Preface

This short book gives an introduction to numerical methods for elliptic partial differential equations (PDEs). It grew out of lecture notes Martin Gander prepared for a graduate course at McGill University in 2001 and 2002 which was followed by Felix Kwok as an undergraduate student, and both later taught the course at the University of Geneva (Martin Gander in 2004, 2008, and 2015 and Felix Kwok in 2012). The material is suitable for a one-semester course given to students from mathematics, computational science, and engineering, with two hours per week of lecturing and exercises.

This book is unique in three aspects:

1. It treats the four main discretization methods for elliptic PDEs, namely, finite difference methods, finite volume methods, spectral methods, and finite element methods.

2. It contains for each of these methods a complete convergence proof in the most simplified setting in order to illustrate the main analysis techniques needed to study these methods.

3. It contains runnable codes in MATLAB which give typical compact first implementations of these methods.

This allows the material to be taught with very little preparation, and all arguments are self-contained. It is also possible to study the material independently and individually, without taking a course. The book contains also an introduction to PDEs since often graduate students from various disciplines have not had such an introduction. Following the long tradition in numerical analysis in Geneva, the book is built on the historical development of the topics and contains precise descriptions of how methods and techniques were developed, including quotes from main contributors.

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