

Math 150: Calculus I

Spring 2016

There are other things of so elevated and subtle a nature, that neither speech nor writing can clearly explain them. They are felt, they are conceived, but they are not to be explained, and yet these things constitute the elevated style, the grand ecôle which it is my ambition to institute for the cornet, even as they already exist for singing and the various kinds of instruments.

Such of my readers as may wish to arrive at this exalted pitch of perfection, should, above all things, endeavor to hear good music, well interpreted. They must seek out, amid singers and instrumentalists, the most illustrious models; and this practice having purified their taste, developed their sentiments, and brought them as near as possible to the beautiful, may perhaps reveal to them the innate spark which may some day be destined to illumine their talent, and render them worthy of being, in their turn, cited and imitated in the future.

— J. B. Arban, *La grande méthode complète de cornet à piston et de saxhorn*, 1864.

Instructor: Wesley Calvert

Office: Neckers A 277

Office Hours: Official (guaranteed) hours: Wednesday 1–3, Thursday 10–11;
Friday 1:30–4:30; also make an appointment or come see me.

Web Page: <http://lagrange.math.siu.edu/calvert/teaching/150s16/>

Office Phone: 453-6573

Home Phone: 985-3429

Cell Phone: 534-8457

e-mail: wcalvert@siu.edu

Course Goals

The Real Goals

The most important goal of calculus, and a central goal of this class, is to provide the student with means of thinking carefully about the infinitely large and the infinitely small. Since infinity is one of the most mind-bending concepts in the history of human thought, and since calculus is one of the most effective tools for dealing with it (as well as for the intrinsic beauty of this tool), it has for many decades now been a critical part of a person's mathematical education, especially (though not exclusively) for those in scientific or technical fields. As Arban told his students to hear the best music available, so also the student should learn the best mathematics available, and calculus is a central such "illustrious model."

Of course, another thing about calculus is its ubiquitous application. Both its ideas and technical details infuse the language and methods of every part of science and engineering. Even when no explicit calculation is involved, it still provides a framework for thinking about mechanics, error propagation, chemical kinetics, physiology, and almost everything else in the scientific world. Consequently, the second goal is that the student will gain facility with the fundamental techniques of calculus and some sense of the range of its applications.

The Official Goals

To acquaint the student of science, engineering, or mathematics with the fundamental concepts, techniques, and applications of limits, continuity, and derivatives; and to provide an introduction to the definition and applications of definite integrals.

The specific objectives below reflect skills the student should be able to demonstrate on the final examination. The instructor should include some of: Newton's method, Riemann sums, the Trapezoidal rule or Simpson's rule, etc., in lecture, homework, quizzes and/or class tests. Also, instructors should be aware that Engineering students are expected to have some familiarity with the hyperbolic functions.

Upon completion of this course, the student should be able to:

- Find one- or two-sided limits of a function $f(x)$ as x approaches a real number, a
- Evaluate limits at infinity and infinite limits
- Interpret continuity and limits in a graphical context
- Use the Intermediate Value Theorem, Rolle's Theorem, and the Mean Value Theorem
- Interpret the derivative both as the slope of a tangent line and as instantaneous rate of change; find average and instantaneous rate of change

- Use the formal definition to find the derivative of a given function
- Use the rules for finding derivatives of sums, differences, products, quotients, composite functions, implicit functions, and functions defined by an integral
- Find derivatives of algebraic, trigonometric, logarithmic, exponential, and inverse trig functions
- Find the equation of a tangent and a normal to the graph of $f(x)$ at a given point
- Find higher order derivatives for a given function
- Solve related rates and maximum/minimum problems
- Recognize and interpret the relationships among f , f' , and f'' in a graphical context. Be able to sketch the graph of a function
- Find antiderivatives of polynomial, rational, trigonometric, and exponential functions
- Use derivatives and antiderivatives (integrals) to solve problems involving velocity and/or acceleration
- Evaluate definite integrals
- Use integration to calculate the area between two curves and the volume of a solid of revolution.

Course Content

We will study the following two ideas:

1. Ratios of infinitely small numbers.
2. Addition of infinitely many numbers, each of which is infinitely small.

Neither idea is nearly as abstract as it sounds. Consider the slope of a line which intersects a parabola at the point $(1, 1)$ and at one other point. Watch what happens as the second point gets closer and closer to $(1, 1)$. The “rise” and the “run” both get infinitely small, but there is still a line, and it still has a slope. This slope we call the *derivative*. It represents the instantaneous rate of change of the function (or whatever other function we want to use; perhaps one describing position as a function of time) at the point $(1, 1)$ (of course, we could use any other point).

For the second big idea, think of the area of a circle. We could estimate the area by inscribing a rectangle in the circle. The estimate would be better if we used more smaller rectangles. The estimate would be perfect if we used infinitely many infinitely small rectangles. Thus, the problem of calculating area is the same as that of adding up the (infinitely small) areas of these (infinitely many) rectangles.

Aside from these two ideas, all the rest is either underpinnings, elaboration, example, or detail. Which doesn’t mean it’s unimportant. Rather, since this is mathematics, that means it’s of paramount importance.

Accordingly, we will start with a rather detailed discussion of limits (e.g. a careful explanation of what we mean by “what happens as the second point gets closer and closer to $(1, 1)$ ”), and then one of derivatives. We will then build a toolbox of techniques for calculating derivatives. One difference of this course from other calculus courses you may have seen (especially in high school) is that we will pay serious attention to why these things work.

The next step will be a discussion of various applications of differentiation, first to geometry, and then to physics, engineering, business, and economics.

Finally, we will begin a discussion of integration (the second big idea). This will bring us to the mathematical high point of the course, the so-called “Fundamental Theorem of Calculus.” This theorem states that integration and derivation are really inverses of one another.

Some particular topics in the course are central. Others are less central, and if time constraints demand it, we may omit some rather than doing everything badly.

Course Activities

The class will meet on Monday, Wednesday, Thursday, and Friday at 9:00am. A typical meeting will begin with a discussion of any questions folks have, with procedural matters treated first. This will be followed by a discussion of new material (often in the form of problems, on which students will work in groups) and typically an assignment of new homework.

You should be in every class meeting, and should make sure that you are actively engaged. It goes without saying that when a problem is assigned for group work, you must do it. If you wait for me to tell you how to do it, then by the time I talk about the solution with the class, everybody else will understand it and will be ready to ask about issues you haven’t encountered, and you will be lost. Don’t do this. You should be careful to ask any questions you

have. You should also feel free to be wrong. We all will be at some point in the class. That's why we gather together, instead of just reading the book on our own: we can help one another understand better, and we can try out ideas on each other, even if we aren't quite sure of them.

Homework will be assigned daily or almost daily and will be collected weekly, on Fridays (unless otherwise announced). There will be a truckload of it, and that's not because I'm mean. The most common thing in all of mathematics — I do it myself, as does every other mathematician I know — is to see somebody else doing a problem and say, "Yes, yes, of course. I understand completely," and then walk away and realize that we had no idea at all what was going on. Homework is your guard against this. If you really understand how to do the homework, you're generally in pretty good shape. If you can't, you've got plenty of time to figure it out, ask me, ask a friend, or take whatever other action you see fit.

Homework will always be due at 4:30 on the appointed day. You are, of course, welcome to turn it in when you come to class. If you wish, though, you may continue to work on it, and may deliver it to my office or my department mailbox.

Cooperation on homework is strongly encouraged. There will almost certainly be problems on which it is necessary. Talk with each other, talk with me, talk with friends, use any resource. It is important, however, to be sure that you understand the solution you present. In designing the tests, I will assume thorough familiarity with all homework problems due before the date of the exam.

You are also encouraged to visit me in my office (see note on office hours above) or to call or e-mail me. To be more clear: It's a hard class. I'd like to see you do well in it. I'd love to talk with you and to help you in any way that I can.

It is wise to work on the homework as it is assigned, for a couple of reasons. First, there will be enough of it that it will not be practical to just sit down and do the whole week's worth in an evening. Second (and more importantly), the material builds on itself, so that a few days without working through at least some of the problems may find you feeling a little lost.

Text: Stewart, *Essential Calculus with Early Transcendentals*, 2ed, Brooks-Cole, ISBN 978-1-133-11228-0

Be warned. The bookstores have been known to offer some other books as "recommended" for math courses. They are recommended by the bookstore, not by the math department, and not by me. I don't particularly recommend against them (since I have little idea what they'll be), but let the buyer be ware.

The text makes a great effort — and a successful one at most points — to be readable. It will provide an important opportunity to get an explanation in a different voice (at times very different) than that of your beloved teacher. It will also be the source of the bulk of the homework problems. Be careful of this, though: One can easily get the impression from the book that the right way to think about things is to memorize some formula or some procedure. In practice, if you try to do this with everything we will learn in the approximately sixty hours we have together in class this semester, plus the time spent outside of class, you will likely be overwhelmed and miserable. Better is to try and find the big ideas, and re-build everything else as you need it. You'll do better with this class and with later ones, and you'll not have to memorize nearly as much (i.e. it's easier).

There will also be some exams. Each exam (except the final) will be preceded by a review sheet indicating *exactly* what material will be covered and an in-class review session. Exams will be given in the regularly scheduled class time and place on February 5, February 26, March 31, and April 22. In addition, there will be a final exam on Monday, May 9, from 5:00pm to 7:00pm. I will forward information on the final exam location as soon as I have it. The final will test your ability to do all of the things we have worked on in class, and will be the same final offered to all other students in Math 150 this semester.

The general philosophy is that class sessions and homework will be very hard and tests will be pretty easy (assuming, of course, that you've suffered through the class meetings and homework leading up to them). Again, my goal with the homework is to help you to understand the material so well that you're unhappy with me for giving such a boring (easy) test.

In all activities for this class, make sure that you *do something*. It is depressing how often students who probably know something relevant to a problem do absolutely nothing, allowing no opportunity to receive credit on the part they actually know.

Calculators

You will need a TI-30 calculator for this course. This calculator, and no other, will be permitted on the final exam. I will be less particular in enforcing the rule on earlier exams, but remember that you don't want to go into the final exam with a calculator you're not already comfortable using.

Grading

Grades will be calculated from the following sources:

Homework	200
Regular Exams (100 each)	400
Final Exam	200

800pts

Failure to attend class regularly will certainly adversely affect your grades on each of these factors. For instance, while I do not artificially lower grades for bad attendance, it has consistently held that almost all grades below C- that have been achieved in classes that I have taught have been associated with significant attendance problems.

In like manner, you should not underestimate the impact of your homework. Not only does the experience of the homework problems impact your test grades, but the homework itself is a considerable portion of the grade in the class. Moreover, since you can use the book, talk with friends, talk with a tutor, ask me how to do the problem, etc., *everyone should receive a grade of near 100% on the homework*. It is depressing how rarely this happens. Indeed, due largely to negligence in completing and turning in all of the assigned problems, many students find that their homework grade instead brings their grade in the course down. Don't let this happen to you.

In all work done for this class, work is more important than answers. A correct answer without correct work (or worse, with work that does not match the answer) is not worth much at all, while generally correct work with an incorrect answer is almost as good as being completely right. Thus, getting the right answer does not guarantee a good grade on the problem, and getting a wrong answer does not guarantee a bad one.

I will make the following guarantees about letter grades. I may decide to lower these criteria (i.e. give a higher grade than the one shown here, if I see that the questions were hard enough that lower numbers more accurately reflect my true standards), but will never raise them.

Percent of total	Grade
90–100	A
80–89	B
70–79	C
60–69	D
≤ 59	E

Prerequisites

The prerequisites of this course are designed to save you from spending a semester being miserable and failing this course. *I am on your side, and wish you success. That is why I am telling you this.* To take this course, you must

1. Have a grade of C or better in Math 111 or equivalent, *and*
2. have a satisfactory placement score, which means an ACT math subscore of at least 26, or completion with a C or better of a *college* course equivalent to Math 111.

This course assumes that you have a *thorough* understanding of functions, their inverses, their compositions, their symmetries, and their notation. You must be completely comfortable with trigonometric, exponential, logarithmic, rational, and polynomial functions before you start if you are to have any hope of passing this course.

Any student not meeting these requirements is *strongly* advised to delay taking this class until they are satisfied.

Catalog Description

Math 150 (4 credits) Calculus I (Advanced University Core Curriculum course) [IAI Course: M1 900] Treatment of the major concepts and techniques of single-variable calculus, with careful statements but few proofs. Differential and integral calculus of the elementary functions with associated analytic geometry. If there is prior credit in 140 or 141 only 2 hours credit for 150 may be applied to graduation requirements. Prerequisite: 111 or equivalent with a grade of C or better. Students must present satisfactory placement scores or obtain the permission of the department of Mathematics. Satisfies University Core Curriculum Mathematics requirements in lieu of 110 or 113.

Emergency Procedures

Southern Illinois University Carbondale is committed to providing a safe and healthy environment for study and work. Because some health and safety circumstances are beyond our control, we ask that you become familiar with the SIUC Emergency Response Plan and Building Emergency Response Team (BERT) program. Emergency response information is available on posters in buildings on campus, available on BERT's website at www.bert.siu.edu, Department of Safety's website www.dps.siu.edu (disaster drop down) and in Emergency Response Guideline pamphlet. Know how to respond to each type of emergency.

Instructors will provide guidance and direction to students in the classroom in the event of an emergency affecting your location. It is important that you follow these instructions and stay with your instructor during an evacuation or sheltering emergency. The Building Emergency Response Team will provide assistance to your instructor in evacuating the building or sheltering within the facility.