M.Sc. in Mathematical Modelling and Scientific Computing

Reading List

September 2016

1 Core Courses

1.1 A1 Mathematical Methods I

1. J. R. Ockendon, S. D. Howison, A. A. Lacey and A. B. Movchan, *Applied Partial Differential Equations* (revised edition, Oxford University Press, Oxford, 2003).

2. M. Renardy and R. C. Rogers, *An Introduction to Partial Differential Equations* (Springer–Verlag, New York, 2004).

3. J. P. Keener, *Principles of Applied Mathematics: Transformation and Approximation* (revised edition, Perseus Books, Cambridge, Mass., 2000).

1.2 A2 Mathematical Methods II

1. S. H. Strogatz, *Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry and Engineering* (Westview Press, 2000).

2. R. H. Rand, *Lecture Notes on Nonlinear Vibrations*. Available for free online at http://audiophile.tam.cornell.edu/randdocs/nlvibe52.pdf.

3. P. G. Drazin, *Nonlinear Systems* (Cambridge University Press, Cambridge, 1992).

4. L. Perko, *Differential Equations and Dynamical Systems* (Second edition, Springer, 1996).

5. K. F. Riley, M. P. Hobson and S. J. Bence, *Mathematical Methods for Physics and Engineering* (3rd edition, Cambridge University Press, 2006).

6. D. G. Duffy, *Transform Methods for Solving Partial Differential Equations* (2nd edition, Chapman and Hall/CRC Press, 2004).

7. Brian Davies, *Integral Transforms and Their Applications* (3rd edition, Springer, 2002).

8. I. N. Sneddon, *Fourier Transforms* (Dover reprint 1995, Chapters 1 to 3).

9. L. C. Andrews and B. K. Shivamoggi, *Integral Transforms for Engineers* (SPIE Press, 1999).

10. *The Transforms and Applications Handbook* (Second edition, CRC Press, 2000). (Chapter 9: The Hankel Transform, R. Piessens and Chapter 11: The Mellin Transform, J. Bertrand, P. Bertrand and J.-P. Ovarlez, see http://dsp-book.narod.ru/TAH/ch09.pdf and http://dsp-book.narod.ru/TAH/ch11.pdf).

1.3 B1 Numerical Solution of Differential Equations

1. A. Iserles, *A First Course in the Numerical Analysis of Differential Equations* (Cambridge University Press, second edition, 2009).
2. R. LeVeque, *Finite Difference Methods for Ordinary and Partial Differential Equations* (SIAM, 2007).
3. E. Süli and D. Mayers, *An Introduction to Numerical Analysis* (Cambridge University Press, 2006). Only Chapter 12.

1.4 B1 & B2 Numerical Linear Algebra

1. L. N. Trefethen and D. Bau III, *Numerical Linear Algebra* (SIAM, 1997).
2. J. W. Demmel, *Applied Numerical Linear Algebra* (SIAM, 1997).
3. A. Greenbaum, *Iterative Methods for Solving Linear Systems* (SIAM, 1997).
4. G. H. Golub and C. F. van Loan, *Matrix Computations* (John Hopkins University Press, 3rd edition, 1996).
5. H. C. Elman, D. J. Silvester and A. J. Wathen, *Finite Elements and Fast Iterative Solvers* (Oxford University Press, 1995). Only Chapter 2.

1.5 B2 Continuous Optimization

1. J. Nocedal and S. J. Wright, *Numerical Optimisation* (Springer, 1999 or 2006).

2 Special Topics

2.1 Approximation of Functions

1. L. N. Trefethen, *Approximation Theory and Approximation Practice* (SIAM, 2013).

2.2 Further Mathematical Biology

1. J. D. Murray, *Mathematical Biology, Volume I: An Introduction* (3rd edition, Springer, 2002).
2. J. D. Murray, *Mathematical Biology, Volume II: Spatial Models and Biomedical Applications* (3rd edition, Springer, 2003).
3. J. Keener and J. Sneyd, *Mathematical Physiology* (1st edition, Springer, Berlin, 1998).
4. N. F . Britton, *Essential Mathematical Biology* (Springer, London, 2003).

2.3 Integer Programming

1. L. A. Wolsey, *Integer Programming* (John Wiley & Sons, 1998).

2.4 Mathematical Geoscience

1. A. C. Fowler, *Mathematical Geoscience* (Springer, 2011).
2. J. T. Houghton, *The Physics of Atmospheres* (3rd edition, Cambridge University Press, Cambridge, 2002).
3. K. Richards, *Rivers* (Methuen, 1982).
4. K. M. Cuffrey and W. S. B. Paterson, *The Physics of Glaciers* (4th edition, Butterworth-Heinemann, 2011).

2.5 Mathematical Physiology

1. J. Keener and J. Sneyd, *Mathematical Physiology* (Springer–Verlag, 1998 or 2009).
2. J. D. Murray, *Mathematical Biology* (Springer–Verlag, 2nd edition, 1993 or 3rd editions, Volumes I and II, 2003).
3. L. Glass and M. C. Mackey, *From Clocks to Chaos* (Princeton University Press, 1988).
4. P. Grindrod, *Patterns and Waves* (Oxford University Press, 1991).
5. R. M. Berne and M. N. Levy, *Principles of Physiology* (2nd edition, Mosby, St. Louis, 1996).
6. J. R. Levick, *An Introduction to Cardiovascular Physiology* (3rd edition, Butterworth–Heinemann, Oxford, 2000).
7. A. C. Guyton and J. E. Hall, *Textbook of Medical Physiology* (10th edition, W. B. Saunders Co., Philadelphia, 2000).

2.6 Perturbation Methods

1. E. J. Hinch, *Perturbation Methods* (Cambridge University Press, 1991).
2. C. M. Bender and S. A. Orszag, *Advanced Mathematical Methods for Scientists and Engineers* (Springer, 1999).
3. J. Kevorkian and J. D. Cole, *Perturbation Methods in Applied Mathematics* (Springer–Verlag, 1981).

2.7 Solid Mechanics

1. R. J. Atkin and N. Fox, *An Introduction to the Theory of Elasticity* (Courier Corporation, 2013)
2. M. E. Gurtin, *An Introduction to Continuum Mechanics* (Academic Press, 1982).
3. S. S. Antman, *Nonlinear Problems of Elasticity* (vol 107 of Applied Mathematical Sciences, Springer, 2015).
4. J. E. Marsden and T. J. R. Hughes, *Mathematical Foundations of Elasticity* (Courier Corporation, 1994).
5. P. G. Ciarlet, *Mathematical Elasticity*, Studies in Mathematics and its Applications; v. 20, 27, 29 (North–Holland, 1988).
6. K. Bhattacharya, *Microstructure of Martensite: Why it Forms and How it Gives Rise to the Shape-Memory Effect* (Oxford University Press, 2003)

2.8 Statistical Mechanics

1. D. Chandler, *Introduction to Modern Statistical Mechanics* (Oxford University Press, 1987).
2. M. Kardar, *Statistical Physics of Particles* (Cambridge University Press, 2007).
3. F. Schwabl, *Statistical Mechanics* (Springer-Verlag, 2002).
4. J. P. Sethna, *Entropy, Order Parameters, and Complexity* (Oxford University Press, 2006). Available online at http://pages.physics.cornell.edu/sethna/StatMech.

2.9 Stochastic Differential Equations

1. M. Yor and D. Revaz, *Continuous Martingales and Brownian Motion* (3rd Edition, Springer, 2010).
2. R. Durrett, *Stochastic Calculus* (CRC Press, 1996).
3. N. Ikeda and S. Watanabe, *Stochastic Differential Equations and Diffusion Processes* (North-Holland Publishing Company, 1989).

4. I. Karatzas and S. E. Shreve, *Brownian Motion and Stochastic Calculus,* Graduate Texts in Mathematics 113 (Springer-Verlag, 1988).

5. L. C. G. Rogers and D. Williams, *Diffusions, Markov Processes and Martingales Vol. 1 (Foundations) and Vol. 2 (Itô Calculus)* (Cambridge University Press, 1987 and 1994).

6. H. P. McKean, *Stochastic Integrals* (Academic Press, New York and London, 1969).

7. B. Øksendal, *Stochastic Differential Equations: An Introduction with Applications* (Universitext, Springer, 6th edition, 2003).

2.10 Topics in Fluid Mechanics

1. L. G. Leal, *Advanced Transport Phenomena* (Cambridge University Press, Cambridge, 2007).

2. O. M. Phillips, *Geological Fluid Dynamics* (Cambridge University Press, Cambridge, 2009).

3. J. S. Turner, *Buoyancy Effects in Fluids* (Cambridge University Press, Cambridge, 1973).

4. A. C. Fowler, *Mathematical Models in the Applied Sciences* (Cambridge University Press, 1997).

5. G. K. Batchelor, H. K. Moffatt and M. G. Worster (eds.), *Perspectives in Fluid Dynamics* (Cambridge University Press, Cambridge, 2000).

2.11 Viscous Flow

1. D. J. Acheson, *Elementary Fluid Dynamics* (Oxford University Press, 1990).

2. H. Ockendon and J. R. Ockendon, *Viscous Flow* (Cambridge Texts in Applied Mathematics, 1995).

3. M. Van Dyke, *An Album of Fluid Motion* (Parabolic Pr, 1982).

4. G. K. Batchelor, *An Introduction to Fluid Dynamics* (Cambridge University Press, Cambridge, 2000).

5. C. C. Lin and L. A. Segel, *Mathematics Applied to Deterministic Problems in Natural Sciences* (Society of Industrial and Applied Mathematics, 1998).

6. L. A. Segel, *Mathematics Applied to Continuum Mechancis* (Society for Industrial and Applied Mathematics, 2007).

2.12 Applied Complex Variables

1. G. F. Carrier, M. Krook and C. E. Pearson, *Functions of a Complex Variable* (Society for Industrial and Applied Mathematics, 2005).
2. M. J. Ablowitz and A. S. Fokas, *Complex Variables: Introduction and Applications* (2nd edition, Cambridge University Press, Cambridge, 2003).
3. J. R. Ockendon, S. D. Howison, A. A. Lacey and A. B. Movchan, *Applied Partial Differential Equations* (Oxford University Press, Oxford, 1999) Pages 195–212.

2.13 Computational Algebraic Topology

1. H. Edelsbrunner and J. L. Harer, *Computational Topology — An Introduction* (AMS, 2010).
2. G. Carlsson, *Topology and Data* (Bulletin A.M.S., Vol. 46, pages 255–308, 2009).
3. H. Edelsbrunner and J. L. Harer, *Persistent Homology: A Survey* (Contemporary Mathematics, A.M.S., Vol. 452, pages 257–282, 2008).
4. S. Weinberger, *What is ... Persistent Homology* (Notices A.M.S., Vol. 58, pages 36–39, 2011).
5. P. Bubenik and J. Scott, *Categorification of Persistent Homology* (Discrete Comput. Geom., pages 600–627, 2014).
6. S. Abramsky and A. Brandenburger, *The Sheaf-Theoretic Structure Of Non-Locality and Contextuality* (New Journal of Physics, Vol. 13, article 113036, 2011).
7. S. Abramsky and L. Hardy, *Logical Bell Inequalities* (Phys. Rev. A, Vol. 85, article 062114, 2012).
8. S. Abramsky, S. Mansfield and R. Soares Barbosa, *The Cohomology of Non-Locality and Contextuality* (In Proceedings of Quantum Physics and Logic 2011, Electronic Proceedings in Theoretical Computer Science, Vol. 95, pages 1–15, 2012).

2.14 Continuum Models in Industry

1. A. B. Tayler, *Mathematical Models in Applied Mechanics* (OUP, 2001).
2. S. D. Howison, *Practical Applied Mathematics: Modelling, Analysis, Approximation* (CUP, 2005).
3. A. C. Fowler, *Mathematical Models in the Applied Sciences* (CUP, 1997).

2.15 Elasticity and Plasticity

1. P. D. Howell, G. Kozyreff and J. R. Ockendon, *Applied Solid Mechanics* (Cambridge University Press, 2008).
2. S. P. Timoshenko and J. N. Goodier, *Theory of Elasticity* (McGraw-Hill, 1970).
3. L. D. Landau and E. M. Lifshitz, *Theory of Elasticity* (Pergamon Press, 1986).

2.16 Finite Element Methods for Partial Differential Equations

1. H. C. Elman, D. J. Silvester and A. J. Wathen, *Finite Elements and Fast Iterative Solvers* (Oxford University Press, 2005 or 2nd edition 2014).
2. S. C. Brenner and L. R. Scott, *The Mathematical Theory of Finite Element Methods* (Springer, 2nd edition, 2002).
3. C. Johnson, *Numerical Solution of Partial Differential Equations by the Finite Element Method* (Cambridge University Press, 1990).
4. E. Süli and D. Mayers, *An Introduction to Numerical Analysis* (Cambridge University Press, 2003). (Chapters 11 and 14 for some introductory material).

2.17 Mathematical Analytics

1. P. Grindrod, *The Mathematical Underpinnings of Analytics* (OUP, 2014).
2. E. T. Jaynes and G. L. Bretthorst, *Probability Theory: The Logic of Science* (CUP, 2003).

2.18 Mathematical Mechanical Biology

1. R. Phillips, J. Kondev, J. Theriot and H. Garcia, *Physical Biology of the Cell* (2nd edition, Garland Science, 2012).
2. J. D. Humphrey, *Cardiovascular Solid Mechanics: Cells, Tissues, and Organs* (Springer, 2002).
3. G. A. Holzapfel, *Nonlinear Solid Mechanics: A Continuum Approach for Enineering* (Wiley, 2000).

2.19 Mathematical Models of Financial Derivatives

1. S. E. Shreve, *Stochastic Calculus for Finance* (Volumes I and II, Springer, 2004).
2. T. Bjork, *Arbitrage Theory in Continuous Time* (Oxford University Press, 1998).
3. P. Wilmott, S. D. Howison and J. Dewynne, *Mathematics of Financial Derivatives* (Cambridge University Press, 1995).
4. A. Etheridge, *A Course in Financial Calculus* (Cambridge University Press, 2002).
5. J. Hull, *Options Futures and Other Financial Derivative Products* (4th edition, Prentice Hall, 2001).

2.20 Mathematics for Energy

1. D. Mackay, *Sustainable Energy — Without the Hot Air.*
(Download from http://www.withouthotair.com/)

2.21 Networks

1. A. Barrat, M. Barthélemy and A. Vespignani, *Dynamical Processes on Complex Networks* (Cambridge University Press, 2008).

2. M. E. J. Newman, *Networks: An Introduction* (Oxford University Press, 2010).

2.22 Numerical Solution of Differential Equations II

1. A. Iserles, *A First Course in the Numerical Analysis of Differential Equations* (Cambridge University Press, second edition, 2009).

2. R. LeVeque, *Finite Difference Methods for Ordinary and Partial Differential Equations* (SIAM, 2007). Only Chapter 10.

3. R. LeVeque, *Numerical Methods for Conservation Laws* (Birkhaüser 1992).

2.23 Stochastic Modelling of Biological Processes

1. R. Erban, J. Chapman and P. Maini, *A practical guide to stochastic simulations of reaction-diffusion processes* (2007). Available at http://arxiv.org/abs/0704.1908

2. H. Berg, *Random Walks in Biology* (Princeton University Press, 1993).

3. D. T. Gillespie, *Markov Processes, an Introduction for Physical Scientists* (Gulf Professional Publishing, 1992).

4. D. T. Gillespie and E. Seitaridou, *Simple Brownian Diffusion: An Introduction to the Standard Theoretical Models* (Oxford University Press, 2012).

5. D. J. Wilkinson, *Stochastic Modelling for Systems Biology* (2nd Edition, CRC Press, 2011).

6. L. S. Allen, *An Introduction to Stochastic Processes with Applications to Biology* (2nd Edition, CRC Press, 2010).

2.24 Waves and Compressible Flow

1. H. Ockendon and J. R. Ockendon, *Waves and Compressible Flow* (Springer, 2004).

2. D. J. Acheson, *Elementary Fluid Dynamics* (Oxford University Press, 1990). Only Chapter 3.

3. J. Billingham and A. C. King, *Wave Motion* (Cambridge University Press, 2000).

4. M. J. Lighthill, *Waves in Fluids* (Cambridge University Press, 1978).

5. G. B. Whitham, *Linear and Nonlinear Waves* (Wiley, 1973).

2.25 Algorithmic Differentiation

1. Uwe Naumann, *The Art of Differentiating Computer Programs. An Introduction to Algorithmic Differentiation* (SIAM, 2012).

2.26 C++ for Scientific Computing

1. J. Pitt-Francis and J. Whiteley, *Guide to Scientific Computing in C++* (Springer 2012).

2.27 Python in Scientific Computing

1. H. C. Elman, D. J. Silvester and A. J. Wathen, *Finite Elements and Fast Iterative Solvers* (Oxford University Press, 1st edition 2005 or 2nd edition 2014). Chapter 1.