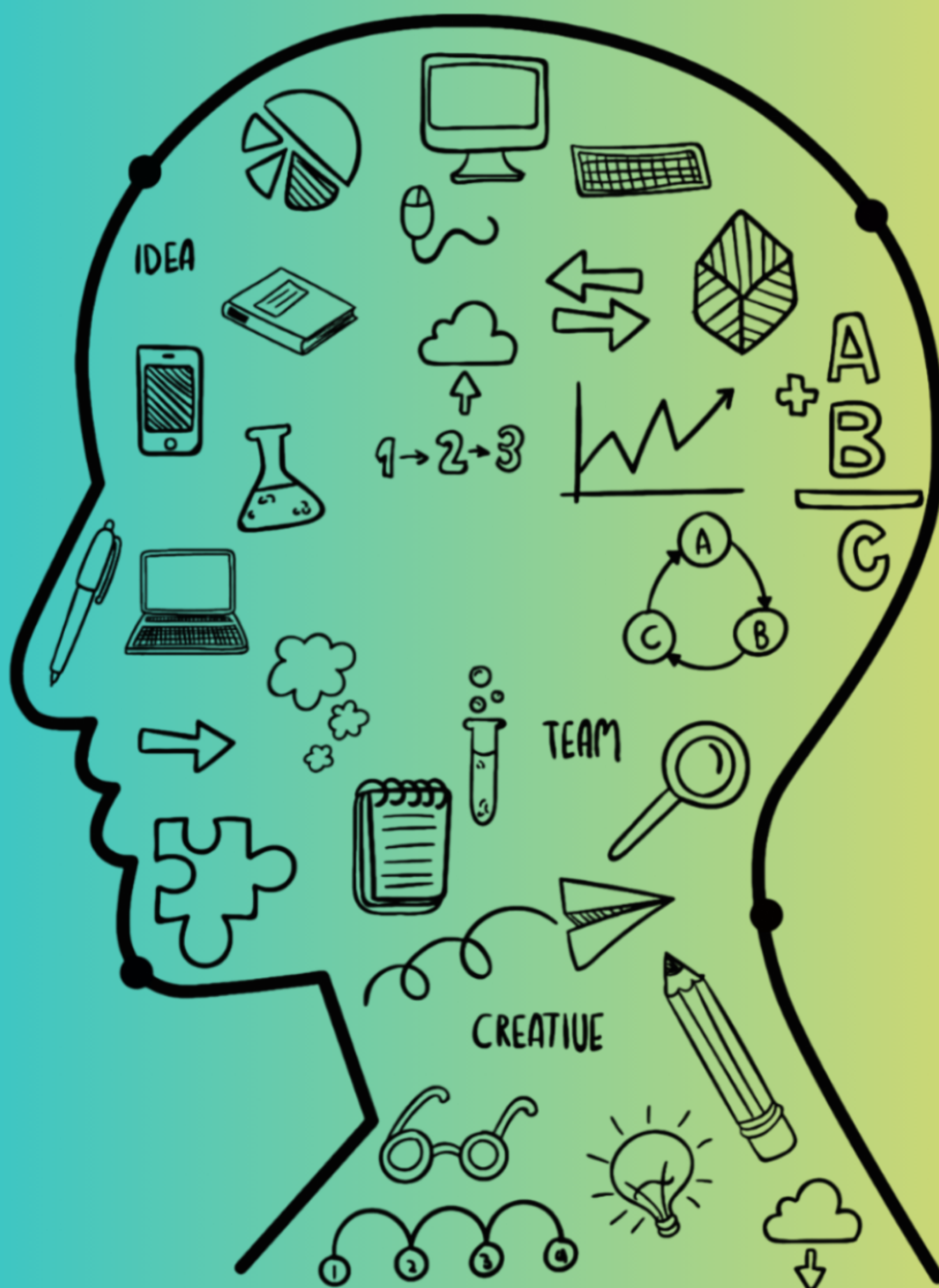


CALCULUS AND ITS APPLICATIONS

From Classical Problems to Modern Challenges



Written by:

Bakti Siregar, M.Sc., CDS.

First Edition

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In the evolving landscape of science, engineering, and technology, calculus remains a fundamental tool for understanding change, modeling complex systems, and solving real-world problems. From the classical challenges of motion and geometry to modern applications in data science, optimization, and engineering, calculus provides a unifying language that bridges theory and practice. By mastering its core concepts and techniques, students and practitioners can analyze dynamic processes, make informed decisions, and develop models that foster innovation and excellence across disciplines.

This book, *Calculus and Its Applications: From Classical Problems to Modern Challenges*, offers a structured and comprehensive introduction to calculus. Beginning with the foundations of real numbers and the essentials of functions, readers are gradually guided through special functions, limits, and the core principles of derivatives. Building on these fundamentals, the text explores both the applications of derivatives in optimization and modeling, as well as the theory and practice of indefinite integrals and their wide-ranging applications. The journey concludes with a discussion of transcendental functions, connecting classical concepts to advanced and contemporary challenges.

Beyond theory, the book emphasizes practical applications—showing how calculus underpins decision-making, system optimization, and problem-solving in diverse fields. Each chapter integrates concepts with examples that reflect both traditional mathematical problems and modern technological contexts.

Through this approach, readers will not only develop a strong understanding of the mathematical principles of calculus but also gain the skills to apply them effectively to real-world challenges—fulfilling the book’s vision of connecting classical problems with modern challenges.

Preface

About the Writer



[Bakti Siregar, M.Sc., CDS](#) works as a Lecturer at the [ITSB Data Science Program](#). He earned his Master's degree from the Department of Applied Mathematics at National Sun Yat Sen University, Taiwan. In addition to teaching, Bakti also works as a Freelance Data Scientist for leading companies such as [JNE](#), [Samora Group](#), [Pertamina](#), and [PT. Green City Traffic](#).

He has a strong enthusiasm for projects (and teaching) in the fields of Big Data Analytics, Machine Learning, Optimization, and Time Series Analysis, particularly in finance and investment. His core expertise lies in statistical programming languages such as R Studio and Python. He is also experienced in implementing database systems like MySQL/NoSQL for data management and is proficient in using Big Data tools such as Spark and Hadoop.

Some of his projects can be viewed here: [Rpubs](#), [Github](#), [Website](#), and [Kaggle](#)

Acknowledgments

Calculus plays a vital role in modeling, analyzing, and optimizing processes across science, engineering, and technology. This book introduces fundamental concepts and techniques in calculus, including:

- A solid foundation in real numbers, functions, and limits
- The ability to analyze and interpret data across engineering and scientific contexts
- A clear understanding of the role of derivatives and integrals in modeling and problem-solving
- Practical skills in applying numerical methods and calculus techniques to real-world challenges

This book is designed for beginners seeking to build a strong foundation in calculus while appreciating its concepts and diverse applications—from classical mathematical problems to modern scientific and engineering challenges. We value the active participation of readers, whose insights and questions enrich the learning journey. It is our hope that this material serves not only as an introduction to calculus but also as a practical guide for applying mathematical reasoning to contemporary problems.

Feedback & Suggestions

Your feedback is invaluable in enhancing the quality of this book. We warmly invite readers to share their thoughts on the content, organization, and clarity of the material. Suggestions for additional topics, extended explanations, or further real-world applications are highly encouraged.

With your support and contributions, our goal is to make this book a comprehensive and accessible resource on calculus and its applications—from classical problems to modern challenges. Thank you for your engagement and feedback.

For feedback and suggestions, please contact:

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Essentials of Functions

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Special Functions

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Chapter 7

Applied of Derivatives

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Indefinite Integrals

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Transcendental Functions

