References for M647

During the course of the semester we will discuss the role of modeling in a wide range of disciplines, and so it's fairly natural that we will have quite a few references.

General Modeling

Since M647 is a course in modeling, I will list here all the reasonably good modeling texts that I'm familiar with. Certainly, we won't be reading all these or even taking material from all of them.

1. *Modeling Basics*, by P. Howard, available on the course web site.

These notes include discussions of regression, parameter estimation, dimensional analysis, and non-dimensionalization. I wrote these notes for the undergraduate mathematical modeling course M442, and so our discussion will differ somewhat, but much of the basic material is the same.

2. *Modeling with ODE*, by P. Howard, available on the course web site.

In these notes, I dicuss our main topics in modeling with ODE: compartment models, chemical reaction kinetics, population dynamics, and mechanics (Newtonian, Hamiltonian, and Lagrangian).

3. *An Introduction to Mathematical Modeling*, by Edward A. Bender, Dover 2000 reprint of the 1978 original.

4. *Mathematical Models: Mechanical Vibrations, Population Dynamics, and Traffic Flow*, by Richard Haberman, SIAM 1998 reprint of the 1977 original.

5. *A Concrete Approach to Mathematical Modeling*, by Michael Mesterton-Gibbons, Wiley-Interscience 1995.

6. *Industrial Mathematics: Modeling in Industry, Science, and Government*, by Charles R. MacCluer Prentice Hall 2000.

7. *Topics in Mathematical Modeling*, by K. K. Tung, Princeton University Press 2007.

This is a modeling text for undergraduates that assumes minimal preparation (a semester or two of calculus) and has several interesting applications.

MATLAB

Except for a necessary introduction to MATLAB that I'll give in the first two lectures, we will learn MATLAB as we need it for our applications. Nonetheless, students may want a reference that provides a broad overview of the software.

1. *MATLAB Basics*, by P. Howard, available on the course web site.

I wrote the first version of these notes several years ago, and I've tried to update them as new versions of MATLAB have appeared.

2. *Solving ODE in MATLAB*, by P. Howard, available on the course web site.

3. *Solving PDE in MATLAB*, by P. Howard, available on the course web site.

4. *MATLAB: An Introduction with Applications*, 3rd Ed., by Amos Gilat Wiley 2008.

This is a good, brief introduction to MATLAB with an emphasis on scientific computation. (Gilat is a mechanical engineer.) There is a 4th edition to this book, but I haven't picked it up yet.

5. *Mastering MATLAB 7*, by Duane Hanselman and Bruce Littlefield, Pearson / Prentice Hall 2005.

This is a MATLAB reference with a considerable amount of material on basic functionality such as data types and logical operations. Our emphasis will be on scientific computation, so this is a good book for picking up a lot of things I'll leave out.

Least Squares Regression

While regression is often briefly discussed in modeling texts, details and technical aspects are generally omitted. For details, we'll turn to probability and statistics texts, including the one listed below.

1. *Probability and Statistical Inference Volume 2: Statistical Inference*, 2nd Ed., by J. G. Kalbfleisch, Springer-Verlag 1985.

Some of our discussion of least squares regression will be taken from Chapters 13 and 14 of this reference. In particular, a discussion of the matrix expression for linear regression coefficients can be found in Section 14.2, and a discussion of our marginal maximum likelihood estimator for variance can be found on page 204 in an unnumbered section "Inferences for σ."

Dimensional Analysis

Dimensional analysis is a standard modeling topic and is discussed in most modeling textbooks. For example, it is discussed in my *Modeling Basics* notes and in Bender's *An Introduction to Mathematical Modeling*, listed under General Modeling texts. We'll also take material from the following reference.

1. *Dimensional analysis and intelligent experimentation*, by Andew C. Palmer, World Scientific 2008.

Discrete Dynamical Systems

Unfortunately, we won't have time this semester to discuss discrete dynamical systems, but these are the references I would probably use if we did have time.

1. *Introduction to Mathematical Modeling Using Discrete Dynamical Systems*, by Frederick R. Marotto, Thomson / Brooks/Cole, 2006.

This is an elementary text intended for Freshmen students.

2. *Discrete Dynamical Systems*, by Oded Galor, Springer 2010.

Ordinary Differential Equations

For the most part we'll take our discussion of modeling with ODE from discipline specific texts such as *The Feynman Lectures on Physics* for mechanics and Murray's *Mathematical Biology* for biology. However, I would additionally like to suggest three good references on the analysis of ODE.

1. *Fundamentals of Differential Equations and Boundary Value Problems*, 4th Ed., by R. Kent Nagle, Edward B. Saff, and Arthur David Snider, Pearson / Addition-Wesley 2004.

This is a standard introductory undergraduate text in ODE.

2. *The Qualitative Theory of Ordinary Differential Equations: An Introduction*, by Fred Brauer and John A. Nohel, Dover 1989 reprint of the 1969 original.

Unfortunately, few undergraduates have a chance to take a full year of qualitative ODE theory, but this is the sort of book that might be used for such a course.

3. *Ordinary Differential Equations*, by Jack K. Hale, Dover 2009 reprint of the 1980 original.

This is my favorite graduate text on ODE. It's a challenging book, but ultimately a good one.

Partial Differential Equations

As with ODE, our study of PDE will mostly be taken from discipline-specific texts, but I would be remiss if I didn't provide a few standard references.

1. *Applied Partial Differential Equations with Fourier Series and Boundary Value Problems*, 4th Ed., by Richard Haberman, Pearson / Prentice Hall 2004.

This is the standard introductory undergraduate PDE text we use at Texas A&M.

2. *Partial Differential Equations*, by Lawrence C. Evans, American Mathematical Society 1998.

We use this book for the graduate PDE sequence at Texas A&M M611-M612.

3. *Linear and Nonlinear Waves*, by G. B. Whitham, Wiley Interscience 1999 reprint of the 1974 original.

Whitham discusses how PDE arise in many applied contexts, so this can almost be regarded as a textbook on modeling with PDE.

Probability and Stochastic Modeling

This is another area (along with discrete dynamical systems) that we won't have time to discuss this semester, but again these are the references I suggest.

1. *Modeling with Probability*, by P. Howard, available on the course web site.

2. *Introduction to Probability Models*, by Sheldon M. Ross, 4th Ed., Academic Press 1989.

3. *Stochastic Differential Equations: An Introduction with Applications*, by Bernt Oksendal, 4th Ed. Springer 1995.

This is my favorite introductory text in the area of stochastic differential equations.

Applied Analysis

When we develop a new model we of course have in mind using it to understand elements of our application. In many cases, it's productive to apply ideas from real and functional analysis to the study of such models, and this is roughly what we mean by applied analysis.

1. *Principles of Applied Mathematics: Transformations and Approximations*, 2nd Ed., by James P. Keener, Westview Press 2000.

This is the book used for the course sequence M641/M642, Analysis for Applications I & II.

Application Areas

In most cases, we'll take our discussions of applications from texts in the application areas.

Physics

1. *The Feynman Lectures on Physics, Volumes I-III*, by R. Feynman, R. Leighton, and M. Sands, Pearson / Addison Wesley 2006.

Although these lectures were given in the early 1960s, they still comprise the best general overview of physics that I'm aware of.

2. *The Road to Reality: A Complete Guide to the Laws of the Universe*, by Roger Penrose, Knopf 2005.

Penrose's claim that this is intended as a general-audience book starts to become suspect when he introduces vector fields and differential forms. Then when he gets to tensors...

3. *Mathematics of Classical and Quantum Physics*, by Frederick W. Byron, Jr. and Robert W. Fuller, Dover 1992 corrected edition of the two-volume 1969-1970 originals.

Chemistry

1. *General Chemistry*, by Linus Pauling, Dover 1988 reprint of the 1970 original.

Even forty years later, I continue to regard this as the standard first reference on chemistry.

Biology

1. *Biology*, 8th Ed., by Neil A. Campbell et al, Pearson / Benjamin Cummings 2008.

This is the freshmen biology text used at Texas A&M and most other universities, and it provides a solid foundation in elementary concepts from biology.

2. *Mathematical Biology*, 2nd Ed., by J. D. Murray, Springer 1993.

Murray's text was one of the first in mathematical biology, and is still considered a standard reference.

3. *Mathematical Biology II: Spatial models and biomedical applications*, 3rd Ed. by J. D. Murray, Springer 2003.

4. *Modeling Differential Equations in Biology*, by Clifford Henry Taubes, Prentice Hall 2001.

5. *Biomedical Engineering: Bridging Medicine and Technology*, by W. Mark Saltzman, Cambridge University press 2009.