most thorough and leisurely development of the BEM in a specific context.

The second part of the book consists of five chapters that basically serve as an annotated and illustrated manual for BEMLIB, software developed by the author and available free under the GNU lesser license. These chapters are not exactly useful as a text *per se*, but they comprise an excellent user's guide. I was unable connect to the stated URL (`bemlib.ucsd.edu`), but BEMLIB was just a couple of clicks away from another given location (`stokes.ucsd.edu`). All the code is in FORTRAN 77. The package is evidently self-contained and without library dependencies. This is convenient and portable, though homemade functions for routine tasks such as Gaussian elimination are perhaps no longer an ideal approach to teaching computational science and engineering. I also wondered why the output wasn't directly prepared for interactive visualization using (for example) MATLAB or gnuplot.

I was able to compile and run a few arbitrarily selected demos in Linux without tweaking any configuration files. (However, the free-boundary `tank_2d` module time-stepped its way into `NaN` oblivion and had to be killed.) The breadth of fully implemented applications – which, like the text, tilt strongly toward flows – is impressive, and the speed of the routines I tried is a good advertisement for the BEM in flow problems. Eventually, though, I was put in mind of Hamming's quote about insight versus numbers, as the BEMLIB demos I tried produce only the latter. Nor are there exercises in the second half of the text to suggest more thoughtful explorations.

This lapse is related to the primary disappointment of the book: it only sporadically delivers the type of real guidance that a novice might hope for. For a professional trying to learn the field, Pozrikidis' book does a capable job of explaining *what* and *how* with its concrete discussions and gritty discretization details, but one would need to look elsewhere to understand matters of *when* and *why* to use various options. This book could be a good choice for a first course in boundary element methods, but only in the hands of an instructor who was already a seasoned veteran of the field.

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