

MATH 251: Calculus I
Model Syllabus 2021-2022
Course coordinator: Dan Dugger

Instructor: Put your name and contact information and office hours in.

Prerequisite: C- or better in Math 112, or satisfactory placement exam score.

Text: *OpenSTAX Calculus Volume I*. An electronic edition of this text is available for free at

<http://openstax.org/details/books/calculus-volume-1>

The course covers most of Chapters 2–5.

Note: For the past couple of years we have been in the process of transitioning from Stewart to OpenSTAX. As of this year we would like to complete the move and have everyone use OpenSTAX. However, if there is a compelling reason for an instructor to stick with Stewart you can bring the issue to the course coordinator, Director of Undergraduate Studies, or Department Head for consideration.

If you find errors in OpenSTAX, or things you don't like and wish were different, please keep track of these and send a list to the course coordinator at some point. We plan to repair these errors and improve the text over time.

Overview: The course should cover roughly Chapters 2–4 of OpenSTAX. Students should read Chapter 1 is review material that is not explicitly covered in the course, though students might want to use it for their own reference.

Chapter 2 is on limits. Limits should not be overemphasized. Their importance is to understanding derivatives and to understanding asymptotic behavior of functions.

Chapter 3 is on techniques of differentiation, whereas Chapter 4 is on applications. Chapter 4 should be the heart of the course, with the most important applications being optimization (4.7). Because of this, it is essential to cover Chapter 4.7 by week 9 at the very latest (new material covered in the last week of class is very rarely retained). Note also that in Fall week 9 is short.

What I actually recommend doing is covering some of the Chapter 4 material much earlier in the course, by Week 4 if possible (my suggested schedule below gets to it in Week 3). One can bounce back and forth between Chapters 3 and 4 in a way that unites this material rather than separating it.

Exams: I've written a schedule for two midterms and a final. One midterm is really not a good idea, since the students in this course need more feedback rather than less.

Bear in mind that there are calculators available that can do symbolic limits and differentiation and can find extrema of functions. If you allow calculators on the midterms, then you will need to write problems that don't give students who possess such calculators an unfair advantage.

You should put the time of your final exam, from the registrar's website based on your class starting time, on the syllabus.

Grade Scheme:

Homework	20%
Midterm 1	25%
Midterm 2	25%
Final Exam	30%

Instructors should feel free to change this system a bit as they see fit, but the above is fairly typical. Large changes should be discussed with the course coordinator.

Synchronization: **This is important!** Many aspects of students' experiences in MATH 251 will of course vary from section to section. It is important, though, that the variation not be too much. If a student is struggling in one section and they see that the problems their instructor is giving are much more difficult than the problems another instructor is giving, that feels horrible. And it can put the math department in a very awkward and untenable position. It is very important that students in different sections of 251 learn basically the same material, and are assessed in basically the same ways. A little variation among instructors is fine and healthy, but it should be kept from veering too far.

For a few years we experimented with a system where we used a common final exam and a common grading system. Currently we are using a much more individualized system, where instructors have the freedom of writing their own finals and making out their own grades. However, with great power comes great responsibility; it is important that the assessments in each section have a similar "look and feel". To accomplish this, during the first week of classes the course coordinator will provide instructors with an exam bank consisting of final exams from the past few years. We ask that you arrange your exams (midterms and final) so that 85% of the points on each exam have a similar "look and feel" to the questions on these model exams.

This "look and feel" issue is of course open to interpretation, and that is intentional. It does not mean that you have to copy the questions from the model exams and change the numbers. It does not mean that you cannot have exam questions on topics that are not covered by the models. It *does* mean that if your questions were swapped into one of the model exams, most people would rate the two exams as being very similar in tone and content.

Here are some extreme situations that would violate the "look and feel" test:

- Your final exam has 5 questions worth 5 points each.

- 50% of the problems on your final exam involve inverse trig or hyperbolic trig functions.
- 50% of your exam is true/false or multiple choice.

We ask that after your final exam is written you send a copy to the course coordinator (Dan Dugger). He will send out an email near the end of the term reminding you of this. You do not have to wait for “approval” before administering your exam, but this way we have a common record of what is happening in the different sections. If your exam differs markedly from the desired “look and feel”, expect a conversation about that.

Workload: There will be homework due every week, as well as reading and class attendance. Some years I have broken up the homework assignment and had the problems due twice a week, say on Tuesdays and Fridays—this keeps students from putting everything off until the last minute and not practicing the skills that are being used in lecture.

An average well-prepared student should expect to spend about 12 hours per week on this course (including time in class), but there will be a lot of variation depending on background and ability.

Broad Course Learning Goals: The students in Math 251 are mostly science majors of some kind. They need to understand how to model problems that can be solved with calculus and then use calculus to solve those problems. (Only a very small percentage of students in Math 251 are math majors, and thus mathematical proof is not a reasonable emphasis for the course.)

A successful student in this course **should be able to model and solve a wide class of optimization problems that are accessible to differential calculus.** Much of the other material covered in this course is necessary for that objective. So subgoals include:

- (1) Learning how to differentiate - this is necessary if you wish to use calculus to solve optimization problems.
- (2) Learning how to sketch graphs of functions - this is necessary to help identify where to search for local/global extrema when trying to optimize.
- (3) Understanding some basic facts about limits - this is needed for two reasons: to incorporate an understanding of the geometric interpretation of the derivative as the slope of the tangent line of a graph, and also to aid in sketching graphs of functions exhibiting asymptotic or discontinuous behavior.

It is not important for students to understand the ϵ - δ definition of limit in this course (which is not to say that an instructor cannot spend a little time on it if he or she sees fit).

- (4) Students should be able to solve related rates problems. These are less central than optimization, but can be introduced early as a source for problems that require students to practice modeling.

- (5) Students should be able to find the linear approximation to a function at a specific value of the variable, graph the linear approximation and the function on the same pair of axes, and use the linear approximation to find approximations to values of the function near the point at which the approximation is taken.

More Detailed Learning Goals: All sections of 251 should cover learning goals (1)–(19) below. Some instructors may wish to cover a selection of goals (20)–(24). If you are adopting additional learning goals, that should be discussed in advance with the course coordinator.

- (1) Evaluate limits using the algebraic limit laws
- (2) Identify limits at $\pm\infty$ for rational functions
- (3) Identify limits of rational functions involving cancellation of linear factors from numerator and denominator
- (4) Compute left and right limits for a function (or decide they do not exist), given an expression for the function.
- (5) Identify the points where common functions are continuous and/or differentiable, and the same for functions given graphically.
- (6) Identify limits, as well as left and right limits, for functions given graphically.
- (7) State and use the product rule, quotient rule, chain rule, and linearity rules for derivatives.
- (8) State the definition of the derivative in terms of a limit of difference quotients.
- (9) Interpret, including units, the derivative as an instantaneous rate of change of a quantity defined in an applied context.
- (10) Recognize the derivative as the slope of the tangent line.
- (11) Use calculus to approximate the value of a function near a point p , given information about the function and/or its derivatives at p .
- (12) Compute derivatives of functions involving polynomials, exponentials, logarithms, and trig functions, using a combination of theorems, differentiation rules, and definitions.
- (13) Find the equation for the tangent line of a curve at a given point.
- (14) Calculate derivatives via implicit differentiation

- (15) Use the methods of calculus to find asymptotes, local minima/maxima, intervals of concavity, intervals where the function is increasing/decreasing, and inflection points. Relate these properties to the graph of the function.
- (16) Find extrema of a function on open and closed intervals.
- (17) Solve optimization problems, including word problems.
- (18) Solve related rates problems, including word problems.
- (19) Use L'Hopital's rule to evaluate indeterminate forms of limits, including cases requiring multiple applications.

Optional learning outcomes:

- (20) Use the Intermediate Value Theorem to prove that roots of a function exist in a given closed interval.
- (21) State the Mean Value Theorem.
- (22) Recognize and use some standard trig identities, for example to calculate $\sin'(x)$ given that $\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$.
- (23) Use and apply modern technology (e.g., computer software) in some way that engages with the other learning outcomes.
- (24) Newton's Method.
- (25) Antiderivatives
- (26) Calculus and exponential growth

Learning Environment: The University of Oregon strives for inclusive learning environments. Please notify me if the instruction or design of this course results in disability-related barriers to your participation. You are also encouraged to contact the Accessible Education Center in 360 Oregon Hall at 541-346-1155 or uoaec@uoregon.edu.

Academic Conduct: The code of student conduct and community standards is at conduct.uoregon.edu. In this course, it is appropriate to help each other on homework as long as the work you are submitting is your own and you understand it. It is not appropriate to help each other on exams, to look at other students' exams, or to bring unauthorized material to exams.

APPROXIMATE SCHEDULE

This is only a suggested schedule, and you should feel free to alter as you see fit. I have taught from this schedule and had it go well.

Week 1	2.1–2.4	Limits
Week 2	3.1–3.3	Intro to derivatives, power rule, exponential rule
Week 3	3.4, 4.7, 3.3	Linear Approximation, Optimization, Product Rule
Week 4	3.3, 3.5, 4.7	Higher derivatives, trig derivatives, more optimization
Week 5	3.6, 3.8, 3.7	Chain rule, implicit differentiation, inverse functions
Week 6	4.7, 4.1	More optimization, related rates
Week 7	4.3, 4.5, 4.6	Maxima/minima, shapes of graphs, limits at infinity
Week 8	4.6, 4.8, 4.4	More limits at infinity, L'Hopital's Rule, MVT and IVT
Week 9	4.8, 4.10, 6.8	Rates of growth, Quick look at antiderivatives, exponential growth
Week 10	4.5, 4.9, 4.2	Second derivative test, Newton's method, differentials

Notes:

- (1) Students have a difficult time with the modelling problems (what used to be called word problems). It works very well to introduce these early in the course and then include some optimization problems every week, involving more complex functions as the course goes on. On a pedagogical level this move is a bit dicey, as early in the course students do not know enough to check via calculus that their critical point is really a min or max—to compensate for this I have the students graph the function and check it that way.
- (2) For me the first week is the most difficult part of the course to get through. The limit material is not very inspiring, and it treads on for days. It is important to keep this material under control and not spend too much time on it: it is not needed heavily in the rest of the course, but the students do need to understand the basic ideas.

I try to talk about slopes of tangent lines during week 1 and use this as motivation for why we need to talk about limits, and to cover the limit material only as needed to quickly get to the definition of the derivative.

- (3) Sections 4.10 and 6.8 from Week 9 are optional, as these are not part of the standard learning outcomes. These can be jettisoned if you are short on time. However, I find this material to be important and to fit well here. Likewise, some of the topics in Week 10 are also optional.
- (4) I usually use WeBWorK when teaching this course. However, the default set of assignments do not follow my schedule above. If you want, I can export to you the set of assignments I used for the above schedule (though this included many custom-made problems). The current set of default assignments (setWeek1 to setWeek10) cover as follows:

Week1. Limits.

Week2. The difference quotient, definition of derivative, secant lines, average and instantaneous velocity.

- Week3. Derivatives using the power rule, exponential functions. Also tangent lines and the derivative as a functions. Velocity and acceleration. Exponential growth (this last topic involves no calculus, but is a convenient way to remind them how to model with exponential functions).
- Week4. Product rule, quotient rule, trig functions.
- Week5. Chain rule, implicit differentiation.
- Week6. Chain rule, related rates, linear approximation, implicit differentiation.
- Week7. Concavity, curve sketching, function optimization.
- Week8. L'Hopital, improper limits, optimizations problems requiring modeling, curve sketching.
- Week9. Optimization, Newton's method.
- Week10. Review.

If you wish to give a short assignment early in the first week, you could use the CandC-4E-1-1 WeBWorK assignment which reviews a few relevant Math 111 topics. Or you may want to break up the Week1 assignment.

See the next page for more information about WeBWork.

Special COVID-related information for AY2021-22:

Because students have been engaged in remote learning for the last year and a half, there is a possibility that they will be coming to calculus with a shallower understanding of the background material than we would normally expect. To the extent that it can reasonably be done, it will be good if we can try to help students through the "re-integration" process by finding ways to shore up their knowledge and fill in their gaps as the course progresses. Of course in extreme cases students might have to go back and repeat earlier courses, and that is sometimes the best way forward. But instructors should be prepared for challenges related to all of this. We routinely incorporate this kind of review into our courses anyway, but this year might require us to do this even more.

Students need to be taught a reasonable approach to using WebWork. My syllabus usually includes something like the following:

Showing work:

When working on your assignment you should have scratch paper available and neatly write out your thought process in solving the problem. While WebWork does not grade you on this process, writing it out carefully will train you in the skills you need. It will help you track down mistakes, and it will help *us* track down mistakes when you ask for our help. If you ask us a question about a homework problem in office hours, the first thing we will probably do is ask you to show us your work.

Also, remember that on quizzes and exams showing your work will sometimes be required. It is important to practice this each week while doing your homework assignments.

Logging in to Webwork: First go to the main login page at

<http://webwork.uoregon.edu/webwork2>

Select the “Math251-13891” section. Your username is your DuckID: for instance, if your uoregon email address is johndoe@uoregon.edu, your DuckID is “johndoe” (without the quotation marks). Your password is the same as your UO email password.

Getting help:

If you have a question about a homework problem, one excellent resource is the “Email instructor” button at the bottom of the WebWork screen. Clicking on that and typing a short message about what you’ve tried on the problem will help me diagnose the issue you’re having.

What you should NOT do: Do not send an email simply saying “What am I doing wrong on this problem” or “I can’t seem to get the right answer on this one.” On most homework problems it is impossible to figure out what you are doing wrong if I only see your answer (which is all WebWork shows me).

What you SHOULD do: If WebWork tells you your answer is wrong, first go back over your work and see if you can find the mistakes yourself. If you can’t, feel free to email me: but include a description of how you solved the problem as well as any work you did for intermediate steps. The more information you give, the more likely it is you will get a prompt and helpful reply.

Also note that the departmental webpage gives tips for using WebWork here:

<http://math.uoregon.edu/undergraduate/webwork>