

COMPUTER ASSISTED PROOFS IN APPLIED MATHEMATICS

Summer Graduate School, MSRI/SLMath, July 7 to 18, 2025

PREREQUISITES

- [1] E. KREYSZIG, *Introductory functional analysis with applications*, Wiley Classics Library, Wiley, New York, NY, 1989, ISBN 0-471-50459-9. [MR](#) [Zbl](#)
- [2] T. SAUER, *Numerical analysis*, 3rd ed., Pearson, Hoboken, NJ, 2018, ISBN 978-0134696454.

RECOMMENDED PREPARATORY READING

- [3] A. NEUMAIER, [Computer-assisted proofs](#), in *12th GAMM - IMACS International Symposium on Scientific Computing, Computer Arithmetic and Validated Numerics (SCAN 2006)* (Duisberg, Germany, 2006), IEEE, Piscataway, NJ, 2006, Article #5, ISBN 978-0-7695-2821-2, [link](#).
- [4] J. B. VAN DEN BERG, [Introduction to rigorous numerics in dynamics: general functional analytic setup and an example that forces chaos](#), in *Rigorous numerics in dynamics* (Seattle, WA, 2016), J. B. VAN DEN BERG and J.-P. LESSARD, eds., Proceedings of Symposia in Applied Mathematics **74**, American Mathematical Society, Providence, RI, 2018, ISBN 978-1-4704-2814-3, [link](#), [alternate](#), pp. 1–25. [MR](#) [Zbl](#)
- [5] R. E. MOORE, R. B. KEARFOTT, and M. J. CLOUD, [The interval number system](#), in *Introduction to interval analysis*, Society for Industrial and Applied Mathematics, Philadelphia, PA, 2009, ISBN 978-0-898716-69-6, Ch. 2, pp. 7–17. [MR](#) [Zbl](#)
- [6] A. QUARTERONI, R. SACCO, and F. SALERI, [Solution of systems of nonlinear equations](#), in *Numerical mathematics*, Texts in Applied Mathematics **37**, Springer, Cham, Switzerland, 2nd ed., 2007, ISBN 978-3-540-34658-6; 3-540-34658-9, §7.1, pp. 286–298. [MR](#) [Zbl](#)

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- [7] K. T. ALLIGOOD, T. D. SAUER, and J. A. YORKE, [Chaos: An introduction to dynamical systems](#), Textbooks in Mathematical Sciences, Springer, Cham, Switzerland, 1997, ISBN 0-387-94677-2. [MR](#) [Zbl](#)
- [8] F. BORNEMANN, D. LAURIE, S. WAGON, and J. WALDVOGEL, [The SIAM 100-digit challenge: A study in high-accuracy numerical computing](#), Society for Industrial and Applied Mathematics, Philadelphia, PA, 2004, ISBN 0-89871-561-X. [MR](#) [Zbl](#)
- [9] J. P. BOYD, *Chebyshev and Fourier spectral methods*, 2nd ed., Dover, Mineola, NY, 2001, ISBN 0-486-41183-4, [references](#), [errata](#). [MR](#) [Zbl](#)
- [10] C. CHICONE, [Ordinary differential equations with applications](#), 3rd ed., Texts in Applied Mathematics **34**, Springer, Cham, Switzerland, 2024, ISBN 978-3-031-51651-1; 978-3-031-51652-8. [MR](#) [Zbl](#)
- [11] J. GUCKENHEIMER and P. HOLMES, [Nonlinear oscillations, dynamical systems, and bifurcations of vector fields](#), Applied Mathematical Sciences **42**, Springer, Cham, Switzerland, 1983, Softcover of 2013 contains 2002 corrected 7th printing. ISBN 0-387-90819-6. [MR](#) [Zbl](#)
- [12] E. HANSEN and G. W. WALSTER, [Global optimization using interval analysis](#), 2nd ed., Monographs and Textbooks in Pure and Applied Mathematics **264**, CRC Press, Boca Raton, FL, 2004, ISBN 978-0-8247-4059-7. [MR](#) [Zbl](#)
- [13] A. HARO, M. CANADELL, J.-L. FIGUERAS, A. LUQUE, and J.-M. MONDELO, [The parameterization method for invariant manifolds: From rigorous results to effective computations](#), Applied Mathematical Sciences **195**, Springer, Cham, Switzerland, 2016, ISBN 978-3-319-29660-9; 978-3-319-29662-3. [MR](#) [Zbl](#)

- [14] T. KACZYNSKI, K. MISCHAIKOW, and M. MROZEK, *Computational homology*, Applied Mathematical Sciences **157**, Springer, Cham, Switzerland, 2004, ISBN 0-387-40853-3. [MR](#) [Zbl](#)
- [15] Y. A. KUZNETSOV, *Elements of applied bifurcation theory*, 4th ed., Applied Mathematical Sciences **112**, Springer, Cham, Switzerland, 2023, ISBN 978-3-031-22006-7; 978-3-031-22007-4. [MR](#) [Zbl](#)
- [16] G. MAYER, *Interval analysis: and automatic result verification*, De Gruyter Studies in Mathematics **65**, De Gruyter, Berlin, Germany, 2017, ISBN 978-3-11-050063-9; 978-3-11-049805-9. [MR](#) [Zbl](#)
- [17] J. D. MEISS, *Differential dynamical systems*, 2nd ed., Mathematical Modeling and Computation **22**, Society for Industrial and Applied Mathematics, Philadelphia, PA, 2017, ISBN 978-1-61197-464-5; 978-1-61197-463-8. [MR](#) [Zbl](#)
- [18] R. E. MOORE, R. B. KEARFOTT, and M. J. CLOUD, *Introduction to interval analysis*, Society for Industrial and Applied Mathematics, Philadelphia, PA, 2009, ISBN 978-0-898716-69-6. [MR](#) [Zbl](#)
- [19] M. T. NAKAO, M. PLUM, and Y. WATANABE, *Numerical verification methods and computer-assisted proofs for partial differential equations*, Springer Series in Computational Mathematics **53**, Springer, Cham, Switzerland, 2019, ISBN 978-981-13-7668-9; 978-981-13-7669-6. [MR](#) [Zbl](#)
- [20] A. QUARTERONI, R. SACCO, and F. SALERI, *Numerical mathematics*, 2nd ed., Texts in Applied Mathematics **37**, Springer, Cham, Switzerland, 2007, ISBN 978-3-540-34658-6; 3-540-34658-9. [MR](#) [Zbl](#)
- [21] G. R. SELL and Y. YOU, *Dynamics of evolutionary equations*, Applied Mathematical Sciences **143**, Springer, Cham, Switzerland, 2002, ISBN 0-387-98347-3. [MR](#) [Zbl](#)
- [22] S. H. STROGATZ, *Nonlinear dynamics and chaos: With applications to physics, biology, chemistry, and engineering*, 3rd ed., Taylor and Francis, New York, NY, 2024, ISBN 978-1-032-70789-1, 978-0-367-02650-9, 2nd edition 2018 (DRM-free). [MR](#) [Zbl](#)
- [23] L. N. TREFETHEN, *Spectral methods in MATLAB*, Software, Environments, and Tools **10**, Society for Industrial and Applied Mathematics, Philadelphia, PA, 2000, ISBN 0-89871-465-6. [MR](#) [Zbl](#)
- [24] W. TUCKER, *Validated numerics: A short introduction to rigorous computations*, Princeton University Press, Princeton, NJ, 2011, ISBN 978-0-691-14781-9. [MR](#) [Zbl](#)
- [25] H. UECKER, *Numerical continuation and bifurcation in nonlinear PDEs*, Society for Industrial and Applied Mathematics, Philadelphia, PA, 2021, ISBN 978-1-611976-60-1. [MR](#) [Zbl](#)
- [26] J. B. VAN DEN BERG and J.-P. LESSARD, *Rigorous numerics in dynamics*, *Notices Amer. Math. Soc.* **62** (2015), no. 9, 1057–1061. [MR](#) [Zbl](#)
- [27] J. B. VAN DEN BERG and J.-P. LESSARD (eds.), *Rigorous numerics in dynamics* (Seattle, WA, 2016), Proceedings of Symposia in Applied Mathematics **74**, American Mathematical Society, Providence, RI, 2018, ISBN 978-1-4704-2814-3. [MR](#) [Zbl](#)

JOURNALS

- [28] *Communications in Nonlinear Science and Numerical Simulation*, 2022, Special issue on “Computer Assisted Proofs in Dynamical Systems”, Elsevier, Amsterdam, Netherlands. ISSN 1007-5704, e-ISSN 1878-7274 [MR](#) [ZBL](#).
- [29] *Physica D: Nonlinear Phenomena*, Elsevier, Amsterdam, Netherlands. ISSN 0167-2789, e-ISSN 1872-8022 [MR](#) [ZBL](#).
- [30] *SIAM Journal on Applied Dynamical Systems*, Society for Industrial and Applied Mathematics, Philadelphia, PA. e-ISSN 1536-0040 [MR](#) [ZBL](#).