Resources for a Modern Differential Equations Course

Henry J. Ricardo
Department of Mathematics
Medgar Evers College (CUNY)
1150 Carroll Street
Brooklyn, NY 11225
(718) 270-6118
herme@cunyvm.cuny.edu

After teaching calculus for several semesters using the CCH materials, I felt it was time to consider teaching a modern, reform differential equations course. I attended conferences and workshops. I read the journals and examined every recent textbook I could find. I learned about the power and limitations of graphing calculators and various software products. Finally I developed the picture of the kind of course I would try to teach.

To me, a "modern" differential equations course is one that develops a lean and lively group of topics from a dynamical systems perspective and uses technology to treat these topics graphically, numerically, and analytically. Such a course acknowledges that many (most?) differential equations cannot be solved in closed form and uses qualitative and numerical methods to analyze solutions. With emphasis on a student's ability to analyze problems orally and in writing, such a differential equations course is a natural successor to a reform calculus sequence.

What follows is a (partially annotated) list of resources that I hope will help others devise their own modern differential equations course. These resources are grouped into four categories: books, journal articles, software, and Internet sites. I welcome comments and additions.

BOOKS:

Differential Equations with Mathematica - M. Abell and J. Braselton
(Academic Press Professional, Orlando, FLA: 1993) ISBN 0-12-041539-9

Differential Equations with Maple - M. Abell and J. Braselton
(Academic Press Professional, Orlando, FLA: 1994) ISBN 0-12-041548-8

Modern Differential Equations: Theory, Applications, Technology - M. Abell and J. Braselton [+ Instructor's Resource Manual, Student Resource Manual]
(Saunders, Orlando, FLA: 1996) ISBN 0-03-098337-1

Differential Equations with Derive - D. C. Arney
(MathWare, Urbana, IL: 1993) ISBN 0-9623629-3-X

Exploring Differential Equations with DERIVE - D. C. Arney [+ Solutions Manual]
(Addison-Wesley, Reading, MA: 1993) ISBN 0-201-50723-4

Differential Equations (Preliminary Ed.) - P. Blanchard, R. Devaney, and G. Hall
(PWS, Boston: 1996) ISBN 0-534-95004-3

Differential Equations: A Modeling Approach - R. Borrelli and C. Coleman
[+ Instructor's Manual]
(Prentice-Hall, Englewood Cliffs, NJ: 1987) ISBN 0-13-211533-6

Differential Equations: A Modeling Perspective (Preliminary Ed.) - R. Borrelli
and C. Coleman [+ Instructor's Manual]
(Wiley, NY: 1996) ISBN 0-471-04181-5

Differential Equations Laboratory Workbook: A Collection of Experiments, Explorations and Modeling Projects for the Computer - R. Borrelli, C. Coleman, and W. Boyce
(Wiley, NY: 1992) ISBN 0-471-55142-2

Elementary Differential Equations and Boundary Value Problems (Sixth Ed.) - W. Boyce
and R. DiPrima [+ Student Solutions Manual, ODE Architect]
(Wiley, NY: **Aug., 1996**) ISBN 0-471-08955-9

Differential Equation Models - ed. by M. Braun, C. Coleman, and D. Drew
(Springer-Verlag, NY: 1983) ISBN 0-387-90695-9

Explorations in Differential Equations Using Maple - P. Bugl
(Prentice-Hall, Englewood Cliffs, NJ: 1995) ISBN 0-13-374752-2

Introduction to Differential Equations with Boundary Value Problems - S. Campbell and
R. Haberman [+ Instructor's Manual]
(Houghton Mifflin, Boston: 1996) ISBN 0-395-70828-1

Differential Equations with Mathematica - K. Coombes, B. Hunt, R. Lipsman, J. Osborn,
and G. Stuck [+ Instructor's Manual]
(Wiley, NY: 1995) ISBN 0-471-10874-X **[See new edition, Fall 1996]**

Differential Equations with Maple - K. Coombes, B. Hunt, R. Lipsman, J. Osborn,
and G. Stuck [+ Instructor's Manual]
(Wiley, NY: 1996) ISBN 0-471-10875-8 **[See new edition, Fall 1996]**

Differential Equations for Mathematics, Science, and Engineering - P. Davis
(Prentice-Hall, Englewood Cliffs, NJ: 1992) ISBN 0-13-211236-1

Modeling with Ordinary Differential Equations - T. P. Dreyer
(CRC, Boca Raton, FLA: 1993) ISBN 0-8493-8636-5

Differential Equations: Computing and Modeling - C. Edwards, Jr. and D. Penney
[+ Computing Projects Manual, Student Solns. Manual]
(Prentice-Hall, Englewood Cliffs, NJ: 1996) ISBN 0-13-382102-1

An Introduction to Differential Equations and Their Applications - S. Farlow
(McGraw-Hill, NY: 1994) ISBN 0-07-020030-0

Ordinary Differential Equations with Mathematica: A Media Approach - A. Gray, M. Mezzino, and M. Pinsky [+ CD-ROM]
(Springer-Verlag, NY: 1996) ISBN 0-387-94481-8 **[Forthcoming]**

Differential Equations: A Dynamical Systems Approach (Vol. 1: Ordinary Differential Equations; Vol. 2: Higher-Dimensional Systems) - J. Hubbard and B. West
(Springer-Verlag, NY: 1991, 1995) ISBN 0-387-97286-2, 0-387-94377-3

Calculus (Chapter 9) - D. Hughes-Hallett, A. Gleason, *et al*.

Differential and Difference Equations Through Computer Experiments (Second Ed.) - H. Koçak [+ *Phaser* software and lab manual]
(Springer-Verlag, NY: 1989) ISBN 0-387-96918-7

Introductory Differential Equations: From Linearity to Chaos (Preliminary Ed.) - E. Kostelich and D. Armbruster
(Addison-Wesley, Reading, MA: 1996) ISBN 0-201-82475-2

Exploring Differential Equations via Graphics and Data (Preliminary Ed.) - D. Lomen and D. Lovelock [+ Soln. Manual, Resource Manual, and DOS-based programs]
(Wiley, NY: 1996) ISBN 0-471-07649-X

Fundamentals of Differential Equations and Boundary Value Problems - R. Nagle and E. Saff [+ Instructor's Guide, Student Solution Manual]
(Addison-Wesley, Reading, MA: 1996) ISBN 0-201-80875-X

Using MATLAB for Differential Equations - J. Polking
(Prentice-Hall, Englewood Cliffs, NJ: 1995) ISBN 0-13-13394-2

Calculator Enhancement for Differential Equations: A Manual of Applications Using the HP-48S and HP-28S Calculators - T. G. Proctor
(Saunders, Orlando, FLA: 1992) ISBN 0-15-092730-7

Maple ODE Lab Book - D. Redfern and E. Chandler [+ Diskette]
(Springer-Verlag, NY: 1996) ISBN 0-387-94733-7 **[Forthcoming]**

Differential Equations: An Introduction with Mathematica - C. Ross
[+ Instructor's Manual and Answer Book, on-line electronic supplement]
(Springer-Verlag, NY: 1995) ISBN 0-387-94301-3

Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering - S. Strogatz
(Addison-Wesley, Reading, MA: 1994) ISBN 0-201-54344-3

Introduction to Differential Equations and Dynamical Systems - R. Williamson
(McGraw-Hill, NY: 1997) ISBN 0-07-070594-1 **[Forthcoming]**

Differential Equations with Computer Lab Experiments - D. Zill
[+ Computer Lab Experiments, Complete Solns. Manual, Student Solns. Manual, *Maple* and *Mathematica* notebooks, assorted numerical and graphical software]
(PWS, Boston: 1995) ISBN 0-534-93785-3

ARTICLES:

Any issue of **C • ODE • E** -- newsletter published quarterly and available *gratis* from C • ODE • E, Math. Dept., Harvey Mudd College, Claremont, CA 91711 (See reference in **INTERNET SITES**.)

Special Issue on Differential Equations - *The College Mathematics Journal* (Vol. 25, No. 5, November 1994)

"Interactive Texts and a Virtual Environment for Exploring Spring-Mass Systems," M. Branton and M. Hale, *Primus* **VI** (No. 1, March 1996), 59-67

"Modelling Mixing Problems with Differential Equations Gives Rise to Interesting Questions," B. J. Winkel, *Int. J. Math. Educ. Sci. Technol.* **25** (1994), 55-60

"A Project Component for a Differential Equations Course," M. McDonald, *Primus* **IV** (No. 3, Sept. 1994), 219-228

"Technology, Cooperative Learning, and Assessment in the Teaching of Ordinary Differential Equations," F. Barber and J. Narayan, *Primus* **IV** (No. 4, December, 1994), 337-346

"Using a Computer Algebra System to Enhance a Traditional Undergraduate Course in Ordinary Differential Equations," A. P. Ferzola, *Primus* **IV** (No. 4, December 1994), 383-395

"Student Research Papers in Freshman Calculus - Modelling with Differential Equations," T. Sherman, *Primus* **III** (No. 1, March 1993), 19-34

"Pendulum Motion - The Value of Multiple Solution Methods," W. Barker, *Primus* **III** (No. 3, Sept. 1993), 225-244

"PHASER-Based Courseware for Ordinary Differential Equations," L. Zia, *Primus* **I** (No. 1, March 1991), 49-64

SOFTWARE:

See the *College Mathematics Journal* **Special Issue on Differential Equations**, pp. 458-461, for brief reviews of a dozen ODE solvers. Issues of the **C • ODE • E** newsletter (see **ARTICLES**) sometimes contain reviews of software. **ODE Architect** has been developed with NSF support by C • ODE • E and is available through John Wiley & Sons and Intellipro, Inc. Page xi of Zill's book (mentioned above) has a list of nineteen programs and their publishers/distributors. Also, **Interactive Differential Equations (IDE)**, a CD-ROM with workbook by B. West, S. Strogatz, J. McDill, and J. Cantwell, will be published in July, 1996 by Addison-Wesley Interactive. (See the first item under **INTERNET SITES** for further information.)

INTERNET SITES:

http://awi.aw.com/products.html#mathematics
Addison-Wesley Interactive page advertising **Interactive Differential Equations (IDE).** (See reference under **SOFTWARE** heading.)

http://brillig.nebrwesleyan.edu/~glarose/delabs/
Bill McClung, Gavin LaRose, and Dick Vogt at Nebraska Wesleyan U....Course material (including 9 *Mathematica* labs), 3 projects, and the Spring 1996 syllabus; plain TeX and PostScript files; physical configuration of computer lab

http://cross.sewanee.edu
Clay Ross at The U. of the South...on-line supplements to his DE book (see above)...*Mathematica* notebooks...DOS and Mac formats

http://math.bu.edu/odes/
Boston U. Differential Equations Project...information about the Blanchard/Devaney/Hall text (see above)...Instructor's Manual, errata...workshop information...sample syllabus; articles on teaching differential equations

http://math.bu.edu/INDIVIDUAL/bob/
Bob Devaney's home page at Boston U....other ODE information and syllabi for various dynamical systems courses taught (or planned to be taught) at BU

http://sol.cms.uncwil.edu/~Kaufmann/de_manual/de_manual.html
Eric R. Kaufmann at U. of North Carolina at Wilmington...Differential Equations Lab Manual...classroom examples (theory and applications)...PostScript and *Maple V* files...traditional approach, but with technology

http://www.ma.iup.edu/MathDept/Projects/CalcDEMma/Summary.html
Indiana University of Pennsylvania...description of computerized learning environment...*Mathematica* notebooks for calculus and differential equations

http://www.math.arizona.edu/Software/azmath.html

U. of Arizona...extensive software for calculus, ode's, and other topics, including "Are You Ready for Ordinary Differential Equations?" and other diagnostic programs

http://www.math.hmc.edu/codee/home.html

Home page (at Harvey Mudd College) for **C • ODE • E** (Consortium for Ordinary Differential Equations Experiments)...on-line issues of the newsletter, reviews of DE solvers, graphics

http://www.math.rpi.edu/~boycew/index.html

William Boyce's home page at Rensselaer Polytechnic Institute...course information, including assignments and class handouts...excellent *Maple* worksheets

http://www.math.scarolina.edu/~meade/math242

Doug Meade, U. of South Carolina...course notes, syllabus, exams, projects, homework assignments (and solutions)...*Maple* worksheets; guest lectures; material from other universities

http://www.math.unl.edu/

Glenn Ledder, U. of Nebraska (Lincoln)...DE course materials...*Maple* and *Mathematica* files; other math course materials

http://www.uidaho.edu/~calvert/

Jim Calvert at the U. of Idaho (Moscow)...course information, *Maple* worksheets...traditional, but with technology

http://www.wam.umd.edu/~stuck/schol/scholhome.html

The SCHOL Project at the U. of Maryland (College Park)--using mathematics software to enhance undergraduate education...samples from the texts Differential Equations with *Maple* [*Mathematica*] (see above), PostScript images of *M*/*M* solutions

http://zelda.thomson.com/rcenters/diffeq/diffeq.html

Differential Equations Resource Center (PWS Publishing Co.)...discussion threads, exercises, problems, lab projects, applications...software...on-line courses and course notes...information on workshops, symposia, conferences...labs at Rose-Hulman Inst. of Tech., Nebraska Wesleyan, et al....labs to accompany Differential Equations with Boundary Value Problems (Third Ed.) by Zill and Cullen; the *Electronic J. of Differential Equations*; Mathematics Archives (U. of Tennessee)