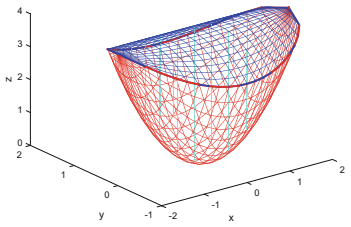
Preface



The preface of a book gives the authors their best chance to answer an extremely important question: What makes this book special?

This book is a reworking and updating for MATLAB of our previous book (joint with Kevin R. Coombes) *Multivariable Calculus with Mathematica*®, Springer, 1998. It represents our attempt to enrich and enliven the teaching of multivariable calculus and mathematical methods courses for scientists and engineers. Most books in these subjects are not substantially different from those of fifty years ago. (Well, they may include fancier graphics and omit several topics, but those are minor changes.) This book is different. We do touch on most of the classical topics; however, we have made a particular effort to illustrate each point with a significant example. More importantly, we have tried to bring fundamental physical applications—Kepler's laws, electromagnetism, fluid flow, energy estimation—back to a prominent position in the subject. From one perspective, the subject of multivariable calculus only exists because it can be applied to important problems in science.

In addition, we have included a discussion of the geometric invariants of curves and surfaces, providing, in effect, a brief introduction to differential geometry. This material provides a natural extension to the traditional syllabus.

We believe that we have succeeded in resurrecting material that used to be in the course while introducing new material. A major reason for that success is that we use the computational power of the mathematical software system MATLAB to carry a large share of the load. MATLAB is tightly integrated into every portion of this book. We use its graphical capabilities to draw pictures of curves and surfaces; we use its symbolical capabilities to compute curvature and torsion; we use its numerical capabilities to tackle problems that are well beyond the typical mundane examples of textbooks that treat the subject without using a computer. Finally, and this is something not done in any other books at this level, we give a serious yet elementary explanation of how various numerical algorithms work, and what their advantages and disadvantages are. Again, this is something that could not be accomplished without a software package such as MATLAB.

As an additional benefit from introducing MATLAB, we are able to improve students' understanding of important elements of the traditional syllabus. Our students are better able to visualize regions in the plane and in space. They develop a better feel for the geometric meaning of the gradient; for the method of steepest descent; for the orthogonality of level curves and gradient flows. Because they have tools for visualizing cross sections of solids, they are better able to find the limits of integration in multiple integrals.

To summarize, we think this book is special because, by using it:

- students obtain a better understanding of the traditional material;
- students see the deep connections between mathematics and science;
- students learn more about the intrinsic geometry of curves and surfaces;
- students acquire skill using MATLAB, a powerful piece of modern mathematical software;
- instructors can choose from a more exciting variety of problems than in standard textbooks; and
- both students and instructors are exposed to a more holistic approach to the subject—one that embraces not only algebraic/calculus-based solutions to problems, but also numerical, graphical/geometric and qualitative approaches to the subject and its problems.

Conventions

Throughout the book, MATLAB commands, such as **`solve`**, are printed in typewriter boldface. Theorems and general principles, such as: *derivatives measure change*, are printed in a slanted font. When new terms, such as *torsion*, are introduced, they are printed in an italic font. File names and URLs (web addresses) are printed in `typewriter font`. Everything else is printed in a standard font.

At the start of each chapter, below the title, is a small illustration. Each is a graphic generated by a MATLAB command. Most are taken from the MATLAB solution to one of the problems in the accompanying problem set. A few are taken from the chapter itself. Finally, in this Preface, the graphic represents a more eclectic choice. We leave it to the industrious reader to identify the source of these graphics, as well as to reproduce the figure.

Acknowledgments

We above all want to thank our former collaborators for their contributions to this project. Kevin Coombes (now at the Department of Biomedical Informatics at Ohio State University) was a co-author of *Multivariable Calculus with Mathematica*® and kindly agreed to let us adapt that book for MATLAB. Brian Hunt was a co-author of *A Guide to MATLAB* and taught us many useful MATLAB tricks and

tips. Paul Green helped develop MATLAB exercises for multivariable calculus that eventually worked their way into this book.

Jonathan Rosenberg thanks the National Science Foundation for its support under grant DMS-1607162. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

College Park, MD, USA
October 1, 2017

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http://www.springer.com/978-3-319-65069-2

Multivariable Calculus with MATLAB®
With Applications to Geometry and Physics
Lipsman, R.L.; Rosenberg, J.M.
2017, XII, 276 p. 87 illus., 86 illus. in color., Hardcover
ISBN: 978-3-319-65069-2