

# **Maple Technology Manual**

by

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to accompany

*Differential Equations and Mathematical Modeling* by Glenn Ledder

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## **Preface**

This manual provides a straightforward and practical introduction to the computer algebra system Maple for students and instructors who wish to use it in the study of ordinary differential equations. Readers will find what they need to get a quick start with the program in the context of simple numerical calculations, fundamental calculus computations, and elementary graphing techniques. Applications are interwoven with explanations of how Maple works and examples illustrating the important features of this important software tool.

Once a sufficient level of confidence has been attained, the reader is guided through Maple procedures designed to solve differential equations, analyze the behavior of solutions, and use solutions, both exact and approximate, in the mathematical modeling process. The exercises can be used to clarify the reader's understanding of how the procedures work. Annotated examples guide the reader through the more challenging problems.

## **Prerequisites and Corequisites**

Instructions in the manual are written with the assumption that the reader knows how to start a computer and make a document using a word processor. The ability to use a mouse: point and click, select and drag, pull down a menu, etc. will be taken for granted. The only mathematics prerequisite is the successful completion of a university level calculus course or its equivalent. As a corequisite it is hoped that the reader is actively engaged in the learning of the fundamentals of ordinary differential equations. Please note that this is not a text in differential equations. Indeed, the reader will often be referred to a differential equations textbook (Ledder) for statements of definitions, algorithms, solution techniques, and solution formulas, as well as background material for some of the examples and exercises.

## **Software and Hardware Requirements**

The manual was written on a Macintosh computer using Maple, version 9.5. As a warning to both students and instructors, the minimal requirements for Maple 9.5 on a Macintosh are OS X (10.3 or higher is best) and 256 MB of RAM; 512 MB would be even better to avoid frequent pageouts due to file swapping. Maple 9.5 will run on a G3 processor, but it is so slow that the G4 is recommended as a minimal configuration. Minimal requirements for a PC include 256 MB of RAM. As with a Macintosh, the more RAM the better.

The manual is divided into four (unequal) parts, Exercises, an Appendix, and solutions to selected exercises.

## **Part I. The Maple Worksheet**

This is a brief overview of Maple's worksheet interface. The essential components of a worksheet are described and simple examples illustrate how to enter and process mathematics and text.

## **Part II. Calculations and Calculus with Maple**

The second part contains a more detailed introduction to Maple and how to use it to "do mathematics." The input/output paradigm is stressed as the reader learns how to use Maple as a calculator. Input and output sequences are discussed. Maple output can be used as subsequent input by assigning the output a name, and then referring to it by that name just as one might do using paper and pencil. The notion of assignments are important for the successful use of any mathematics software to a problem that requires more than one calculation. This idea is illustrated several times using familiar examples from calculus. Graphing examples introduce plotting procedures.

## **Part III. First Order Ordinary Differential Equations**

The discussion of differential equations in Maple starts here in the context of mathematical models requiring first order equations in their analysis. Readers who are already familiar with Maple are encouraged to skim over Parts I and II and begin in Part III. Direction fields and exact solution curves are plotted. Implementation of Euler's method provides the reader with an opportunity to learn how to write a Maple program that can easily be converted into a user-defined procedure.

## **Part IV. Linear Differential Equations**

Linear differential equations, linear systems, and Laplace transforms are featured in this part of the manual. Procedures in the LinearAlgebra package are introduced to handle vectors and matrices gracefully.

## **Exercises**

Exercise sets are divided by Part and Section. Solutions to asterisked exercises appear in the solution section.

## **Appendix**

The appendix, which itself is divided into parts 1 - 5 contains miscellaneous items that did not fit nicely into Part I, II, III, or IV: Power series and special functions, Picard iterates, Partial differential equations, A glossary of the Maple terms and procedures, and some Sound advice and encouraging words.

## **Solutions to Selected Exercises**

A list of solutions to the exercises that appear with an asterisk.

The Table of Contents that follows is detailed enough to be used as a complete outline of the topics that are treated in the manual.

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