

Course Outline
Mathematics 5410-1
Introduction to Differential Equations
Fall 2002

Time and Place: 5410-1 MTWF 9:40am, 208 JWB

Instructor. Professor Grant B. Gustafson, JWB 113, 581-6879 ¹

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WWW page. Open the site <http://www.math.utah.edu/~gustafso/> where you will find any additional material for 5410. Most support material for the textbook, in particular solutions for group projects, can be found at the site <http://www.wiley.com/college/borrelli/>.

Office Hours. MWF after class, and other times by appointment. You are welcome to drop in any time I am free or call at strange hours. Specific questions by email are welcome (like “Will you be in tomorrow at 3pm?”). I am usually unavailable before class MWF. On Tuesday-Thursday, please call or write email if possible, as a drop-in may not work.

Required Text. Borrelli–Coleman, *Differential Equations: A modeling approach*, John Wiley and Sons (1998), ISBN 0-471-04230-7.

Additional Non-required Texts:

Birkhoff and Rota, *Ordinary Differential Equations*, Fourth Edition, Wiley, NY (1989), 0-471-86003-4.

Brauer and Nohel, *The Qualitative Theory of Ordinary Differential Equations*, Dover, 0-486-65846-5. Reprint of the 1969 edition. P.Waltman, *A Second Course in Elementary Differential Equations*, Academic Press, NY (1986), ISBN 0-12-733910-8.

D.Sanchez, *Ordinary Differential Equations and Stability Theory*, Dover Publishers, ISBN 0-486-63828-6.

W.E.Boyce and R.C.DiPrima, *Elementary Differential Equations*, Fifth Edition, Wiley, NY (1992), 0-471-50997-3.

R.L. Borrelli and C.S. Coleman, *Student Resource Manual* for the textbook. John Wiley and Sons, 1998. Contains solutions for every other part (a), (c), (e), etc, for all the odd problems.

Prerequisite: An introduction to ordinary differential equations such as Math 2250 or Math 3210. A basic course in matrix theory is assumed both in the lectures and in the textbooks. The

¹Pronunciation: In the phrase *Gust of Wind* change *Wind* to *Sun*.

LAB assumes no particular knowledge, however, it is an advantage to have an introductory course in one of the standard computer languages (FORTRAN, PASCAL or C) or working knowledge of MAPLE. A good working knowledge of calculus is essential.

Course Description. There will be a computing component within take-home exams. The take-home exams replace the traditional homework problems. The four midterm exams are take-home plus a 15-minute in-class component.

Course Content. The course will consist of six parts, as follows.

- Chapter 1. First Order DE
- Chapter 2. Initial Value Problems
- Chapter 3. Second Order DE
- Chapter 4. Applications
- Chapter 5. Systems of DE
- Chapter 6. Laplace Transform

The lectures will be guided by the book of Borrelli-Coleman. Some of the sections will be skipped because of timing constraints.

Take-Home Exams. The usual homework assignments will be replaced by take-home examinations, which have a special requirement for format and completeness. About three days will be allowed to complete each exam. All students must complete each of the exams, in their own writing. Collaboration is permitted and encouraged. Credit should be given for help and advice from others to avoid issues of plagiarism.

Use of MAPLE. Certain aspects of the Take-Home problems can be done efficiently by using the computer algebra system `maple`. Generally, this aspect is for checking answers or re-doing a hand calculation by another method, to check validity. Computer assist is encouraged, when it makes sense, which happens in about 10% of the problems. Often a graphing calculator can be used in place of `maple`. Use your own judgement to determine when `maple` is useful or appropriate.

Take-Home Due Dates and Midterm Exam Date

Take-Home exams	Due daily, lowest 4 dropped.
Midterms (4), 208 JWB	Tuesdays, InClass 9:40am (15 min)

The collection dates are designed so that you have three days per take-home exam. Exams are due on the given date before the building is locked. Deliver your exam in class, or to 113 JWB. The last take-home exam will be graded by December 2.

Grading Policy. Final grades will be based on the Take-Home Exams (about 60 Problems) plus comprehensive midterm examinations (15 minutes in class, 4 problems prepared outside class). A passing grade in the course requires an average grade for the Take-Homes of at least 40%. If this condition is met then the final grade will be 50% of the Take-Home average plus 50% of the Midterm grade average.

Example: You have a 98% average on the Take-Homes but write 88% on the midterms. The final grade is $(98 + 88)/2 = 93$ which is an A- by the scale below.

Grading Scale:

A = 95-100, A- = 92-94, B+ = 88-91, B = 84-87,
B- = 80-83, C+ = 75-79, C = 65-74, C- = 60-64

This scale is determined from 40% passing use GPA increments. It is used for grading and for final grade reporting. This scale is for internal use only by Professor Gustafson and it *does not apply* to the department in general.

Take-Home Exams. The course consists of numerous 1-day projects (no more than 60), each allotted a few days for completion. A project is primarily mathematical problem-solving, including a detailed writeup of the solution, with page references and links to past courses. Symbolic computation and numerical methods are optionally applied to check answers or to extend the ideas of a project. Collaboration is permitted, and encouraged, in teams of not more than 2.

Purpose of the Take-Homes. The *purpose* of the projects is to practice doing mathematics, that is, to write out in detail the solutions to problems. A project consists of computational problems, usually devoid of proofs (but not always). The process that you will go through is this:

- **Understand the problem.** Understanding usually involves reading the *problem notes* and the textbook. Answers are provided and perhaps (but not always) an outline of the solution, to increase the probability that the project gets completed on schedule. Problems are discussed in class in great detail, often with the aid of transparencies (and xerox copies of same). Slides cover a similar problem or sometimes the exact problem considered in the project.
- **Background reading.** To solve a problem, a second opinion of the theory and method is essential. It might be that you can flesh it out of your book's examples, the college algebra text, the calculus text or some other mathematics book. No matter, go to a source that works for you. This is *reading* and not a tutorial.
- **Scratch Paper Write-up.** The initial creation of a solution is the essence of the learning process. Everyone learns by repetition, and here is where you do it. Use a pencil and a big eraser, lots of paper, and flesh out a first draft at full speed. This is not the paper you turn in.
- **Final Copy.** The final copy of the solution uses the scratch paper draft as raw material to *present* the details of the solution. As such, it is more than a collection of formulas on paper. There is no strict requirement, except that neatness and completeness are a must.

- **Final Copy Format.** The most successful format to date was invented by several engineering mathematics students over the years 1990–2002. In this format, formulas appear one per line (one equal sign per line), on the left 60% of the page. The right 40% is reserved for English sentences, page references, results from college algebra and calculus, theorem names and statements, running accounts of the main ideas and cross-references to similar problems and examples. Engineering paper works nicely as does plain white paper. Lined notebook paper is less ideal because of the way it tends to force vertical spacing in large increments.

I will look at **presentation**, and expect improvement throughout the 14 weeks of the course. You are not expected to be an expert in the first week. Correct answers are assumed, because the book has selected answers. In class, further details are communicated. Your job is to *improve* on the initial start into the solution. Add the particulars, make comments, chase down the details from algebra and calculus. The difficulty is generally college algebra, with calculus running a close second. Writing up the solution identifies the stumbling blocks and forces a review of background material.

Makeups and Late Work. Due to the number of exams being collected, work is considered late and therefore unacceptable when two (2) days have elapsed since collection in class. The lowest four (4) take-homes are dropped from consideration in order to eliminate makeups. If more than five days have zero scores, then please call 581–6879 and discuss the situation and options for getting a passing grade in the course.

UofU Fall Semester 2002 Calendar

Wednesday, Aug 21	Classes begin
Thursday, December 5	Classes end

Maple and Computing. This course provides an opportunity to learn about computer algebra systems (eg, maple) as an alternative to spreadsheets, computer languages and hand calculators. However, it is not our policy to force-feed the idea, because technology changes quickly and there may be better alternatives.

Reports that use a computing language must use `maple` as the programming language. Knowledge of `maple` is not assumed nor is it required that you learn it to pass the course. Your computer account makes this system available to all and it is a reasonable standard to adopt.

Never submit maple printout with reports. Always condense it to a few lines. For example, if you code something and it is clever, then say why it is clever, but don't show us the code. Unless it is extremely interesting to read, assume that you can leave it out. If is absolutely essential or extremely clever and unforgettable, then email the maple code, so it does not get lost. If you graph something in maple, then *draw a replica* with pencil, or cut and paste a shrunken 2×2 inch copy onto your report. Please save the trees!

Most persons use maple like they use a hand calculator: to check computations, increase reliability and to lighten the work load. Humans are amazing adept at finding the path of least resistance; maple might work out to be one of your favorite paths.

Exams are due on the given date before the building is locked. They are considered late and therefore unacceptable when two (2) days have elapsed since collection in class. The lowest four (4) take-homes are dropped from consideration in order to eliminate makeups. If more than five days have zero scores, then please call 581-6879 and discuss the situation and options for getting a passing grade in the course.

Deliver your exam to 113 JWB. Mark it **5410, 9:40am**, the time of your class, so that it gets immediately into the correct stack. You may also deliver the exam in class on the due date. If two people work on the exam, then deliver one original copy only.

The last take-home exam will be graded by end of the last week of classes. Others are generally graded by the next class meeting. After grading is completed, those exams not yet submitted are late and considered unacceptable. Please keep this absolute deadline in mind when trying to use the 2-day grace period.

Midterm Exam Rules. A midterm is supplied, to be completed in one week outside class. You are to solve the problems on the midterm and bring it to class on exam day. Bring also on exam day your handwritten and computer-produced notes. Any additional handwritten notes, computer-generated notes and take-home exams may be used. This includes xerox copies of classroom slides. However, **no books are allowed**. Calculators are considered normal equipment. Books and tables are not allowed: transfer what you need to handwritten or computer notes. The in-class 15-minute exam is one problem which duplicates one of those already solved in the take-home portion. After solving it, staple your solution to the other problems and submit your exam.

A quote you might find useful, from a former student:

“I didn’t realize how poorly organized and incomplete my notes were, until exam day. Basically, I couldn’t find anything, even though I distinctly remember writing it up (somewhere). I could have gotten one more problem right on the midterm, if I hadn’t wasted so much time hunting for information.”

Computing Equipment. Work is done either on existing computer accounts or personal computers that may be available to students, or on Math Dept UNIX accounts which are issued on registration. The user name and password rules are posted in the lab located in 205 So Physics. For operating hours, please consult the mathematics department in 233 JWB (581- 6851) or ask one of the lab instructors in LCB. The schedule is posted on bulletin boards near 233 JWB and also on Angie Gardener’s door.

Modem access to the mathematics department UNIX machines can be made via the campus network at 581-5650. You must have a student account to use this facility. Contact the computer

center for details. After login to the CC server, enter the internet address of the machine, e.g. `public.math.utah.edu`. In this environment X-windows is unavailable without special setup and equipment. It exists because a number of students own personal computers with modems.

Maple Tutorial. Angie Gardener teaches tutorials on Emacs, Unix and Maple to be used with your computer account. Please join this tutorial, learning the basics equivalent to a scientific calculator. Use your classmates and the lab instructors in to help you over the rough spots. This tutorial is a *rite of passage* that is required before you can do any serious and interesting work. No grade is issued for learning this small amount. The grading takes place only for the take-home exams (less than 3% is computer-related). As you complete the tutorial, please learn specifically these skills:

- How to log onto unix and use the mouse and keyboard. This includes some skill with X-windows, especially printing text files (the `print` command) and screen printing (the `xdpr` command).
- How to turn on and exit `xmaple`. Use of the various X-windows buttons.
- How to use Maple's help facility in `xmaple` (Version 6). The online tutorial is invoked in `xmapleV3` using the command `tutorial()`; — this command is unavailable in `xmaple` or `xmapleV4` and `xmapleV5`.
- How to use `emacs` and `xmaple` together to make programs and reports.

Chapter 1. Exercises 1.1-2, 1.2-2,3a,4a,4d, 1.3-1,5d,6,11, 1.4-3,4,9,14, 1.5-3,10,12, 1.6-2,3,5,7, 1.7-1,5, 1.8-1,3,5, 1.9-1c,2c,3a,5,9.

Chapter 2. Exercises 2.1-1,2,4, 2.2-1a,4,5, 2.3-1,5, 2.4-1a,2a,3a,4a,7, 2.5-1,2b, 2.6-2b,3d,3e,4b, 2.7-2,3.

Chapter 3. Exercises 3.1-1,2,6, 3.2-1b,1e,2b,4,10b,11a, 3.3-1,2,4, 3.4-1,2a,2b,2c,3b,4b, 3.5-1,3,4, 3.6-1,3,4,5,6,10, 3.7-3,4,7.

Chapter 4. Exercises 4.1-1,4,5, 4.2-1b,2a, 4.3-1,2, 4.4-2,7,8.

Chapter 5. Exercises 5.1-1,2d,3,4b, 5.2-1,2a,2b,3d, 5.3-1c,2a,3a,4, 5.4-1c,2c,3c,4.

Chapter 6. Exercises 6.1-1a,1b,1c,2a,2c,3a, 6.2-1d,1g,1i,3e, 6.3-1a,1c,1g,1h,2d,2f,3b,3e,4a,4c,5b,5c, 6.4-1a,2a,3a, 6.5-1b,2.

Chapter 7. Exercises 7.1-1,3, 7.2-1,7, 7.3-1b,2a,2b,2c,3,8a, 7.4-1a,1b,1e,1g,2,5,7, 7.5-1a,2b,3a,3c,4a, 7.6-1,2,3a,4a, 7.7-2a,2c,3a,3c,4,6, 7.8-1a,1b,2a,2b,4c,6a, 7.9-1a,2a,4,7a,9a,10c,12a, 7.10-Skip, 7.11-2,3,4a.