Course Outline
Mathematics 5420
Introduction to Differential Equations
Spring Semester 2001

Time and Place: 5420-1 MWF NS 205

Instructor. Professor Grant B. Gustafson, JWB 113, 581-6879
The telephone is left on 2-ring *answer* when I am out of the office.

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WWW page. Open the site `http://www.math.utah.edu/~gustafso/`

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 not available 10:00-2:00 T-Th. Good times on T-Th are 8:30am and 2:15-3:15, this semester.

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.

L.Andrews, *Elementary Partial Differential Equations with Boundary Value Problems*, Academic Press, NY (1986), ISBN 0-12-059510-9.

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

Prerequisite: Math 5410. The latter required an introduction to ordinary differential equations such as Math 2250 (old Math 351 or Math 321) or the material in Bronson's Schaums Outline Series on Differential Equations. A basic course in matrix theory is assumed both in the lectures and in the textbooks.

Course Description. This semester course is a re-packaging of old Math 541-542-543 into two semester courses. There will be a computing component within take–home exams. The take-home

exams replace the traditional in-class midterm examinations. The traditional midterm exams and final exam are replaced by a term project plus a 50-minute in-class midterm exam. Grading rules appear below.

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

Chapter 5.	Systems of DE (exercises)
Chapter 6.	Laplace Transform
Chapter 7.	Linear Systems of DE (exercises)
Chapter 8.	Stabilty theory
Chapter 10.	Fourier series and PDE
Chapter 9.	Bifurcations
Chapter 11.	Applications to PDE

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 and in-class midterm examinations will be replaced by take-home examinations. About three days will be allowed to complete each exam. All students must complete each of the exams. Collaboration is permitted and encouraged in teams of not more than 2. For a team of 2 the report is submitted jointly and both authors receive the some grade. This does not apply to the term project.

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 approriate.

Take–Home Due Dates and Midterm Exam Date

Take-Home exams	Due daily, lowest 4 dropped.
Midterm 5420, NS 205	Tuesday, Week 13, InClass 9:40am (50 min)
Term Project 5420, Take-home	Due Friday of the week before Dead Week. All problems due by 6pm Project problems are inspected by chapter, periodically.

The collection dates are designed so that you have one weekend 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. If two people work on the exam, then deliver one original copy only. The last take-home exam will graded by end of Dead Week.

Grading Policy. Final grades will be based on the Take-Home Exams (about 60 Problems) plus a comprehensive midterm examination (50 minutes In-Class), 25-problem take-home term

project. 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 **either** 50% of the Take-Home average plus 50% of the Midterm grade **or** 100% of the Midterm grade (Term Project + Midterm exam) if it exceeds the combined average.

Grading Scale:

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

The algorithm for the letter grade in the course is as follows:

Define A =Take-home average (0-100), B =average of the midterm grade and the term project grade. Let letter(C) denote the conversion to a letter grade of score C, $0 \leq C \leq 100$, according to the above scale.

Case	Letter Grade
$A < 40$	E
$40 \leq A \leq 100$ $A \leq B$	letter(B)
$40 \leq A \leq 100$ $A \geq B$	letter$\left(\frac{A+B}{2}\right)$

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. If you work in a team of 2 persons, then the report can be submitted jointly and both authors will get the same grade.

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 1990–1998. 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 solution manual contains answers plus a solution outline. 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 calculus. 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 six (6) 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 Spring Semester 2001 Calendar

Monday, Jan 8	Classes begin
Thursday, April 26	Classes end
April 30 to May 3	Final exam period (None for 5420)

Deliver your exam to 113 JWB. Mark it **5420, 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 graded by end of Dead Week. 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 sample midterm is supplied in the last weeks of the semester. You are to work out the problems on the sample midterm and bring to the exam your handwritten and computer-produced notes. Any additional handwritten notes, computer–generated notes and take-home exams may be used on midterm exam day. 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 reason for these rules is to eliminate any motivation to cheat or to move the exam date. On the exam date you are to demonstrate in writing skills and knowledge learned in the course. Books are not allowed because of the impossibility of learning new material on exam day. Time constraints require a narrow focus of effort and highly organized notes.

The *term project* consists of 25 problems over the various topics in the course. This project is to be done in your own handwriting following the rules for detail and format suggested above. The project counts 1/2 of the midterm grade, and the in-class portion is the other half. Submit the project on or before the last Friday before Dead Week. This date is absolute: extensions of time will not be considered. Please plan ahead and work on the project each week.

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

> "I didn't realize how poorly organized and incomplete my notes were, until midterm 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."

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

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.

Project 6: 6.1-3a, 6.2-4a,4c, 6.3-9, 6.4-3c, 6.5-1e

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.

Project 7: 7.5-7, 7.6-5d, 7.7-8, 7.8-2b,4d, 7.9-10d

Chapter 8. Exercises 8-1-1,3a,3e,3j,5f,5g,7g,7k, 8.2-1a,2a,3a,6a, 8.3-1a,1c,1d, 8.4-1a,1b,1d,2a,2e

Project 8: 8.2-5, 8.4-9a,9b,9c