M.Sc. in Mathematical Modelling and Scientific Computing

Reading List

September 2020

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

2. Y. A. Kuznetsov, *Elements of Applied Bifurcation Theory* (Second edition, Springer, 1998).

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

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

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

6. J. Guckenheimer and P. J. Holmes, *Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields* (Springer, 1983).

7. P. E. Hydon, *Symmetry Methods for Differential Equations: A Beginner's Guide* (Vol. 22, Cambridge University Press, 2000).

8. G. I. Barenblatt and B. G. Isaakovich, *Scaling, Self-Similarity, and Intermediate Asymptotics: Dimensional Analysis and Intermediate Asymptotics* (Vol. 14, Cambridge University Press, 1996).

9. E. J. Hinch, *Perturbation Methods* (Cambridge University Press, 1991).

10. H. Ockendon and J. R. Ockendon, *Viscous Flow* (Vol. 13, Cambridge University Press, 1995).

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

12. A. B. Tayler, *Mathematical Models in Applied Mechanics* (Vol. 4, Oxford University Press, 2001).

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). [Chapters 1–6, 16].

2. R. LeVeque, *Finite Difference Methods for Ordinary and Partial Differential Equations* (SIAM, 2007). [Chapters 5-9].

3. E. Süli and D. Mayers, *An Introduction to Numerical Analysis* (Cambridge University Press, 2006). [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). [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. L. Edelstein-Keshet, *Mathematical Models in Biology* (SIAM, 2005).
4. J. Keener and J. Sneyd, *Mathematical Physiology* (1st edition, Springer, Berlin, 1998).
5. N. F . Britton, *Essential Mathematical Biology* (Springer, London, 2003).

2.3 Integer Programming

1. M. Conforti, G. Cornuéjols, and G. Zambelli, *Integer Programming* (Springer, 2014).
2. L. A. Wolsey, *Integer Programming* (John Wiley & Sons, 1998). [Parts of Chapters 1–5 and 7].

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. Cuffey 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). [Chapters 1–3, 5–7].

2. C. M. Bender and S. A. Orszag, *Advanced Mathematical Methods for Scientists and Engineers* (Springer, 1999). [Chapters 6, 7, 9–11].

3. J. Kevorkian and J. D. Cole, *Perturbation Methods in Applied Mathematics* (Springer–Verlag, 1981). [Chapters 1, 2.1–2.5, 3.1, 3.2, 3.6, 4.1, 5.2].

2.7 Solid Mechanics

1. R. Ogden, *Nonlinear Elastic Deformations*, (Dover, 1997).

2. M. E. Gurtin, *An Introduction to Continuum Mechanics* (Academic Press, 1982).

3. A. Goriely, *The Mathematics and Mechanics of Biological Growth*, (Springer, 2017). [Chapters 4 and 11].

4. S. S. Antman, *Nonlinear Problems of Elasticity* (vol 107 of Applied Mathematical Sciences, Springer, 2015).

5. P. G. Ciarlet, *Mathematical Elasticity*, Studies in Mathematics and its Applications; v. 20, 27, 29 (North–Holland, 1988).

2.8 Stochastic Differential Equations

1. M. Yor and D. Revaz, *Continuous Martingales and Brownian Motion* (3rd Edition, Springer, 2010).

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

3. 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).

4. R. Durrett, *Stochastic Calculus* (CRC Press, 1996).

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

6. N. Ikeda and S. Watanabe, *Stochastic Differential Equations and Diffusion Processes* (North-Holland Publishing Company, 1989).

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

2.9 Theories of Deep Learning

1. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*, Adaptive Computation and Machine Learning Series (MIT Press, 2017).

2.10 Topics in Fluid Mechanics

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

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

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

4. J. Pedlosky, *Geophysical Fluid Dynamics*, (Springer-Verlag, New York, 2nd edition, 1987).

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. R. P. Feynman, R. B. Leighton, and M. Sands, *The Feynman Lectures on Physics, volume II* (Addison Wesley, 1964). [Chapter 41 "The Flow of Wet Water" available at http://www.feynmanlectures.caltech.edu/II_41.html].

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

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

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

7. 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. G. Carlsson, *Topology and Data* (Bulletin A.M.S., Vol. 46, pages 255–308, 2009).

2. H. Edelsbrunner and J. L. Harer, *Persistent Homology: A Survey* (Contemporary Mathematics, A.M.S., Vol. 452, pages 257–282, 2008).

3. S. Weinberger, *What is ... Persistent Homology* (Notices A.M.S., Vol. 58, pages 36–39, 2011).

4. P. Bubenik and J. Scott, *Categorification of Persistent Homology* (Discrete Comput. Geom., pages 600–627, 2014).

5. S. Abramsky and A. Brandenburger, *The Sheaf-Theoretic Structure Of Non-Locality and Contextuality* (New Journal of Physics, Vol. 13, article 113036, 2011).

6. S. Abramsky and L. Hardy, *Logical Bell Inequalities* (Phys. Rev. A, Vol. 85, article 062114, 2012).

7. 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 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).

2.15 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, 1st edition, 2005 [mainly Chapters 1 and 5] or 2nd edition, 2014 [mainly Chapters 1 and 3]).

2. S. C. Brenner and L. R. Scott, *The Mathematical Theory of Finite Element Methods* (Springer, 2nd edition, 2002). [Chapters 0–3, Chapter 4: Sections 4.1–4.4, Chapter 5: Sections 5.1–5.7].

3. C. Johnson, *Numerical Solution of Partial Differential Equations by the Finite Element Method* (Cambridge University Press, 1990). [Chapters 1–4; Chapter 8: Sections 8.1–8.4.2; Chapter 9: Sections 9.1–9.5].

4. E. Süli and D. Mayers, *An Introduction to Numerical Analysis* (Cambridge University Press, 2003). [Chapters 11 and 14 for some introductory material].

2.16 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).

4. A. Goriely, *The Mathematics and Mechanics of Biological Growth* (Springer, 2017).

2.17 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).

2.18 Networks

(course lecture notes)

2.19 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). [Chapters 8–10, 17].

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

3. R. LeVeque, *Numerical Methods for Conservation Laws* (Birkhaüser 1992). [Chapters 10–16].

2.20 Statistical Mechanics

1. J. P. Sethna, *Entropy, Order Parameters, and Complexity* (Oxford University Press 2006).
2. F. Schwabl, *Statistical Mechanics* (Springer-Verlag 2002).
3. David Chandler, *Introduction to Modern Statistical Mechanics* (Oxford University Press 1987).
4. M. Kardar, *Statistical Physics of Particles* (Cambridge University Press 2007).
5. M. Kardar, *Statistical Physics of Fields* (Cambridge University Press 2007).

2.21 Stochastic Modelling of Biological Processes

1. R. Erban and S. J. Chapman, *Stochastic Modelling of Reaction-Diffusion Processes* (Cambridge University Press, 2019).
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. P. Attard, *Non-Equilibrium Thermodynamics and Statistical Mechanics* (Oxford University Press, 2012).
5. A. Nitzan, *Chemical Dynamics in Condensed Phases* (Oxford University Press, 2006).
6. P. Krapivsky, S. Redner and E. Ben-Naim, *A Kinetic View of Statistical Physics* (Cambridge University Press, 2010).
7. D. Anderson and T. Kurtz, *Stochastic Analysis of Biochemical Systems* (Springer, 2015).
8. B. Leimkuhler and C. Matthews, *Molecular Dynamics: with Deterministic and Stochastic Numerical Methods* (Springer, 2015).

2.22 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). [Chapter 3].
3. J. Billingham and A. C. King, *Wave Motion* (Cambridge University Press, 2000). [Chapters 1–4, 7, 8].
4. M. J. Lighthill, *Waves in Fluids* (Cambridge University Press, 1978).
5. G. B. Whitham, *Linear and Nonlinear Waves* (Wiley, 1973).

2.23 C++ for Scientific Computing

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

2.24 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].