The Joy of Finite Mathematics

The Language and Art of Math

Chris P. Tsokos and Rebecca D. Wooten

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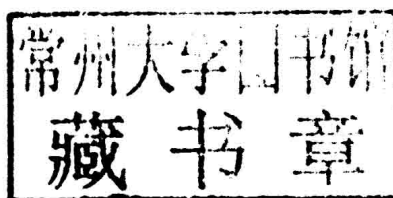## The Language and Art of Math

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Dedications

"We think faster than we speak and speak faster than we write; therefore, when creating great things we abbreviate everything. This abbreviated language is called Math."

RDW

This text is dedicated to my wife Debbie and my children Matthew, Jonathan and Maria.
Chris P. Tsokos

This text is dedicated to my husband Dana Miller, and all my family.
Rebecca D. Wooten

About the Authors

Chris P. Tsokos is Distinguished University Professor of Mathematics and Statistics at the University of South Florida. Dr. Tsokos received his B.S. in Engineering Sciences/Mathematics, his M.A. in Mathematics from the University of Rhode Island, and his Ph.D. in Statistics and Probability from the University of Connecticut. Professor Tsokos has also served on the faculties at Virginia Polytechnic Institute and State University and the University of Rhode Island.

Dr. Tsokos' research has extended into a variety of areas, including stochastic systems, statistical models, reliability analysis, ecological systems, operations research, time series, Bayesian analysis, and mathematical and statistical modeling of global warming, both parametric and nonparametric survival analysis, among others. He is the author of more than 300 research publications in these areas.

For the past four years Professor Tsokos' research efforts have been focused on developing probabilistic models, parametric and nonparametric statistical models for cancer and GLOBAL WARMING data. Specifically, his research aims are data driven and are oriented toward understanding the behavior of breast, lung, brain, and colon cancers. Information on the subject matter can be found on his website.

Professor Tsokos has more than 300 publications in his research areas of interest. He is the author of several research monographs and books, including *Random Integral Equations with Applications to Life Sciences and Engineering, Probability Distribution: An Introduction to Probability Theory with Applications, Mainstreams of Finite Mathematics with Applications, Probability with the Essential Analysis, Applied Probability Bayesian Statistical Methods with Applications to Reliability,* and *Mathematical Statistics with Applications,* among others.

Dr. Tsokos is the recipient of many distinguished awards and honors, including Fellow of the American Statistical Association, USF Distinguished Scholar Award, Sigma Xi Outstanding Research Award, USF Outstanding Undergraduate Teaching Award, USF Professional Excellence Award, URI Alumni Excellence Award in Science and Technology, Pi Mu Epsilon, election to the International Statistical Institute, Sigma Pi Sigma, USF Teaching Incentive Program, and several humanitarian and philanthropic recognitions and awards.

Professor Tsokos is a member of several academic and professional societies. He is serving as Honorary Editor, Chief-Editor, Editor or Associate Editor of more than twelve academic research journals.

Rebecca D. Wooten is Assistant Professor of Mathematics and Statistics at the University of South Florida. She received her M.A./B.A. in Mathematics and her Ph.D. in Statistics from the University of South Florida. She has worked for 15 years in teaching and has been recognized for her excellence in teaching; teaching courses such as Liberal Arts Math, Finite Mathematics, Basic Statistics, Introduction to Statistics, and Applied Statistics Methods.

Her research interests are concentrated in Applied Statistics with emphasis on Environmental Studies. Her research publications span a variety of areas such as Global Warming (carbon dioxide and temperature), Atmospheric Sciences and Geography (hurricanes), Geology (volcanic ash fall), Marine Biology (red tide), among others.

Professor Wooten is extensively involved in activities to improve education not only in Mathematics and Statistics, but Education in general. She is the Academic Coordinator for two free-educational assistance program which offer opportunities for students to volunteer and the local community to get the assistance in their studies that they would otherwise be unable to afford.
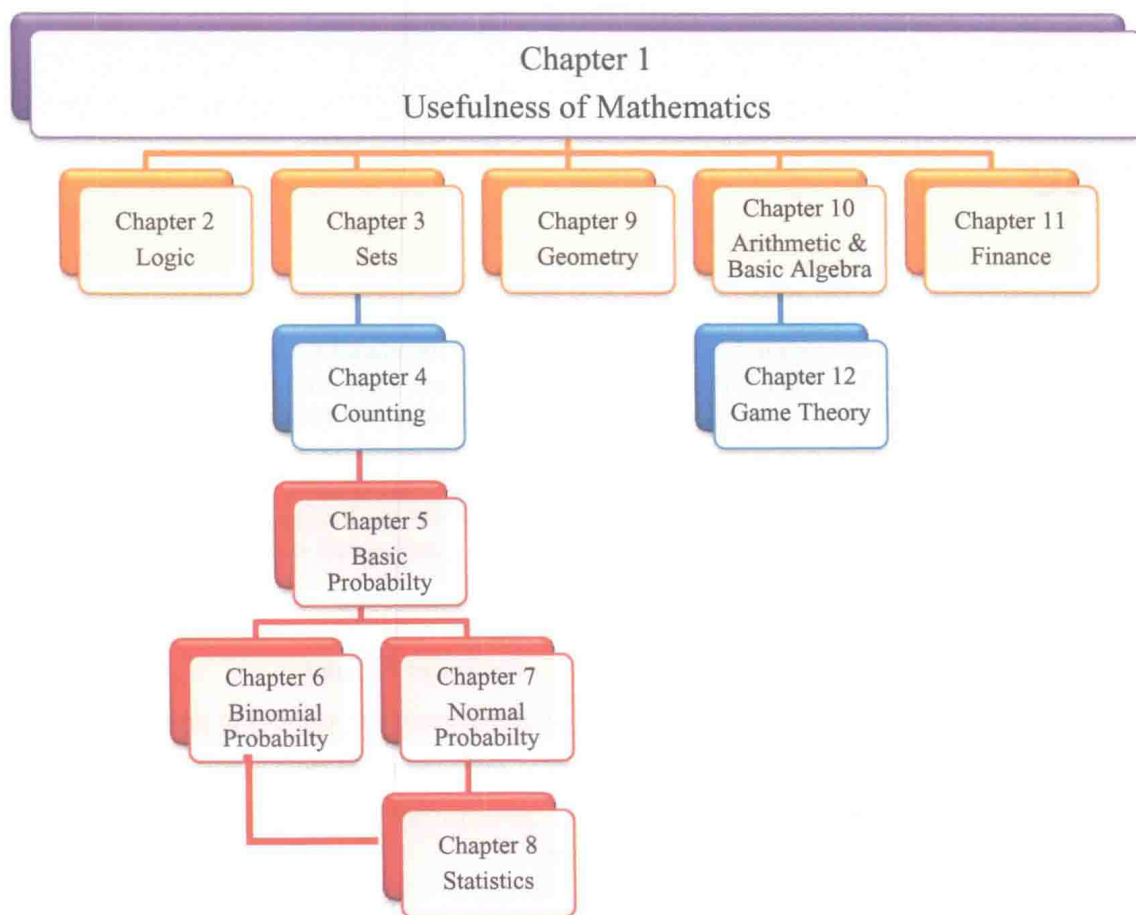
Preface

This book has been written to present certain aspects of modern finite mathematics from an elementary point of view, with emphasis on relevance to real-world problems. The objective is to create a positive attitude toward mathematics for the non-science-orientated college student and to demonstrate its usefulness in solving problems that we frequently encounter in our complex society.

Throughout the text, the aim has been to de-emphasize difficult theoretical concepts; thus, an intuitive treatment leads to practical applications of the various subject area topics. We believe that with such an approach, the modern college student will complete this course with the good feeling that mathematics is not only useful but enjoyable to work with.

The *Joy of Finite Mathematics* has several distinguishing features:

▣ The text has been written for students with only high school mathematics.

▣ Diagrams and graphs are used to illustrate mathematical concepts or thoughts.

▣ Step-by-step directions are given for the implementation of mathematical methods to problem solving.

▣ Emphasis has been placed on usefulness of mathematics to real-world problems.

▣ To provide motivation to the reader, most chapters are preceded by a short biography of a scientist who made important contributions to the subject area under consideration.

▣ Mathematical concepts are introduced as clearly and as simply as possible, and they are followed by one or more examples as an aid to thorough understanding.

▣ Each chapter ends with a complete summary that includes the definitions, properties, and rules of the chapter, followed by a Review Test.

▣ Each chapter contains numerous critical thinking and basis exercises with problems that reflect on the mainstream of the chapter.

The book has been designed to give the instructor wide flexibility in structuring a one or two-semester course, or a full-year course. Although some chapters are dependent on other others, many options are allowed (see accompanying diagraph).

Chapter 1
Usefulness of Mathematics

- Chapter 2 — Logic
- Chapter 3 — Sets
- Chapter 9 — Geometry
- Chapter 10 — Arithmetic & Basic Algebra
- Chapter 11 — Finance

Chapter 3 (Sets) → Chapter 4 (Counting)

Chapter 10 (Arithmetic & Basic Algebra) → Chapter 12 (Game Theory)

Chapter 4 (Counting) → Chapter 5 (Basic Probabilty)

Chapter 5 (Basic Probabilty) → Chapter 6 (Binomial Probabilty), Chapter 7 (Normal Probabilty)

Chapter 7 (Normal Probabilty) → Chapter 8 (Statistics)

Chapter 6 (Binomial Probabilty) → Chapter 8 (Statistics)

Very Special Acknowledgment

We wish to express our appreciation to the following academic educators for having reviewed our book and expressed their opinions.

An outstanding book for students to obtain basic knowledge of the usefulness of mathematics. Excellent motivation strategies throughout the book. It will inspire the student to learn the importance of mathematics.

> Dr. Ram Kafle, Department of Mathematics and Statistics, Sam Houston University.

A very constructive and motivating book of finite mathematics. Special emphasis on the applications of math to real-world problems. The interactive approach of presenting their material is excellent. The student will acquire a very good understanding of what mathematics is all about.

> Dr. Bong-jin Choi, Lineberger Comprehensive Cancer Center, The University of North Carolina at Chapel Hill.

This book is a masterful treatment of finite mathematics for undergraduate students who are afraid of mathematics. It will enlighten the student of the interdisciplinary use of mathematics at the very basic level. The book provides excellent illustrations of the use of mathematics/statistics to solve important problems.

> Dr. Yong Xu, Department of Mathematics and Statistics, Radford University.

The Joy of Finite Mathematics *provides an excellent treatment of the subject. Unique emphasis on the importance of mathematical sciences to our society. The non-mathematics-oriented undergraduate student will find the contents of the book easy to read and very inspiring to learn more of the subject matter.*

> Dr. K. Pokhrel, Department of Mathematics & Computer Systems, Mercyhurst University.

This is an excellent book of finite mathematics. It offers a justifiable, useful, and motivating approach to what mathematics is all about to the undergraduate student with minimum prior knowledge of the subject. The selection of the contents of the book, examples, and exercises is outstanding.

> Dr. N. Khanal, Department of Mathematics, University of Tampa.

Several Options for a Semester Course in Finite Mathematics

Five possible options in designing a basic course in **finite mathematics** are given below, along with some remarks for each selection.

Options 1 and 2 offer a detailed coverage of specific topics in **math**, each spanning seven chapters:

Option 1:

Chapters Covered	Title
Chapter 1	The Usefulness of Mathematics
Chapter 2	Logic
Chapter 3	Sets
Chapter 4	Counting Techniques
Chapter 5	Probability
Chapter 8	Statistics
Chapter 9	Geometry

Covering materials necessary for the **CLAST** (**College Level Academic Skill Test**) exam, excluding algebra, these six topics are often taught collectively. In addition to the necessary high school algebra, these topics prepare a student well for the **CLAST** exam.

Option 2:

Chapters Covered	Title
Chapter 1	The Usefulness of Mathematics
Chapter 2	Logic
Chapter 3	Sets
Chapter 5	Probability
Chapter 6	Bernoulli Trials
Chapter 7	The Bell-shaped Curve
Chapter 8	Statistics

Option 2 provides the materials necessary for a comprehensive understanding of basic **probability** and **statistics**. This option is a broad introduction, including the underlying probabilities necessary to compute basic descriptive statistics, as well as inferential statistics in terms of interval estimates and tests of hypothesis.

Options 3-5 offer a more detailed coverage of specific topics in **math, each spanning** six chapters:

Option 3:

Chapters Covered	Title
Chapter 1	The Usefulness of Mathematics
Chapter 3	Sets
Chapter 4	Counting Techniques
Chapter 5	Probability
Chapter 6	Bernoulli Trials
Chapter 7	The Bell-shaped Curve

These topics enhance the study of **probability**. Option 3 begins with the basic concepts of categorization into **sets, counting** sets, and measuring **basic probabilities** empirically. It then continues with measuring basic probabilities hypothetically using either the discrete **binomial probability distribution, or** the **continuous normal probability** distribution.

Option 4:

Chapters Covered	Title
Chapter 1	The Usefulness of Mathematics
Chapter 4	Counting Techniques
Chapter 5	Probability
Chapter 6	Bernoulli Trials
Chapter 7	The Bell-shaped Curve
Chapter 8	Statistics

Option 4 covers materials necessary for the study of the basic aspects of **statistics**. This option includes **counting basic** empirical and hypothetical **probabilities** empirically. It also includes the basic necessities of **statistics**, descriptively and inferentially, for means and proportions.

Option 5:

Chapters Covered	Title
Chapter 1	The Usefulness of Mathematics
Chapter 2	Logic
Chapter 3	Sets
Chapter 4	Counting Techniques
Chapter 9	Geometry
Chapter 11	Arithmetic and Algebra

Option 5 covers materials necessary to gain a basic understanding of the language of deterministic **math**. This option provides a basic understanding of **logic, sets, counting, geometry**, and **algebra**.

Note: Game theory can be included in any scheme that includes the algebra and arithmetic.

A SUMMARY OF THE PROPOSED OPTIONS

Depending on which option you choose (1, 2, 3, 4, or 5), the purple indicates which chapters should be included; the green indicates optional chapters in each scheme.

Options → / Chapter ↓	1	2	3	4	5
1	purple	purple	purple	purple	purple
2	purple	purple			purple
3	purple	purple	purple		purple
4	purple		purple	purple	purple
5	purple	purple	purple	purple	
6		purple	purple	purple	
7		purple	purple	purple	
8	purple	purple		purple	
9	purple				purple
10	green	green	green	green	green
11					purple
12	green	green	green	green	green