MATHEMATICS 2250
Ordinary Differential Equations and Linear Algebra
Fall semester 2001

Time: MWF 7:30–8:20am ARCH 127

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

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

Tuesday Lab: Held each Tuesday in ARCH 127 at 7:30, or you may attend at another time: in JTB 310 from 8:35-9:25 a.m.; in LS 111 from 10:45-11:35 a.m.; in LS 101 from 11:50 a.m-12:40 p.m.; in LS 107 from 4-5:30 p.m. Students may attend as many or as few of these sessions as they wish.

In addition to the special 2250 sessions, the Math Department Tutoring Center is located in Mine 210, and is open for free tutoring from 8 a.m. to 8 p.m. on M-Th, and from 8 a.m. to 2 p.m. on Friday. Some, but not all of the math tutors welcome questions from Math 2250 students. To see the times and specialities of various tutors, consult the web address

`www.math.utah.edu/ugrad/tutoring.html`.

Web Page: `http://www.math. utah.edu/~korevaar/`

Web Page: `http://www.math. utah.edu/~gustafso/`

Office: JWB 113

Office Hours: MWF 9:30-10:30am, JWB 113

Telephone: 581-6879, An answering machine is ON when I am out of the office. The machine takes only short messages, about 30 seconds. Please use email whenever possible.

Email: gustafso@math.utah.edu

Texts:

Differential Equations and Linear Algebra, by C.H. Edwards Jr. and David E. Penney

Also recommended:

> Schaum's Outline (McGraw-Hill), Richard Bronson's *Differential Equations*, especially for examples, solutions and numerical methods.
>
> *Differential Equations*, Cliff's Notes series. Contains concise examples and readable explanations of topics found in the Edwards-Penney text.
>
> *Student Solution Manual*, for the Edwards and Penney text *Differential Equations and Linear Algebra*

Prerequisites:

Math 1210 and 1220 or the equivalent. This is first-year Calculus, with a very brief introduction to linear differential equations. The old Math 111-112-113 of 1997-98 fulfills the requirement. In addition, background is required in vectors, curves, velocity (tangent), and acceleration vectors from Physics 2210 or Math 2210, or their equivalent courses.

A passive knowledge of `maple` is assumed. Truthfully, the entire course can be done without `maple`. A good replacement for persons without computer training is a graphing calculator and

Microsoft's `Excel` or the MathWork's `matlab`. To cooperate with the engineering programs on campus, some `maple` contact is required in the coursework for 2250. The corequisite is Physics 2210 (old 301), with actual use of physics minimal.

Persons without the passive knowledge of `maple` and `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. The dates and times are printed on Angie's door, JWB 112.

Course content:

This course is an introduction to linear algebra and differential equations in engineering and science. Chapters 1-7 and 10 in the Edwards-Penney text plus class notes will make up the course material.

Grading:

Final grades will be based on:

> Take-Home Exams, about 120 problems.
>
> Three computer projects, each counted as six (6) problems.
>
> The Term Project, at least 25 problems.
>
> In-class 50-minute written midterm examination.
>
> Optional oral and written final exam, by written agreement.
>
> If the oral–written final exam is elected, then the Term Project and the midterm exam scores are replaced by the final exam scores. *Register* for the optional final before the midterm exam date. Each final exam will be created on an individual basis. Due to the oral component, the exam must be scheduled.

Written In-Class Exams:

An oral–written final exam is optional; you may use the sum of the term project score and the midterm exam score to replace the oral–written final exam.

The only in-class exam is the midterm exam.

Written Take-Home Exams:

The usual homework assignments and in-class quizzes will be replaced by take-home examinations and three computer labs.

There is a term project to be completed before the last week of classes. Less than 3 percent of this project involves computers. Collections of first drafts for the project problems will occur periodically, but the final version is the one submitted at the end of the course. The term project consists of 25 or more problems, similar to the ones required in the daily work, selected to be representative of the entire subject area.

There are three computer projects, equal to six take-home exam problems per project.

Take-Home Exams:

About three days will be allowed to complete a take-home exam problem. All students must complete each exam problem. 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.

There are certain rules for writing up these exam problems. See below for more detail.

Computer projects:

There will be three computer projects assigned during the semester, related to the classroom material. Each project counts the same as 6 take-home exam problems. They will be written by hand and also using the software package `maple`. There is a Math Department Computer Lab (Phyics South 205) at which you all automatically have accounts, and there are other labs around campus where `maple` is also available, for example at the College of Engineering. There will be *free* tutoring center support for these projects (Tuesdays) and for your other coursework as well.

Term project. The *Term Project* consists of 25 or more 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 below. Submit the project by Wednesday of the last week of regular classes. This date is absolute: extensions of time will not be considered. Please plan ahead and work on the project each week.

Midterm exam. 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.

Grading Details:

A passing grade in the course requires an average grade for the Take-Homes (includes computer projects) of at least 40%. The final grade will be determined as follows:

Grade I. Equals 50% of the Take-Home average (includes computer projects) plus 25% of the Midterm grade plus 25% of the Term project grade.

Grade II. Equals 50% of the Midterm grade plus 50% of the Term Project grade.

Final Grade. If the take-home average is less than 40%, then the final grade is E. Otherwise, the final grade is the higher of Grade I and Grade II.

A sample calculation:

$$\begin{aligned}\text{Average} &= \frac{94}{2} + \frac{1}{2}\frac{73+92}{2} \\ &= \frac{94}{2} + \frac{1}{2}\frac{73+92}{2} \\ &= 47 + 41.25 \\ &= 88.25 \\ &= \text{B+}\end{aligned}$$

Above, the take-home average is 94, the midterm 73 and the term project 92. Each number represents the percentage out of 100 percent for that item. Since the take-home average of 94 exceeds the midterm plus term project average of 82.5, the number 88.25 is used to compute the final grade.

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.

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.

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.

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 engineering–style "crank" problems, usually devoid of proofs. The process:

- **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 engineering 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 1990–2001. 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 problem notes contain the 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 college algebra, with calculus running a close second. Writing up the solution identifies the stumbling blocks and forces a review of background material.

Generally, cite a reference on the first occurrence of its use. After that, omit the citation. It is appropriate, however, to refer to the previous assignment on which the citations originated. A statement like "References parallel Exercises 1-5" is enough.

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.

Iterations. You may be asked to iterate your work in order to straighten out bugs in the presentation or details. Kindly mark your work accordingly. Submit whatever is requested, but no more, in order to keep the paper trail brief.

Tentative Daily Schedule

exam dates fixed, Maple start dates fixed
daily subject matter approximated

W	22 Aug	1.1	modeling and differential equations
F	24 Aug	1.2	integral solutions
M	27 Aug	1.3	direction fields and solution curves
W	29 Aug	1.4	separable equations
		Maple I	*begin* project on chapter 1-2 material
F	31 Aug	1.5	first order linear DE's
M	3 Sept	none	Labor Day
W	5 Sept	2.1	population models
F	7 Sept	2.2	equilibrium solutions and stability
M	10 Sept	2.3	acceleration-velocity models
		Maple I due	*hand in* first Maple project
W	12 Sept	2.4 & 2.6	numerical techniques: Euler and Runge Kutta
F	14 Sept	3.1	introduction to linear systems
M	17 Sept	3.2	matrices and Gaussian elimination
W	19 Sept	3.3	reduced row-echelon form
F	21 Sept	3.4	matrix operations
M	24 Sept	3.5	inverses of matrices
W	26 Sept	3.6	determinants
F	28 Sept	3.6	determinants
M	1 Oct	continue	Review of chapters 1-3
W	3 Oct	4.1	the vector space $\mathcal{R}^{\ni}$
F	5 Oct	none	fall break day
M	8 Oct	4.2	the vector space $\mathcal{R}^{\setminus}$ and subspaces
W	10 Oct	4.3	linear combinations and linear independence
F	12 Oct	4.4	bases and dimension of vector spaces
M	15 Oct	4.5	general vector spaces
W	17 Oct	5.1	second-order linear differential equations
F	19 Oct	5.2	general solutions of linear equations
M	22 Oct	5.3	homogeneous equations with constant coefficients
W	24 Oct	5.4	mechanical vibrations
F	26 Oct	5.5	undetermined coefficients and variation of parameters
		Maple II	*begin* Tacoma narrows

M	29 Oct	5.5-5.6	and forced oscillations and resonance
W	31 Oct	Midterm	Midterm 50-minute exam
F	2 Nov	6.1	introduction to eigenvalues
M	5 Nov	6.2	diagonalization of matrices
		Maple II due	*hand in* second Maple project
W	7 Nov	continue	Review of chapters 4-6
F	9 Nov	7.1	first order systems and applications
M	12 Nov	7.2	matrices and linear systems
W	14 Nov	7.3	eigenvalue method for linear systems
F	16 Nov	7.3-7.4	& second order systems and mechanical applications
		Maple III	*begin* shaking building
M	19 Nov	7.4	continued
W	21 Nov	10.1	Laplace transforms and inverse transforms
F	23 Nov	none	Thanksgiving recess
M	26 Nov	10.2	transformation of initial value problems
W	28 Nov	10.3	translation and partial fractions
		Maple III due	*hand in* third Maple project
F	30 Nov	10.4	derivatives, integrals, products of transforms
M	3 Dec	10.4-10.5	& periodic and piecewise continuous forcing functions
W	5 Dec	10.5	continued
F	7 Dec	none	Course over! University reading day
Wed	12 Dec	Grades ready!	This course does not have a final exam - see above