

# MATHEMATICS 5410

## Introduction to Differential Equations

### Fall semester 2008

**Time:** MTWF 9:40 - 10:30am in WBB 207

**Instructor:** Professor Grant B. Gustafson<sup>1</sup>, JWB 113, 581-6879.

**Office Hours:** JWB 113, MWF 8:40-9:20am and 2:30pm. Other times will appear on my door card, a copy of which can be found on the course web page.

**Telephone:** 581-6879. Please use email whenever possible.

**Email:** ggustaf@math.utah.edu

**Web site:** <http://www.math.utah.edu/~gustafso/>

**Consultations:** See me in my office 113 JWB, at posted hours. If the hours don't fit your needs, then please send email or call on the telephone. The Math Department Tutoring Center, located in LCB, is open for free maple help from 8 a.m. to 8 p.m. on M-Th, and from 8 a.m. to 2 p.m. on Friday. For more information, consult the web address [www.math.utah.edu/ugrad/tutoring.html](http://www.math.utah.edu/ugrad/tutoring.html).

#### Prerequisites:

Math 2270 (Linear Algebra) or the equivalent. Assumed is first-year Calculus, with a very brief introduction to linear differential equations. Background is required in planar curves, velocity and acceleration vectors from Physics 2210 or Math 2210, or their equivalent courses.

A passive knowledge of `maple` is assumed. The entire course can be done without `maple`, but all computer code examples are supplied in `maple` only.

Persons without passive knowledge of `maple` and/or `unix` may attend one of the *tutorials* on the subject offered during the first two weeks of the term. The instructor for these tutorials is Angie Gardiner, 585-9478, [gardiner@math.utah.edu](mailto:gardiner@math.utah.edu). Angie's office is MC 155A (building LCB).

See also the tutoring web address cited above. The LCB math center hours 8:00 a.m. to 8:00 p.m. daily except until 6:00pm on Friday, closed weekends and semester holidays. Besides this public access to computers we will try to schedule LCB 115 on some Tuesdays during the semester, during our class time.

#### Required Text.

Borrelli and Coleman, *Differential Equations: A modeling approach*, John Wiley and Sons. Most recent edition. The 1998 edition has ISBN 0-471-04230-7.

*WWW Documents for 5410*, by GB Gustafson, at web site [www.math.utah.edu/~gustafso](http://www.math.utah.edu/~gustafso/). All are pdf or text documents that can be printed from `firefox` or `MS iexplorer` web browsers.

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<sup>1</sup>Pronunciation: In the phrase `Gust of Wind` change `Wind` to `Sun`

## **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.

## **Grading:**

Final grades will be based on:

Textbook problems and maple labs, called **dailies**, 116 scores.

Written midterm examinations (3).

A term paper worth one midterm score.

## **Written In-Class Exams:**

There are three (3) in-class midterm exams. There is a term paper due in week 12, which counts as a fourth midterm exam. All submitted work is graded by G.B. Gustafson. No outside graders are employed.

## **Hand-written Dailies:**

There will be 124 dailies due during the semester, including textbook problems and maple labs. Of these, 116 count towards a grade.

## **Course Content:**

This course is an introduction to differential equations for mathematics majors and science majors. All chapters of Borrelli-Coleman's text plus class notes will make up the course material.

The basic course consists of six chapters

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 ordering of topics for the basic part will be 1,2,3,6,5,4. Additional chapters, especially stability theory, will be in the final weeks of the course.

### **Textbook problems:**

Textbook problems to be submitted for grading are listed on the **gradesheet** for the course. Tentative dates are set for each problem set. Visit the web site for extra copies. The actual due dates for problems appear only on the web site only and they are dynamically updated to reflect the reality of what was discussed in class. Generally, problems are submitted shortly after they are discussed in class, and hopefully during the week printed on the gradesheet.

Submitted textbook problems must be your own work in your own handwriting. Collaboration is permitted and encouraged on textbook problems. However, you must write your own report: no joint reports, please!

There are certain **suggestions** for writing up the textbook problems and the take-home portion of a midterm exam. A full accounting of the *presentation suggestions* contributed by Utah students appears on the internet course page as *presentation suggestions for submitted work*. Kindly pirate the good ideas therein and apply them to your written textbook problems.

### **In-class midterm exam problems:**

A midterm sample in-class exam or outline is supplied a few days before the in-class exam. Exam problems are modeled after those in the sample exam or exam outline.

Books, tables, notes and calculators are not allowed on exam day.

An in-class Midterm exam has different presentation rules, and none of the textbook problem presentation suggestions apply in this case. Basically, the in-class exam is a first draft with no answer checks and almost no reference dialog.

### **Computer projects:**

There will be six computer projects assigned during the semester, related to the classroom material. They will be written by hand and use the software package **maple**. There is a Math Department Computer Lab in the **math center** in building LCB. Registered students automatically own accounts. Drop-in maple tutoring in the math center computer lab starts the second week of the semester.

### **Final exam:**

There is a term paper requirement instead of a final exam. The term paper is due in week 12. Details will be distributed on the web site.

### **Withdrawal:**

It is the Math Department policy, and mine as well, to grant any withdrawal request until the University deadline. This promise also means that such a withdrawal requires no explanation. Withdrawals are always initiated by the registered student. All paperwork is the duty of the student. My job is the signature.

## ADA statement:

The American with Disabilities Act requires that reasonable accommodations be provided for students with physical, sensory, cognitive, systemic, learning, and psychiatric disabilities. Please contact me at the beginning of the semester to discuss accommodation (113 JWB or 581-6879), which is to say, accommodation shall be made.

## Grading Scale:

$$\begin{aligned} A &= 95-100, & A^- &= 92-94, & B^+ &= 88-91, & B &= 84-87, \\ B^- &= 80-83, & C^+ &= 75-79, & C &= 65-74, & C^- &= 60-64 \end{aligned}$$

This scale is determined from 40% passing use grade point average (GPA) increments. It is used for grading and for final letter grade reporting. This scale is for internal use only.

## Grading Details:

**Rite of passage:** A passing grade in the course requires at least 50 of the 124 dailies (includes computer projects) to be submitted. A grade of *E* is assigned if less than 50 Dailies are submitted. The scores on the 50 dailies are expected to be passing at *C* level or higher.

The right of passage is absolute, similar to the European system, which requires a body of work to be presented before written and oral final exams are taken. For example, the Czech *vypočet* is a requirement to show a body of completed work as the entrance requirement to administration of written and oral final exams.

**Final grade:** It will be determined as follows:

$$\text{Final Grade} = \frac{30}{100}(\text{Dailies Average}) + \frac{70}{100}(\text{Midterm} + \text{Term Paper Average}).$$

An example: the Dailies Average for 116 textbook problems and maple labs is 91% and the Exam Average of the three midterms and the term paper is 86%. The final grade is  $0.3(91) + 0.7(86) = 87.5\%$ , which by the scale above is a *B*. While 87.5 rounds to 88, a *B+*, the deciding factor is really the exam average of 86, which is squarely a *B*. The final grade is *B*. If the dailies average was 93 or higher, then the final grade would be 88.1 or higher for a *B+*.

**Purpose of the textbook problems.** The *purpose* of the problems is to practice doing mathematics, that is, to write out in detail the solutions to problems. A textbook problem is either a proof or else a routine “crank” problem. The process:

- **Understand the problem.** Understanding usually involves reading the *problem notes* and the textbook. Answers are usually not provided. You may get an outline of the solution, to increase the probability that the project gets completed on schedule. Problems are discussed in class in greater detail.
- **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, a linear algebra text, an advanced calculus text or some alternate 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 Presentation.** The most successful presentation ideas to date were invented by numerous mathematics and engineering mathematics students over the years 1990–2008. The ideas are described below and in greater detail in the internet document *presentation suggestions for submitted work*.

If you are enrolled in 5410, then it is expected that you already have a style developed for writing mathematics. The suggestions below are just a list of ideas, stolen from students who had excellent presentations. Please use the ideas to improve your presentations. Expect to make presentation improvements over many weeks.

## Some Presentation Suggestions

1. Use engineering paper or plain white paper. Lined notebook paper and graph paper are inferior, because they cause inappropriate vertical white space for mathematics.
2. Reports are hand-written. They start with a problem statement followed by the book's answer or by a final answer summary. Supporting material appears at the end, like a tax return.
3. Every report has an answer check. For odd-numbered problems it is usual to see *the answer matches the textbook* or *b.o.b* for *back of book*. For even-numbered problems, a full answer check is expected. Obviously proofs do not have formal answer checks.
4. One equal sign per line. Justify equations left or align on the equal signs. Mathematical notation might appear on the left, text on the right, about a 60% to 40% ratio.
5. Text includes explanations, references by keyword or page number, statements and definitions, references to delayed details (long calculations, graphics, answer checks). Text might be left-justified on the right side in a column 40% of the text width.
6. Suggestions 4-5 may be ignored, they are presentation ideas, not rules.

**Cooperative efforts** are allowed and encouraged in groups of two. Where appropriate, **citations** are required for those who help you, with the exception of mathematics staff and tutoring staff. There is no penalty for getting help from others – it is encouraged. Please cite those who help, because it is an honorable and meritorious gift to those who spend their time on you.

**Presentation** is expected to improve throughout the 14 weeks of the course. You are not expected to be an expert in the first week. Correctness of answers will be checked. The class notes might contain answers plus a solution outline. Your job is to *improve* upon the initial start into the solution. Add the particulars, make comments, chase down the details from background courses. Writing up the solution identifies the hurdles and it forces a review of background material.

**References** are required on the first occurrence. After that, omit the citation. It is appropriate, however, to refer to the previous location on which the citations originated. A statement like “References parallel Exercises 1-5” is enough.

**Due dates.** All due dates are updated dynamically, at [www.math.utah.edu/~gustafso/](http://www.math.utah.edu/~gustafso/). Consult this resource often. To repeat: **the due dates are not given in class!** Sometimes, email communication about due dates and exams will be made from the registrar’s list. If your campus information data becomes dated and incorrect, then please visit the campus WWW system (where you pay tuition) to update the information.

**Makeups and Late Work.** Due to the number of dailies being collected, work is considered late and therefore unacceptable when two (2) days have elapsed since collection in class. The lowest eight (8) dailies are dropped from consideration in order to eliminate makeups. If more than eight textbook problems have zero scores, then please call 581–6879 or email [ggustaf@math.utah.edu](mailto:ggustaf@math.utah.edu) to discuss the situation and the possible options for catching up with the class.

**Missed Deadlines.** There is an absolute deadline for each collection. After the stack has been graded, all late work received henceforth earns a zero.

**Missed Midterm Exams.** See me in JWB 113, or write email, or call 581-6879. After you have missed the exam, then the crisis is over. Please schedule a meeting to jointly decide what to do next.

## Fall 2008 Chapter Problem List

Chapter 1. Exercises 1.1-2, 1.2-2,7b,8c,8d, 1.3-25,28,37, 1.4-5,12,14,16,

Chapter 2.

Chapter 3.

Chapter 4.

Chapter 5.

Chapter 6.

Chapter 7.