



# The Real Numbers: An Introduction to Set Theory and Analysis (Undergraduate Texts in Mathematics)

By John Stillwell

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While most texts on real analysis are content to assume the real numbers, or to treat them only briefly, this text makes a serious study of the real number system and the issues it brings to light. Analysis needs the real numbers to model the line, and to support the concepts of continuity and measure. But these seemingly simple requirements lead to deep issues of set theory?uncountability, the axiom of choice, and large cardinals. In fact, virtually all the concepts of infinite set theory are needed for a proper understanding of the real numbers, and hence of analysis itself.

By focusing on the set-theoretic aspects of analysis, this text makes the best of two worlds: it combines a down-to-earth introduction to set theory with an exposition of the essence of analysis?the study of infinite processes on the real numbers. It is intended for senior undergraduates, but it will also be attractive to graduate students and professional mathematicians who, until now, have been content to "assume" the real numbers. Its prerequisites are calculus and basic mathematics.

Mathematical history is woven into the text, explaining how the concepts of real number and infinity developed to meet the needs of analysis from ancient times to the late twentieth century. This rich presentation of history, along with a background of proofs, examples, exercises, and explanatory remarks, will help motivate the reader. The material covered includes classic topics from both set theory and real analysis courses, such as countable and uncountable sets, countable ordinals, the continuum problem, the Cantor–Schröder–Bernstein theorem, continuous functions, uniform convergence, Zorn's lemma, Borel sets, Baire functions, Lebesgue measure, and Riemann integrable functions.

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#### Review

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“This book is an interesting introduction to set theory and real analysis embedded in properties of the real numbers. ... The 300-plus problems are frequently challenging and will interest both upper-level undergraduate students and readers with a strong mathematical background. ... A list of approximately 100 references at the end of the book will help students to further explore the topic. ... Summing Up: Recommended. Lower-division undergraduates.” (D. P. Turner, *Choice*, Vol. 51 (11), August, 2014)

“This is an informal look at the nature of the real numbers ... . There are extensive historical notes about the evolution of real analysis and our understanding of real numbers. ... Stillwell has deliberately set out to provide a different sort of construction where you understand what the foundation is supporting and why it is important. I think this is very successful, and his book ... is much more informative and enjoyable.” (Allen Stenger, *MAA Reviews*, February, 2014)

“This book will be fully appreciated by either professional mathematicians or those students, who already have passed a course in analysis or set theory. ... The book contains a quantity of motivation examples, worked examples and exercises, what makes it suitable also for self-study.” (Vladimír Janiš, *zbMATH*, 2014)

“The book offers a rigorous foundation of the real number system. It is intended for senior undergraduates who have already studied calculus, but a wide range of readers will find something interesting, new, or instructive in it. ... This is an extremely reader-friendly book. It is full of interesting examples, very clear explanations, historical background, applications. Each new idea comes after proper motivation.” (László Imre Szabó, *Acta Scientiarum Mathematicarum* (Szeged), Vol. 80 (1-2), 2014)

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#### About the Author

John Stillwell is a professor of mathematics at the University of San Francisco. He is also an accomplished author, having published several books with Springer, including *Mathematics and Its History*; *The Four Pillars of Geometry*; *Elements of Algebra*; *Numbers and Geometry*; and many more.

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