

# Calculus

First Edition

Angelo Mingarelli - Carleton University

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In its quest for accessibility and ease of use Mingarelli's single variable *Calculus* text has been used for more than 5 years in engineering and science classrooms at Carleton University in this preliminary edition. Students' comments have been incorporated throughout since its early beginnings in 1998. This book is borne out of classroom interaction with students and written with their usage in mind. In actual classroom settings, where the text has been used for the period 1998-2003, we have found that students get better passing grades when using it and that their ability to develop a conceptual understanding of the basic concepts of Calculus is enhanced greatly. The text has already been used by over 6000 students and the comments of all those who chose to submit them are included herein with due credit being made to the individual student(s). One of its characteristics is the continued use of real everyday applications of Calculus.

## About the author

Angelo B. Mingarelli received his B.Sc. (*Hons*) in Mathematics from Loyola College in Montreal, with the mention, *summa cum laude*. After being awarded an NRC 1967 Science Scholarship, he pursued his graduate studies at the University of Toronto where he received his Master's and Doctorate in Mathematics, the latter with a dissertation on the spectral theory of differential and integral operators under the supervision of the late Professor F.V. Atkinson. His teaching career began at The Pennsylvania State University, in University Park, followed by a tenured appointment at the University of Ottawa where he was an NSERC University Research Fellow for many years. While there he was nominated for the University-wide award of *Teacher of the Year* in 1987. After his move to Carleton University in Ottawa, he received Faculty of Science Awards for Excellence in Teaching on two occasions (in 1992, and again in 1996). These were complemented recently by a *Teaching Achievement Award for 1998-1999* offered by the University in recognition of Excellence in teaching and teaching development. His web site was honored with a StudyWeb Award for Excellence in Online Education. His interests include research in differential equations and mathematical education.

## Philosophy

Every chapter features lots of motivation and is prefaced by a section entitled *The Big Picture* on its aims and uses, historical tidbits and the development of ideas. For example, the chapter on Limits (Chapter 2) includes an opening discussion of the records in the 100 meter Track and Field race and poses the question as to what is the limit of human locomotion? The text is full of effective new strategies for tackling the basic topics in Calculus. The occasional cartoon figures in the margin has helped to facilitate the reading of the material and students have enjoyed their presence.

This is usually followed by a box entitled *Review* where it becomes clear that some skills are more necessary than others for mastery of the subject matter at hand. In some cases we present the material in an odd mix of combined verbal, theoretical, practical, numerical, and geometrical approaches in an attempt to satisfy as many learning styles as possible. The presentation is very personal and it is based upon the author's delivery of the material in a large classroom setting (normally comprised of around 200 students).

At various times in the text, *Shortcuts* are introduced in an attempt to simplify the solution of a given exercise, or class of exercises. Most chapters have individual breaks at a box entitled *Snapshots*. These snapshots consist of *more* examples where we leave out many of the details and outline the rest. We have made a conscious attempt at being repetitive as, in many cases, this is a key to remembering material. Each chapter and its sections concludes with many routine and not so routine exercises that complement the examples. Many applications are real and represent everyday uses of the Calculus. In many cases, notably in the early chapters, we leave in the most simple of details in order to reinforce those skills which students may find nebulous at times. The student will find it useful to know that the Tables

listed under the heading *List of Tables* comprise most of the material and definitions necessary for proficiency in the subject and for study purposes.

## Table of Contents

**1. Functions and their Properties** The meaning of a function, Function values and the Box Method, The natural domain of a function, A quick review of inequalities, Chapter Exercises and Using computer algebra systems. **2. Limits and Continuity** One-sided limits of functions, Two-sided limits and continuity, Important theorems about continuous functions, Evaluating limits at infinity, How to guess a limit, Chapter Exercises and Using computer algebra systems. **3. The Derivative of a Function** Motivation, Working with derivatives, The Chain Rule, Implicit functions and their derivatives, Derivatives of trigonometric functions, Important results about derivatives, Inverse functions, Inverse trigonometric functions, Derivatives of inverse trigonometric functions, Relating rates of change, Newton's method for calculating roots, L'Hospital's Rule, Chapter Exercises and Using computer algebra systems. **4. Exponentials and Logarithms** Exponential functions and their logarithms, Euler's number, Euler's exponential function and the Natural logarithm, Derivative of the natural logarithm, Differentiation formulae for general exponential functions, Differentiation formulae for general logarithmic functions, Applications, Chapter Exercises and Using computer algebra systems. **5. Curve Sketching (optional)** Solving polynomial inequalities (optional), Solving rational function inequalities (optional), Graphing techniques, Applications of the derivative to business and economics, Single variable optimization problems, Chapter Exercises and graphing using the free Plotter. **6. Advanced Topics (optional)** Infinite sequences, Limits from the right, Limits from the left, Continuity, Limits at infinity, Infinte limits, The epsilon-delta method. **7. Integration** antiderivatives and the indefinite integral, Definite integrals, The summation convention, Area and the Riemann integral, Chapter Exercises and Using computer algebra systems. **8. Techniques of Integration** Trigonometric identities, The substitution rule, Integration by parts, Partial fractions, Products of trigonometric functions, Trigonometric substitutions, Numerical integration, Improper integrals, Chapter Exercises and Using computer algebra systems. **9. Applications of the Integral** Motivation, Finding the area between two curves, The volume of a solid of revolution, Measuring the length of a curve, Moments and centers of mass, Chapter Exercises and Using computer algebra systems. **10. Simple Differential Equations** Why study differential equations? First order separable equations, Laws of growth and decay, Using computer algebra systems. **11. Multivariable Optimization Techniques** Functions of more than one variable, Continuity, Partial derivatives, Higher order partial derivatives, The Chain rule for partial derivatives, Extrema of functions of many variables, Chapter Exercises.

**Appendix A** Review of Exponents and Radicals, **Appendix B** The Straight Line.

## New to this Edition

- The Box Method; a powerful new tool developed for manipulating compositions and using the Chain Rule
- An important review on how to handle inequalities and removing absolute values
- A method for solving polynomial and rational function inequalities
- An optional section on how to guess limits and using extended real numbers for obtaining their values
- Everyday-life experiences are used to reinforce the applicability of Calculus
- A systematic presentation of curve sketching based on solving inequalities and using a plotter
- A thorough introduction to the definite integral using antiderivatives, thus minimizing the use of Riemann sums
- A development of the Table Method for keeping track of minus signs when repeatedly integrating by parts
- Lots of reinforcement and repetition throughout, and a return to basics for sharpenng student skills in algebra
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