Numerical Differential Equations:Theory and Technique, ODE Methods, Finite Differences, Finite Elements and Collocation

John Loustau

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This text presents numerical differential equations to graduate (doctoral) students. It includes the three standard approaches to numerical PDE, FDM, FEM and CM, and the two most common time stepping techniques, FDM and Runge-Kutta. We present both the numerical technique and the supporting theory.

The applied techniques include those that arise in the present literature. The supporting mathematical theory includes the general convergence theory. This material should be readily accessible to students with basic knowledge of mathematical analysis, Lebesgue measure and the basics of Hilbert spaces and Banach spaces. Nevertheless, we have made the book free standing in most respects. Most importantly, the terminology is introduced, explained and developed as needed.

The examples presented are taken from multiple vital application areas including finance, aerospace, mathematical biology and fluid mechanics. The text may be used as the basis for several distinct lecture courses or as a reference. For instance, this text will support a general applications course or an FEM course with theory and applications. The presentation of material is empirically-based as more and more is demanded of the reader as we progress through the material. By the end of the text, the level of detail is reminiscent of journal articles. Indeed, it is our intention that this material be used to launch a research career in numerical PDE.

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