Reading List for Numerical Analysis Group D. Phil. Students

Hilary & Trinity Terms 2024

Each student should make a serious and continuing effort to familiarise himself/herself with the contents of several books from the following annotated list.

The list is divided into subject areas and comments are given on the relative level and difficulty of each book.

As a general rule, you should expect to study the most advanced books in the area of your dissertation together with a reasonable spread of books in related areas. A rough guide could be that you should be familiar with about a dozen books drawn from half a dozen of the listed areas.

Journals

Acta Numerica
SIAM Review
SIAM Journal on Numerical Analysis
SIAM Journal on Matrix Analysis & Applications
SIAM Journal on Scientific Computing
SIAM Journal on Optimization
SIAM Journal on Mathematics of Data Science
Numerische Mathematik
IMA Journal of Numerical Analysis
Mathematics of Computation
Foundations of Computational Mathematics
BIT Numerical Mathematics
Electronic Transactions on Numerical Analysis
Journal of Computational Physics
Mathematical Programming
Mathematical Programming Computation

Floating point arithmetic

M.L. Overton: *Numerical Computing with IEEE Floating Point Arithmetic*, SIAM, 2001.
[Very readable and systematic presentation.]

See also Chapters 1 and 2 of the book by N.J. Higham listed below

Numerical Linear Algebra

J.W. Demmel: *Applied Numerical Linear Algebra,* SIAM, 1997.
[Best source on recent algorithms such as divide-and-conquer.]

H.C. Elman, D.J. Silvester, A.J. Wathen: *Finite Elements And Fast Iterative Solvers,* Oxford University Press, 2nd ed. 2014.
[Major book at the interface of finite elements and matrix iterations.]

N.J. Higham: *Accuracy and Stability of Numerical Algorithms,* SIAM, 2nd ed. 2002.
[An exceptionally careful and up-to-date study of error analysis.]

G.H. Golub & C.F. Van Loan: *Matrix Computations,* Johns Hopkins, 4th ed. 2012.
[The most comprehensive introduction to the subject.]

A. Greenbaum: *Iterative Methods for Solving Linear Systems*, SIAM 1997.
[Excellent survey of Krylov subspace iterations.]

R. A. Horn and C. R. Johnson: *Matrix Analysis,* Cambridge University Press, 2nd ed. 2012.
[Classic textbook on matrix analysis; not numerical.]

R. A. Horn and C. R. Johnson: *Topics in Matrix Analysis,* Cambridge University Press, 1991.
[Goes deeper than Matrix Analysis in more specific topics.]

B.N. Parlett: *The Symmetric Eigenvalue Problem,* Prentice-Hall, 1980.
[Excellent account of Lanczos-type methods.]

Y. Saad: *Iterative Methods for Sparse Linear Systems*, 2nd edition, SIAM, 2003.
[Classic textbook on iterative methods, with a focus on Krylov methods.]

L.N. Trefethen & D. Bau: *Numerical Linear Algebra,* 1997.
[General graduate-level text, including Krylov subspace iterations.]

Approximation Theory

D. Braess: Nonlinear Approximation Theory, Springer, 1986.
[Expert/advanced treatment of nonlinear (incl. rational) approximation.]

I. Daubechies: *Ten Lectures on Wavelets*, SIAM, 1992.
[Bestselling introduction to this topic.]

P.J. Davies: *Interpolation and Approximation,* Blaisdell, 1963, reprinted by Dover, 1975.
[Old, but extremely well written as an introduction to most aspects of the subject.]

S. Mallat: *A Wavelet Tour of Signal Processing: The Sparse Way,* Academic Press (Elsevier), 3rd ed. 2008.

M.J.D. Powell: *Approximation Theory and Methods,* Cambridge, 1981.
[Broad introductory text.]

L.N. Trefethen: *Approximation Theory and Approximation Practice*, SIAM, 2013.
[Accessible treatment of polynomial and rational approximation theory and methods.]

Optimisation and Solution of Algebraic Equations

C. Cartis, N.I.M. Gould & P. L. Toint: *Evaluation complexity of algorithms for nonconvex optimization: theory, computation and perspectives,* SIAM-MOS Series on Optimization, SIAM Publishing, 2022.

J.E. Dennis & R.B. Schnabel: *Numerical Methods for Unconstrained Optimization and Nonlinear Equations,* Prentice Hall, 1983.
[Excellent textbook introduction to quasi-Newton methods, including systems of equations as well as optimisation.]

R. Fletcher: *Practical Methods of Optimization,* Wiley, 2nd ed. 1987.
[Very good general account of methods in this area, with strong practical bias.]

J. Nocedal and S.J. Wright: *Numerical Optimization,* Springer, 2nd ed. 2006.
[The leading general text.]

S. Wright: *Primal-Dual Interior-Point Methods,* SIAM, 1996.
[Exceptionally well written introduction to primal-dual methods in mathematical prog

Applied Functional Analysis

V.C.L. Hutson & J.S. Pym: *Applications of Functional Analysis and Operator Theory,* Academic Press, 1980.
[Introductory.]

E. Kreyszig: *Introductory Functional Analysis with Applications,* Wiley, 1978.
[Introductory.]

P.D. Lax: *Functional Analysis,* Wiley, 2002.

A. Pazy: *Semigroups of Linear Operators and Applications to Partial Differential Equations,* Springer, 1983.
[Advanced.]

W. Rudin: *Functional Analysis*, McGraw-Hill, 1973.
[Advanced.]

R.E. Showalter: *Hilbert Space Methods for Partial Differential Equations*, Pitman, 1977.
[Introductory.]

Mathematical Analysis and Complex Analysis

R.A. Adams & J.J.F. Fournier: *Sobolev Spaces*, Elsevier, 2nd ed. 2003 (Reprinted 2005).
[Advanced.]

L.V. Ahlfors: *Complex Analysis: An introduction to the theory of analytic functions of one complex variable,* McGraw-Hill, 3rd ed. 1979.
[Outstanding text by the master.]

C.M. Bender & S.A. Orszag: *Advanced Mathematical Methods for Scientists and Engineers*, McGraw-Hill, 1978.
[Classic book on ODEs, asymptotics, and much more.]

J. Jost: *Postmodern Analysis*, Springer, 2003.
[Excellent introductory text.]

A.N. Kolmogorov & S.V. Fomin: *Introductory Real Analysis*, Dover, 1970.
[Introductory]

E.H. Lieb and M. Loss, *Analysis*, AMS, 1997.
[Very nice introductory text.]

H.A. Priestley: *Introduction to Complex Analysis,* 2nd ed., Oxford University Press, 2003.

W. Rudin: *Real and Complex Analysis*, McGraw-Hill, 3rd ed. 1986.
[Introductory but challenging.]

Ordinary Differential Equations (Theory and Numerical Solution)

U.M. Ascher and L.R. Petzold: *Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations,* SIAM, 1998.
[Accessible text including DAE's.]

G. Birkhoff & G.-C. Rota: *Ordinary Differential Equations,* Wiley, 4th ed. 1989.

J.C. Butcher: *The Numerical Analysis of Ordinary Differential Equations,* Wiley, 1987.
[Extensive advanced treatment.]

E. Hairer, S.P. Norsett & G. Wanner: *Solving Ordinary Differential Equations I*: *Nonstiff Problems*, Springer, 2nd rev. ed. 1993, Corr. 2nd printing, 2000.
[Delightfully readable advanced account, full of personality.]

E. Hairer & G. Wanner: *Solving Ordinary Differential Equations II: Stiff and Differential-Algebraic Problems,* Springer, 2nd rev. ed. 1996. 3rd printing, 2004.
[Second volume of above.]

H.B. Keller: *Numerical Solution of Two Point Boundary Value Problems*, SIAM, 1976.
[Brief but lucid.]

L.F. Shampine: *Numerical Solution of Ordinary Differential Equations,* Chapman & Hall, 1994.
[Includes many practical illustrations.]

Partial Differential Equations - Theory

R. Courant & D. Hilbert: *Methods of Mathematical Physics*, I (1953), II (1962), Interscience.
[Old, but well written as an introduction to partial differential equations of mathematical physics.]

L.C. Evans: *Partial Differential Equations,* AMS, 1998.
[Excellent textbook, especially good on nonlinear PDE.]

G. Folland: *Introduction to Partial Differential Equations*, Princeton, 2nd ed. 1995.
[Very elegant introduction.]

P.R. Garabedian: *Partial Differential Equations*, Wiley, 1964.
[Classic, with links to analytic function theory.]

D. Gilbarg & N.S. Trudinger: *Elliptic Partial Differential Equations of Second Order*, Springer, 2nd ed. 1998 (Reprinted 2001).
[Advanced.]

F. John: *Partial Differential Equations*, Springer, 4th rev. ed. 1991.
[Outstanding introduction.]

R. McOwen: *Partial Differential Equations: Methods and Applications*, Pearson, 2nd ed. 2002.

M. Renardy & R.C. Rogers: *An Introduction to Partial Differential Equations*, Texts in Applied Mathematics, Vol. 13, Springer, 2nd ed. 2004.
[A basic introduction into modern PDE theory.]

J. Smoller: *Shock Waves and Reaction-Diffusion Equations*, Springer, 2nd ed. 1994.
[Contains much more introductory material than the title suggests.]

M.E. Taylor: *Partial Differential equations, v.1: Basic Theory*, Springer, 1996.
[Very nice textbook by the author of "the" multivolume treatise on PDE.]

Partial Differential Equations - Finite Difference and Spectral Methods

B. Fornberg: *A Practical Guide to Pseudospectral Methods*, Cambridge University Press, 1996.

B. Gustaffson, H.-O. Kreiss & J. Oliger: *Time Dependent Problems and Difference Methods*, Wiley, 1995.

A. Iserles: *A First Course in the Numerical Analysis of Differential Equations*, Cambridge University Press, 1996.

B.S. Jovanovic & E. Süli: *Analysis of Finite Difference Schemes for Linear Partial Differential Equations with Generalized Solutions.* Springer 2014.
[Advanced.]

R.J. LeVeque: *Finite Difference Methods for Ordinary and Partial Differential Equations,* SIAM, 2007.

R.D. Richtmyer & K.W. Morton: *Difference Methods for Initial-Value Problems,* Wiley, 2nd ed. 1967, reprinted by Krieger, 1994.
[A classic.]

L.N. Trefethen: *Finite Difference and Spectral Methods for Ordinary and Partial Differential Equations,* freely available online.

[Trefethen's text from courses taught at MIT and Cornell.]

L.N. Trefethen: *Spectral Methods in MATLAB*, SIAM, 2000.
[Basis of one of our occasional MSc courses.]

Partial Differential Equations - Finite Element Methods

S.C. Brenner and L.R. Scott: *The Mathematical Theory of Finite Element Methods*, Springer, 3rd ed. 2008.

D. Braess: *Finite Elements*, Cambridge University Press, 2001.
[A very accessible account of the theory of finite element methods.]

P.G. Ciarlet: *The Finite Element Method for Elliptic Problems*, North-Holland, 1978, reprinted by SIAM, 2002.

See also the book by Elman, Silvester and Wathen listed under Numerical Linear Algebra.

C. Johnson: *Numerical Solution of Partial Differential Equations by the Finite Element Method*, Cambridge, 1987.
[Introductory.]

G. Strang & G.J. Fix: *An Analysis of the finite Element Method*, Prentice-Hall, 1973.
[Old classic.]

Fluid Dynamics

J.D. Anderson: *Modern Compressible Flow*, McGraw-Hill, 2nd ed. 1990.
[A modern treatment, very readable.]

G.K. Batchelor: *An Introduction to Fluid Dynamics*, Cambridge, 1967, Reprinted 2000
[Classic, incompressible flow.]

C. Hirsch: *Numerical Computation of Internal and External Flows 1*: *Fundamentals of Numerical Discretisation*, Wiley, 1989.

C. Hirsch: *Numerical Computation of Internal and External Flows 2*: *Computational Methods for Inviscid and Viscous Flows*, Wiley, 1990.

R.J. LeVeque: *Finite Volume Methods for Hyperbolic Problems*, Cambridge, 2002.

R.J. LeVeque: *Numerical Methods for Conservation Laws*, Birkhäuser, 2nd ed. 1992.
[Earlier, shorter introductory text, very readable.]