

# Preface

The motivation for this book was to construct a mathematics module that encouraged first-year university students to appreciate the diverse ways in which the mathematics they already knew, or were just about to learn, can impact on everyday occurrences. The applications discussed here will give students further practice in working with calculus, linear algebra, geometry, trigonometry and probability, thus supporting other modules. The chapters are largely independent of each other, and within most chapters, sections are often self-contained, giving teachers freedom in selecting topics to their taste. All in all, there is likely to be more material than would be covered in a one-semester course. Readers are assumed to have a background roughly equivalent to single-subject Mathematics at A-level in the UK.

In many degree courses, students have the opportunity, or even the obligation, to write an extended essay on a mathematical topic of their choice. They will find a range of ideas here, in the set exercises as well as the formal text, and references to more substantial accounts.

Mathematics has many applications: it is unrealistic to expect one book to do more than give a representative sample of them. My selection runs from the obviously practical, such as how to calculate mortgage repayments, or schedule nurses to cover hospital wards, to amusing ways in which mathematical ideas can give pointers to tactics in TV Game Shows, or influence the scoring systems in sporting events. We see how simple differential equations can model bacterial growth, mixing liquids, emptying baths, evaporating mothballs, and the spread of epidemics; when looking at darts, roulette and how people progress through hierarchical organisations, we use combinatorics, logic, difference equations, and calculations with matrices and vectors. The variety of voting systems in use throughout the world is inevitable, given Kenneth Arrow's "Impossibility Theorems"—that no system can be constructed that satisfies *all* among a simple list of desirable properties! Mathematics is versatile: and discovering the unusual places where it provides insights or answers is enjoyable.

When young children first use the rule for dividing by a fraction—“turn it upside down and multiply”—they seldom understand why it works. But they quickly find that the rule is easy to apply, and gives the right answer. Only much later are they able to appreciate a valid justification. Similarly with more advanced material: heuristic explanations, or worked examples, can be more enlightening than an all-encompassing general approach. Meeting and understanding a formal proof of a theorem or technique the first time you use it is not essential. But it is vital that students appreciate the necessity for formal proofs at some stage of their studies, else they will not be confident about the conditions under which particular techniques can properly be applied. One of the most vital, if unacknowledged, words in mathematics is “if”: *if* certain conditions hold, *then* some result follows. All too often, it is tempting to use that result without checking the “if” part.

Each chapter ends with a collection of exercises, which are an integral part of the book. Seeking to solve them should help students reinforce their understanding of basic principles. I do not indicate whether an exercise is expected to be routine, or quite tricky; lack of that knowledge is exactly the position mathematicians find themselves in when confronted with a problem to solve. I am happy to supply a set of Solutions to these exercises to any teacher who emails me at J.Haigh@sussex.ac.uk. (Students, please don’t pretend. The best way to learn maths is to try to solve problems from scratch, without having looked at a solution first. And if handing in my work in your name would gain you significant credit, is your degree qualification worth having?)

It is a pleasure to acknowledge the feedback from the cohorts of Sussex students who have taken a module based on much of this material, as well as the helpful comments from three anonymous referees, and the support from the Springer production team.

The Appendix contains several formulae, techniques and approximations that working mathematicians will have used so often that they are as familiar as common multiplication tables. No student will regret the time spent in committing this list to memory.

Brighton  
September 2015

John Haigh



<http://www.springer.com/978-3-319-27937-4>

Mathematics in Everyday Life

Haigh, J.

2016, IX, 159 p. 16 illus., 14 illus. in color., Softcover

ISBN: 978-3-319-27937-4