Calculus I - Math 251
Syllabus and guidelines 2010–2011
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This syllabus is largely based on the version for 2009–2010, which was written by Hal Sadofsky. It is written for Fall 2010. The dates of holidays and a possible edition change in the textbook will force minor changes for Winter 2011 and Spring 2011.

Textbook: *Single Variable Calculus, Early Transcendentals*, Stewart, 6th Edition. We will cover roughly Chapters 2, 3 and 4.

A new edition is expected to be available in January 2011. Unless the department takes specific action to the contrary, the new edition will be the official text starting in Winter 2011 or Spring 2011, depending on how soon it is actually available. The main differences between editions are usually in the homework problems. Since homework is on the internet (see below), it is very likely that students can use older editions of the book (even the 5th edition and lower), as long as they can match the material in the course to the appropriate sections in the book. Indeed, students can probably even use textbooks by other authors. At a minimum, though, the textbook must be intended for scientists and engineers; texts on calculus for business and social science students will not do. I am not familiar enough with other textbooks to be able to make specific recommendations.

Exams: There will be two midterms: at the end of week 4, and at the end of week 8. There will be a two hour final exam at the time specified by the registrar's final exam calendar. (I will also give a Midterm 0 at the beginning of the quarter. Its purpose is to ensure that students can do algebra sufficiently reliably to be able to pass the course. Please ask N. Christopher Phillips if you also want to do this.)

Homework: There will be (mostly) weekly homework assignments, homework will usually be due on Wednesday. The homework assignments will be over the internet via software called *WeBWorK*. The advantage to this system is students will get instant feedback about whether an answer is correct, and thus will have an opportunity to find mistakes and correct them if they did a problem incorrectly. Some students have used *WebAssign*. (It was last used in Math 111 and 112 in 2008–2009.) *WeBWorK* is similar, but the Math Department believes it is more reliable and easier to use.

WeBWorK has the disadvantage that students need not show work. They are therefore less well prepared to show work on exams. They also start using wrong notation in their work, and it doesn't get corrected. For this reason, I plan to collect one or two written problems per week, and pay careful attention to notation when grading them.

Probably all the problems you assign will be correctly coded in *WeBWorK*, but to reduce anxiety about *WeBWorK* errors, at least one instructor in 2009–2010 rounded all homework scores of 90% and above up to 100%.

When doing *WeBWorK* problems, there is a link "email instructor". Students should use that link to ask any questions about a problem they are having trouble with. Doing this gives the instructor a link that shows me the version of the problem the student was working on (the problems are individualized) and the student's most recent attempted answer. (If I find that I get html only messages this way, or anything else that isn't plain text, I will change this instruction in my section.)

Grades: Each hour exam is worth 20% of the grade, the total homework is worth 20% of the grade, and the final exam is worth 40% of the grade. (With Midterm 0, adjustment will need to be made. I find that students don't take Midterm 0 seriously unless it counts for a substantial portion of the grade.) In my sections, I use two additional rules.

- The course grade may not be more than one letter grade above the final exam grade. This makes sure students don't pass without being able to put the material of the course together, or pass by doing well in the first part of the course but just not doing the end of the course. (Few students will be hurt by this rule, but experience suggests it is occasionally important.)
- If I give extra credit, it is only counted if the course grade without it would be at least B^- (or some similar cutoff). This prevents students from passing on extra credit without having learned the basics of the course. (Again, few students will be hurt by this rule, but experience suggests it is occasionally important.)

Use of calculators: You will have to decide whether to allow or prohibit calculators before starting the course, so you can put the information on the syllabus.

If you prohibit calculators, be prepared for students who complain because they can't find $2 + 3$ without a calculator. Also, some students use a calculator as a crutch: even if they don't actually do anything with it, they feel insecure without it.

If you allow calculators, you still probably need to prohibit ones which can do symbolic differentiation, such as the TI-89 and TI-92. You aso need to choose problems carefully so that the students can't use the calculator to substitute for calculus. For example, on exams, ask them to sketch graphs of functions for which the interesting parts of the graph are far enough away from zero so that they have to work so hard to notice what is going on with their calculator that most of the students who are dependent on their calculators for sketching curves will get them wrong. Or, don't give them a formula for the function, just some information about the derivative (and maybe the second derivative) and ask them to sketch the graph from that. Of course you need to have given them homework questions like this as well if you are going to give them such questions on the exam. There are apparently at least some suitable problems on *WeBWorK*. Also consider Section 4.6 of the book, but note that the problem are long (even if you give them the first and second dervatives in factored form) and difficult to show how to do in class.

Beware of unexpected ways to use calculators to avoid calculus. For example, I once had a student minimize a function $f\colon [1,6] \to \mathbb{R}$ by just choosing the smallest of $f(1), f(2), \ldots, f(6)$, and then complain after not getting credit that he "got the right answer".

Approximate Schedule: This is an approximate schedule for Fall 2010. It will also work for Spring 2011. The holiday in Winter 2011 is much earlier in the quarter.

Week 1	Sections 2.1, 2.2, 2.3, 2.5, 2.6.
Week 2	Sections 2.7, 2.8, 3.1, 3.2.
Week 3	Sections 3.3, 3.4, 3.5.
Week 4	Sections 3.6, 3.7; Midterm 1.
Week 5	Sections 3.8, 3.9. 3.10.
Week 6	Sections 4.1, 4.3, 4.4.
Week 7	Sections 4.5, 4.7.
Week 8	Review, Midterm 2.
Week 9	Sections 4.2; 4.8 or 4.6; Thanksgiving.
Week 10	Review.

A set of WebWork assignments used by one instructor in 2009–2010 will be available. Others can use this set as a starting point.

Suggestions to students:

- It is extremely important to study the relevant part of the text *before* the related lecture. This will make lectures easier to understand and give you a chance to ask questions that come up reading the text.
- Doing the homework seriously is the **most** important thing you can do to succeed in this course. Start early, and do some every day. I encourage you to work together on homework, as long as the work you do is really your own.

  The best way to do the *WeBWorK* homework is to print out the homework, do the problems, and then enter the numeric and symbolic answers. Each student's problems will be similar but individualized. So the same techniques will work to solve your homework as your friend's but the answers will be different.
- Please do ask questions about the homework, or any other aspect of the course in class. I will always be happy to spend the first few minutes of class dealing with homework questions, or questions from previous lectures, so come prepared!

In order to ask questions effectively, make notes to yourself as you review lectures (and discover points that are unclear to you), as you study the text (and notice things that you are not sure you understand), and as you work on homework and come to problems you have trouble with.

Course Goals: The overall goal is for the students to understand the derivative as the slope of the tangent line and to be able compute derivatives and to apply derivatives. I see the most important applications as:

(1) Optimization problems. Both word problems and finding minima and maxima of functions on domains such as closed intervals, open intervals (and noticing when there is no minimum or maximum), etc. This is hard to teach because students are still internalizing the idea of "look at endpoints and critical points" when they need to be also translating the words of word problems into mathematics.

(2) Curve sketching. I think this is harder for students to learn than it used to be because it is so easy to use their calculator. Also, many students with weaker algebra skills find it quite difficult to solve inequalities like $f'(x) < 0$.

Less major goals that are still worthwhile:

(3) Limits. I'd like them to understand the basic idea of limits, though I don't expect them to learn ε-δ proofs. (If Newton could revolutionize physics with only an intuitive understanding of limits, then such an intuitive understanding might be enough for Math 251).

This is a slightly contentious point and not everyone agrees with me. The majority of students in Math 251 are not math majors, but there is a significant minority who are. The math majors probably *should* see the ε-δ definition, but I don't think it is worth it given how many students aren't math majors.

Two additional points are worth making here. First, it very is difficult to learn the meaning of the definition the first time. If we don't at least talk about the ε-δ of a limit in any earlier course, then for those that do go on we are expecting them to master the definition the first time they see it (Math 315). Thus, I don't think this definition should disappear entirely from lower level courses.

Second, it is easier for most people to understand limits of sequences than limits of functions.

For these reasons, although I don't cover the ε-δ definition of a limit in Math 251, I do cover the ε-N definition of the limit of a sequence in Math 253. I spend a day or two on it, and put a problem about it on a midterm (for an explicit sequence and explicit value of N, find a corresponding value of ε), but I don't worry too much about the fact that many don't "get" it, and I don't put such a problem on the final exam.

(4) Improper limits (limits as $x \to \infty$ and analyzing whether undefined limits are ∞ or $-\infty$ or neither). These are critical to curve sketching.
(5) Implicit differentiation and tangent lines. They may not be so vital for anything in the course, but they are nice for the minority of students who will take multivariable calculus later.
(6) Linear approximation. Also hard to justify as really important in the course, though lots of scientists use linear approximation all the time to replace complicated functions with simpler ones. But it is hard to make good examples that convince the students this is worthwhile. So I use this mostly as an illustration of tangent lines, and I don't make it important. I also omit all discussion of "differentials".
(7) L'Hopital's rule. Often useful when taking limits to sketch graphs. They need the ∞/∞ form too.
(8) Newton's method. At least one previous instructor thinks this is really fun, and also thinks it is useful for students to understand the general idea that lots of equations can't be solved explicitly so that techniques for approximating solutions are very important.

<u>Potential Problems:</u>

(1) As I said, a main goal is learning to do optimization problems. This comes late in the course. In this syllabus I have pushed it early enough so that optimization questions can appear on the second midterm as well as the final. If you let it slide to the last week, the students won't have time to learn this properly.
(2) Algebra background. A lot of the students in this course will have insufficient algebra background. Many of them can catch up, but they'll have a real slog, and will have to spend way more time on homework than the 8–9 hours per week that I expect from everyone.

    They have trouble with things like factoring polyonmials and simplifying rational expressions. This makes it hard for them to do things like analyze whether derivatives (and second derivatives) are positive and negative. They commonly fail to distribute minus signs and make other errors resulting from leaving out parentheses. They also commonly make inadmissible cancellations and errors in evaluating functions, especially expressions such as $f(x+h)$. This is why I give Midterm 0.

<u>Materials available:</u> I have a substantial collection of real and sample exam problems from previous versions of Math 251, organized by type, all in TeX, and with solutions in TeX, which I am willing to share. (I ask that you give me for my collection any new problems you make.) Some of these problems have been specifically designed to frustrate calculators, even ones capable of symbolic algebra and differentiation. Contact N. Christopher Phillips.