# Graduate Material

- Center for Nonlinear Studies Los Alamos National Laboratory. The eleventh workshop on mathematical problems in industry June, 1995. Technical Report LA–UR 95–4038, Center for Nonlinear Studies, Los Alamos National Laboratory, 1995.

  This report has open problems presented by industry representatives to the workshop participants. To use these problems for projects, the instructor will have to spend quite a bit of time on developing them into a form appropriate for students.

- J. A. Adam and N. Bellomo. *A Survey of Models for Tumor-Immune System Dynamics*. Modeling and Simulation in Science, Engineering and Technology, Birkhäuser, 1996.

  This book is a collection of modeling projects on the interaction between tumor growth and immune system. Most of the projects require advanced mathematical tools to be investigated. This book can be used for an advanced graduate mathematical modeling class whose audience is intersted in biology and medecine. The book tries to be self-contained from the mathematician prospective. The students for such a class would need to have broad knowledge in applied mathematics, numerical analysis, and partial differential equations.

- J. G. Andrews and R. R. McLone. *Mathematical Modelling*. Butterworths, 1976.

  This book is a collection of modeling projects that will be solved with advanced mathematical tools. It has a very good chapter on how to set up mathematical models from the description of the problem. It can be used in an introductory graduate class in mathematical modeling. The models considered cover a wide range of applications.

- M. Braun, C. S. Coleman, and D. A. Drew, Eds. *Differential Equation Models*. Springer–Verlag, 1978.

  This book is a collection of modeling projects that will be solved with advanced mathematical tools. It has a very good chapter on how to set up a differential equation model from the description of the problem. It can be used in an introductory graduate class in mathematical modeling. The models considered are population, traffic flow, heat transfer, and flow models.

- J. D. Buckmaster and G. S. S. Ludford. *Lectures on Mathematical Combustion*, volume 43 of *CBMS-NSF Regional Conference Series in Applied Mathematics*. SIAM, 1983.

  This book concentrates on mathematical models in combustion. These models require knowledge of partial differential equations and are challenging mathematically. The problems require a rather strong mathematical background; they can be a starting point for advanced projects or a thesis.

- P. Doucet and P. B. Sloep. *Mathematical Modeling in the Life Sciences.* Ellis Horwood, 1992.

  This book would give good lectures ideas and projects if you were to teach modeling class for a non science audience. It requires knowledge in differential equations, probability, and statistics and it is self-contained since the first half of the book is a summary of the methods needed to solve the problems presented in the second half. Two chapters are discussing the modeling philosophy. This book could be used for an introductory graduate class.

- L. Edelstein–Keshet. *Mathematical Models in Biology.* Random House, 1987.

  This book considers three different types of models: discrete, continuous, and spatially distributed. It can give good ideas for lectures if you want to spend all or the majority of the time on models in biology. The discrete and some of the continuous models may be of interest but they will not present a mathematical challenge to graduate students.

- B. G. Fitzpatrick and H. T. Tran, Editors. Industrial Mathematics Modeling Workshop for Graduate Students. Technical Report CRSC-TR96-7, Center for Research in Scientific Computation, North Carolina State University, 1996.

  This report has real-world problems from industry or applied science. These problems are interesting and challenging mathematically; they require a rather strong mathematical background. They can be a starting point for advanced projects.

- N. D. Fowkes and J. J. Mahony. *An Introduction to Mathematical Modelling.* Wiley, 1994.

  The book covers numerous interesting modeling projects. It has a section on scales and dimensional analysis. The title of the book is only justified by the fact that the models derived are rather simple; the mathematics used to solve then is rather advanced.

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

  This book presents a short review on techniques used to solve modeling problems and a series of problems which are rather challenging. This book could be used as a text book for an advanced graduate class. The students for such a class would need to have broad knowledge in applied mathematics, numerical analysis, asymptotic analysis, perturbation methods, and techniques for nonlinear equations.

- A. Friedman. *Mathematics in Industrial Problems*, volume 16 of *IMA Volume in Mathematics and its Applications.* Springer–Verlag, 1988.

- A. Friedman. *Mathematics in Industrial Problems, Part II*, volume 24 of *IMA Volume in Mathematics and its Applications.* Springer–Verlag, 1989.

- A. Friedman. *Mathematics in Industrial Problems, Part III*, volume 31 of *IMA Volume in Mathematics and its Applications*. Springer–Verlag, 1990.

- A. Friedman. *Mathematics in Industrial Problems, Part IV*, volume 38 of *IMA Volume in Mathematics and its Applications*. Springer–Verlag, 1991.

- A. Friedman. *Mathematics in Industrial Problems, Part V*, volume 49 of *IMA Volume in Mathematics and its Applications*. Springer–Verlag, 1992.

- A. Friedman. *Mathematics in Industrial Problems, Part VI*, volume 57 of *IMA Volume in Mathematics and its Applications*. Springer–Verlag, 1993.

- A. Friedman. *Mathematics in Industrial Problems, Part VII*, volume 67 of *IMA Volume in Mathematics and its Applications*. Springer–Verlag, 1995.

  These books contain a collection of problems coming from industry, covering a broad range of areas. These problems are interesting and challenging mathematically; they require a rather strong mathematical background. They can be a starting point for advanced projects or thesis. See Kapila's [3] or Ockendon's [4] reviews for further information on some of these books.

- A. Friedman and R. Gulliver, Organizers, Mathematical Modeling for Instructors, july 29-August 16, 1996. Institute for Mathematics and its Applications technical Report 1422, 1996.

  This report gathers a collection of problems on which teams of student instructors and graduate students worked on for 10 days while attending the IMA Mathematical Modeling workshop. the audience needs to have some knowledge in physics, ODEs, PDEs, and some computational experience. Most of the problems presented here require a broad range of applied mathematics tools and can be quite challenging.

- D. Greenspan. *Particle Modeling*. Birkhäuser, 1997.

  This book has a collection of interesting problems which are solved with a particle method. The audience needs to have some knowledge in physics, ODEs, PDEs, and some computational experience. Most of the problems presented here require a broad range of applied mathematics and numerical analysis tools can be quite challenging if studied in depth. The instructor may not be able to get his lectures right out of the textbook.

- R. Haberman. *Mathematical Models*. Prentice–Hall, 1977.

  This book requires knowledge of physics, ODEs, PDEs, and the method of characteristics. It can give very good examples for lectures or projects.

- H. W. Hethcote and J. W. Van Ark. *Modeling HIV Transmission and AIDS in the United States*, volume 95 of *Lectures Notes in Biomathematics*. Springer–Verlag, 1992.

This book requires knowledge of ODEs. It can give ideas for projects or thesis problems.

- J. C. Hull. *Options and Futures and Other Derivatives Securities.* Prentice–Hall, second edition, 1993.

  This book requires knowledge of stochastic PDEs and of the financial markets lingo. It can give good ideas for projects or thesis.

- J. N. Kapur. *Mathematical Modelling.* Wiley 1988.

  This book considers mathematical modeling with a different perspective than most of the other books listed here: it introduces it through one or more specific techniques rather than through obtaining an insight on real-world problems with mathematical tools.

- C. C. Lin and L. A. Segal. *Mathematics Applied to Deterministic Problems in the Natural Sciences.* SIAM, 1988.

  This book requires a good background in physics, ODEs, PDEs, and methods in applied mathematics. It covers interesting topics and can give good lecture ideas or projects.

- J. D. Logan. *Applied Mathematics: A Contemporary Approach.* Wiley, 1987.

  This book requires a strong mathematical background and has a modeling approach about teaching methods in applied mathematics. The techniques are taught in the context of a physical problem and the first chapter of the book is on dimensional analysis.

- P. A. Markowich, C. A. Ringhofer, and C. Schmeiser. *Semiconductor Equations.* Springer–Verlag, 1990.

  This book requires knowledge in physics, ODEs, PDEs, functional analysis, and methods in applied mathematics. It can give good ideas for projects and thesis. See Gardner's review [2] for further information on the book.

- J. D. Murray. *Mathematical Biology.* Springer–Verlag, second edition, 1993.

  This book requires knowledge in ODEs and PDEs. All the models are deterministic and the book is self-contained when it comes to biology. It can give ideas for projects or dissertations. See Bell's review [1] for further information on the book.

- H. G. Othmer, F. R. Adler, M. A. Lewis, and J. C. Dallon. *Case Studies in Mathematical Modeling – Ecology, Physiology, and Cell Biology.* Prentice–Hall, 1997.

  This book is for an audience of graduate students who already have research experience and of researchers who both have knowledge in mathematics and biology. The reader needs to have a strong background in ODEs, PDEs, stochastic processes, and numerical techniques since the appendices succinctly present the results needed to solve the models. This book is very nice and really illustrates what can be achieved with mathematical modeling in biology. It can be used in an advanced graduate class on biological modeling, for projects, and to get dissertation problems.

Additional unevaluated references for graduate classes

- M. B. Allen III, I. Herrera, and G. F. Pinder. *Numerical Modeling in Science and Engineering*. Wiley, 1988.
- M. Anthony and N. Biggs. *Mathematics for Economics and Finance: Methods and Modelling*. Cambridge University Press, 1996.
- N. Bellomo and L. Preziosi. *Modelling Mathematical Methods and Scientific Computation*. CRC Press, 1994.
- W. E. Boyce. *Case Studies in Mathematical Modeling*. Pitman, 1981.
- J. C. Frauenthal. *Introduction to Population Modeling*. Birkhauser, 1980.
- A. Friedman. *Mathematics in Industrial Problems, Part VIII*, volume 83 of *IMA Volume in Mathematics and its Applications*. Springer–Verlag, 1996.
- A. Friedman. *Mathematics in Industrial Problems, Part IX*, volume 88 of *IMA Volume in Mathematics and its Applications*. Springer–Verlag, 1997.
- A. Friedman. *Mathematics in Industrial Problems, Part X*, volume 100 of *IMA Volume in Mathematics and its Applications*. Springer–Verlag, 1998.
- G. Fulford, P. Forrester, and A. Jones. *Modelling with Differential and Difference Equations*. Cambridge University Press, 1997.
- S. G. Krantz. *Techniques of Problem Solving*. AMS, 1997.
- J. T. Sandefur. *Discrete Dynamical Modeling*. Oxford University Press, 1993.
- T. P. Svobodny. *Mathematical Modeling for Industry and Engineering*. Prentice-Hall, 1998.

# Book Reviews

[1] J. G. Bell. Book review of *Mathematical Biology* by J. D. Murray. *SIAM Rev.*, 32:487–489, 1990.

[2] C. L. Gardner. Book review of *Semiconductor Equations* by P. A. Markowich, C. A. Ringhofer, and C. Schmeiser. *SIAM Rev.*, 33:675–677, 1991.

[3] A. K. Kapila. Book review of *Mathematics in Industrial Problems* and *Mathematics in Industrial Problems, Part 2* by A. Friedman. *SIAM Rev.*, 32:506–507, 1990.

[4] J. R. Ockendon. Book review of *Mathematics in Industrial Problems, Part 4* by A. Friedman. *SIAM Rev.*, 34:679–680, 1992.