Math 1337: Calculus I (Fall 2020)

Instructor: Ross Parker (rhparker@smu.edu)
Course hours: MWF 12-12:50pm
Location: Dallas Hall 306 and online via Zoom (SMUFlex format)
Office Hours: remote via Zoom, hours TBA (will conduct online poll)

Course Description

If calculus were a best-selling novel, the back cover might look something like this.

- "One of humankind's most inspiring collective achievements." (Steven Strogatz)
- "The language God talks." (Richard Fenyman)
- "The outcome of a dramatic intellectual struggle which has lasted for twenty-five hundred years." (Richard Courant)
- "Sorcery devised by Isaac Newton, one of the most prestigious and powerful sorcerers in the world." (urbandictionary.com)
- "The math class you take after pre-calculus." (anonymous student)
- "The study of curvy things by approximating them with not-curvy things." (me)

Calculus is the mathematics of change and motion. Using calculus, we can describe a near limitless array of phenomena, including the trajectory of a baseball, the motion of planets, the rise and fall of the stock market, the flow of traffic on a highway, and the transmission of a signal along a neuron. By the end of the course you will be able to do the following (don't worry if you have no idea what some of these are, you will learn what they mean and how to do them by the end of the course!):

- Demonstrate an ability to interpret mathematical models in the form of formulas, graphs, and/or tables and draw inferences from them.
- Understand the concept of the limit of a function, and compute limits for a wide variety of functions.
- Understand the mathematical definition of a derivative and its interpretation as an instantaneous rate of change.
- Compute derivatives of polynomials, exponentials, logarithms, and trigonometric functions, as well as products and quotients of these functions and composite functions.
- Apply your knowledge of differentiation to optimization problems and sketching graphs of functions.
- Understand how the integral is defined as the limit of Riemann sums.
- Integrate simple functions, as well as composite functions using the substitution technique.

Nuts and Bolts

Class format: This is a SMUFlex/hybrid course. SMUFlex courses are conducted in real-time with some students attending in-person and others participating remotely via Zoom. SMUFlex courses follow a Red-Blue rotation schedule, in which you attend class in person on your assigned day and engage virtually via Zoom on the alternate days. (You can check your assignment to either the Red cohort or the Blue cohort on `https://my.smu.edu`). Since this course takes places MWF, this means that you will alternate weekly between in-person attendance and remote attendance. The official Red-Blue rotation calendar can be found at `https://sites.smu.edu/des/registrar/pdf/calendars/SMU%20Fall%202020%20RedBlue%20Calendar.pdf`. For this course, the Blue cohort attends in person the first week, the red cohort attends in person the second week, etc. Some students will be participating in a fully remote experience, where all classes will be attended via Zoom. In addition,

- Although you are expected to attend class either in person or remotely, all lectures will be recorded. You can view them using the Panopto tab in Canvas.
- All materials used in class will be posted on Canvas as well.
- All assignments and exams will be done remotely, and will be submitted via Canvas.
- All office hours will be conducted remotely via Zoom.
- All classes will be remote after Thanksgiving break.

Classes will be taught for the most part in a traditional lecture format, but I will incorporate class participation and in-class activities to the extent that I can while still maintaining social distancing. Please feel free to interrupt me at any time to ask me to repeat something, clarify a point, request I slow down, fix my handwriting, point out a mistake I have made, etc. Remote students will be audible via the classroom sound system, so please participate as well! I will also post surveys a few times throughout the course and welcome your feedback and suggestions for improvement.

Office hours: I will hold office hours for 3 hours per week via Zoom. I will send out a when2meet poll during the first week of class to schedule these hours so that the majority of the class can attend at least one block of hours. Please come to office hours for any questions or for more practice questions.

Teaching assistant hours: A teaching assistant will be holding additional help sessions for Math 1337, Mondays 5-5:50pm and Thursdays 6-6:50pm. These will be held remotely via Zoom. A zoom link will be shared once it is available.

Prerequisites: Placement out of Math 1304 (pre-calculus) or a C- or higher in Math 1304. You should be familiar with graphs, functions, basic analytic geometry, exponentials, logarithms, trigonometry, and inverse functions. While I will not expressly teach these topics, I will review them as needed.

Textbook: This course will be taught using the open source textbook *Calculus, Volume 1*, from the Openstax Project, which is available free online at `https://openstax.org/details/calculus-volume-1`. You can also download a PDF of the complete text book for free, and can purchase a physical copy for about $30.

Optional reading: Where did calculus come from? What does it all mean? If you want to step back from the nitty-gritty and look at the big picture, I highly recommend *Infinite Powers: How Calculus Reveals the Secrets of the Universe* by Steven Strogatz. Published in 2019 and written for a general audience by one of the best mathematical writers I know, it not only discusses the history and philosophical underpinnings of calculus, but connects calculus to topics relevant to the modern world, including the GPS system, the spread of infectious diseases, and Shrek.

Other resources: Here are some other online resources you may find helpful to learn calculus. Although they are geared towards Calculus I, the topics covered may not line up exactly with this course. If you find any other online resources you find helpful, please let me know!

1. Paul's online notes. This has been around for years, and many students have found it very helpful. `https://tutorial.math.lamar.edu/Classes/CalcI/CalcI.aspx`.
2. Videos by Krista King. These short videos, each covering a single topic, are designed for AP Calculus, but work well for any calculus course. Playlists for Calculus 1 (limits and continuity, derivatives, application of derivatives: `https://www.youtube.com/c/Integralcalc/playlists?view=50&flow=grid&shelf_id=22`. We will also be covering some topics from the Calculus 2 playlist (integrals, applications of integrals): `https://www.youtube.com/c/Integralcalc/playlists?view=50&flow=grid&shelf_id=23`.
3. Videos by Professor Leonard. These videos are longer, and cover multiple topics, but I think they are very clear. `https://www.youtube.com/playlist?list=PLF797E961509B4EB5`.
4. Videos by NancyPi. She has playlists for limits, derivatives, and integrals. `https://www.youtube.com/c/NancyPi/playlists`.
5. Khan academy. The most well-known video series. `https://www.khanacademy.org/math/calculus-1`.

Course Outline: This is a preliminary schedule of the topics we will be covering in class.

week	**book sections**	**topics**
8/24 - 8/28	2.2, 2.3	limits
8/31 - 9/4	2.4, 3.1, 3.2	continuity, derivatives, tangent lines
9/7 - 9/11	3.3, 3.5	differentiation rules, product and quotient rules
9/14 - 9/18	3.6, 3.7	chain rule, inverse functions, higher derivatives
9/21 - 9/25	3.8, 3.9	implicit differentiation, derivatives of exp functions and logs
9/28 - 10/2	4.1, 4.2	related rates, linear approximation
10/5 - 10/9	4.3, 4.4	critical points, mean value theorem
10/12 - 10/16	4.3, 4.5	maxima and minima, concavity, curve sketching
10/19 - 10/23	4.5, 4.6	asymptotes, end behavior, curve sketching
10/26 - 10/30	4.7, 4.8, 4.9	optimization problems, L'Hôpital's rule, Newton's method
11/2 - 11/6	4.10, 5.1	antiderivatives, areas
11/9 - 11/13	5.1, 5.2	areas, Riemann sums, definite integral
11/16 - 11/20	5.3, 5.4	fundamental theorem of calculus, integration formulas
11/23	5.5	integration by substitution
11/25		no class (yay!)
12/2 - 12/4	5.5, 5.6	substitution, exponentials and logs, review (all classes online)

Homework: There will be problem sets due every Monday and Friday. Homework will be submitted on Canvas and is due at the start of class. This sounds like a lot, but learning mathematics, like getting to Carnegie Hall, is all about practice, practice, practice. For all assigned problems, you must show all of your work. This means you should display the process used, not just state a final result. Your goal is to convince me you know how to do the problem, not just what the answer is. You may discuss assignments with other students, but you must write up your own solution independently. When you have collaborated with other students, please acknowledge this by adding a note such as "I discussed question X with A and B." If you use any electronic resources, such as Desmos or Mathematica, please indicate that as well. Do not postpone the problem sets until the last minute, as some answers may not come to you immediately, but then become clear a day later. If you are stuck on a problem, seek help from office hours or discussing with other students. Finally if you are not able to complete a question, write a short note to describe what you tried and what you think may be important. Credit on assignments will come from a serious effort as much as anything else.

Homework policy: Since homework assignments are bi-weekly, and solutions will be posted, late assignments not be accepted. Your lowest homework grade will be dropped.

Skills assessments and final exam: There will be three skills assessments (similar to midterm exams, but graded differently), as well as a final exam. You will be given a 48-hour window in which to complete each skills assessment, but it must be completed in a single, uninterrupted block of time. They will be released after class on Monday, and will be due by the start of class on Wednesday. The dates of the skills assessments are:

Assigned	**Due**
Mon 9/14	Wed 9/16
Mon 10/5	Wed 10/7
Mon 10/26	Wed 10/28
Mon 11/16	Wed 11/18

The final exam will be Tuesday, December 15, and must be taken during the block of time scheduled by the university. For skills assessments and the final exam,

- You may use a calculator if you wish.
- No other electronic devices may be used, except to physically write the exam.
- You may use a study sheet, which you must make yourself. Study sheets must be one standard 8.5x11 sheet of paper. You may use both sides of the paper and may write whatever you want on it. You will be asked to turn in your study sheet on Canvas.

Logistics for taking the skills assessments and final exams remotely will be given in the week leading up to the first skills assessment.

Grades: The grade for this class is based on your performance on the homework, mastery of the essential skills of calculus I, and a cumulative final exam. It will be determined as follows.

Homework	15 %
Skills	60 %
Final Exam	25 %

This course will be taught using a *standards based* or *skills based* approach. I have identified 29 essential skills for Calculus I. These are listed on the last page of the syllabus. Your grade on the skills portion of the class will be determined by how well you demonstrate mastery of these 29 skills on your skills assessments. What makes these different from the traditional approach is that if you have not demonstrated a skill to your satisfaction, you may *repeat the assessment* for that skill. Since this method may be unfamiliar to you, here's how it works:

- Each skills assessment will test a certain number of skills from the list. You will know which ones will be tested ahead of time. The skill being tested will be clearly indicated for each problem on the skills assessment.
- Rather than lose points for mistakes, you will earn points by demonstrating your mastery of the skill being tested. Each skill will be assessed using the following scale

  4 Excellent
  3 Good
  2 Basic
  1 Improving

- For any skill in which you have not received a score of 4 (excellent), you may take a repeat assessment for that skill. The logistics for reassessment will be given after your first skills assessment. You will be allowed up to two additional assessments for each skill. If you improve after reassessment, your old score will be replaced with the new score.
- Your grade for the skills portion of the class is determined as follows

  A 4s or higher on at least 80% of skills, with no scores below a 3
  B 3s or higher on at least 80% of skills, with no scores below a 2
  C 2s or higher on at least 80% of skills

An online webapp is available to compute your grade at any time at `https://rhparker.github.io/mygrade/index.html`.

tl; dr. If you demonstrate you know how to do Calculus I, you will get an A for the skills portion of the course.

Finally, you are expected to attend the synchronous portion of class either in-person or virtually over Zoom. While attendance and participation are not directly reflected in your grade, they will be used to decide any borderline grades.

Communication: Email is the best way to reach me. During the week, I will try to respond within 24 hours. Email responses may be slower on the weekends, but I will try to reply by Sunday evening. For complex questions, I may ask you to talk with me during office hours.

Diversity Statement

Mathematics, in its idealized form, is objective. (Important exception: mathematics applied to fields such as the social sciences.) The field of mathematics, however, has long been dominated by white males. Pop culture and the media have not made this any better, from Teen Talk Barbie telling us that "math class is tough" to the stereotypical "nerdy male" mathematicians in movies

and television. It is my intent that students from all diverse backgrounds and perspectives be well-served by this course. To that end,

- If you feel like your performance in the class is being impacted by your experiences outside of class, please do not hesitate to come and talk with me.
- If you have a name and/or set of pronouns that differ from those that appear in your official records, please let me know.
- If something was said in class (by me or anyone else) that made you feel uncomfortable, please talk to me about it.
- I will provide a web address at which you can submit anonymous feedback.
- If you have a name and/or set of pronouns that differ from those that appear in your official records, please let me know.

Disability Accommodations

Students needing academic accommodations for a disability must first register with Disability Accommodations and Success Strategies (DASS). Students can call 214-768-1470 or visit `http://www.smu.edu/Provost/ALEC/DASS` to begin the process. Once registered, students should then schedule an appointment with the professor as early in the semester as possible, present a DASS Accommodation Letter, and make appropriate arrangements. Please note that accommodations are not retroactive and require advance notice to implement.

Religious Observance

Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. (See University Policy No. 1.9.)

Excused Absences for University Extracurricular Activities

Students participating in an officially sanctioned, scheduled University extracurricular activity should be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the instructor prior to any missed scheduled examination or other missed assignment for making up the work. (see University Undergraduate Catalogue.)

COVID-19 information

Students experiencing COVID-19 symptoms or who have been notified through contact tracing of potential exposure and a need to self-quarantine or isolate should follow the protocols laid out by SMU CAN. To ensure academic continuity, students in these situations will not be penalized and will be provided appropriate modifications to assignments, deadlines, and testing. Please also note that your SMUFlex class might go remote for two-week periods to accommodate COVID-related issues. To ensure these necessary accommodations, affected students should:

- Provide as much advance notification as possible to the instructor about a change in circumstances. Students are not required to disclose health details, but should notify their instructor about a potential absence as well as plans for a return to class. For cases in which students test positive for COVID-19, they should fill out a CCC form (`https://www.smu.edu/Coronavirus/Contact-Tracing`). With the student's permission, a member of the contact tracing team could reach out to the student's instructors.

- Communicate promptly with the instructor to establish, as necessary, alternative assignments and/or changes to deadlines and exams. Students are then responsible for meeting the expectations laid out in these alternative arrangements.

- Continue participation in class via Zoom, as health circumstances permit. Attend class regularly, when not in a situation outlined above, in accordance with safety measures laid out by SMU CAN (including wearing masks, maintaining social distancing, and cleaning personal space after class).

- In-person participation in SMUFlex classes is required on students' assigned red/blue rotation days except in cases when students are experiencing COVID-19 symptoms, in self-quarantine or in isolation.

- Students facing multiple or extended COVID-19-related absences can work with the Office of Office of the Dean of Students to consider options such as fully remote learning or medical withdrawal.

This policy, aligned with the SMU Honor Code and the SMU Pledge to Protect, relies on mutual trust and respect between students and faculty to ensure safety, academic integrity, and instructional continuity.

List of Skills for Calculus I

Limits and Continuity

1. Find the limit of a function, and identify when a limit does not exist. (2.2)
2. Find one-sided limits and infinite limits, and identify vertical asymptotes. (2.3)
3. Identify when a function is continuous or not continuous, and classify discontinuities as one of three types. (2.4)

Derivatives

4. Understand the limit definition of the derivative, and find the derivative of a function using this definition. (3.1)
5. Determine if a function is differentiable, and describe at least three conditions for when a function is not differentiable. (3.2)
6. Compute basic derivatives, including those of constants, powers, constant multiples, sums, and differences. (3.3)
7. Apply the product rule and quotient rule for derivatives. (3.4)
8. Find the derivative of expressions involving trigonometric functions. (3.5)
9. Apply the chain rule for differentiation. (3.6)
10. Compute the derivative of an inverse function, including inverse trigonometric functions. (3.7)
11. Use implicit differentiation to find the slope of the tangent line to an arbitrary curve at a specific point. (3.8)
12. Find the derivative of expressions involving exponential and logarithmic functions. Use logarithmic differentiation to compute derivatives of complicated functions. (3.9)

Applications of derivatives

13. Set up and solve a related rate question. (4.1)
14. Use linear approximation to find the approximate value of a function, and compute the relative error of my approximation. (4.2)
15. Find all critical points of a function, and determine the absolute minumum and maximum of a continuous function on a closed interval. (4.3)
16. State and understand graphically Rolle's theorem and the mean value theorem. (4.4)
17. Use the first derivative to identify when a function is increasing or decreasing, and use the first derivative test to identify local minima and maxima. (4.5)
18. Determine the concavity of a function, and locate inflection points. (4.5)
19. Use the second derivative test to identify local minima and maxima of a function. (4.5)
20. Compute limits of a function at infinity, and identify horizontal asymptotes. (4.6)
21. Set up and solve an optimization problem. (4.7)
22. Identify an indeterminate limit, and use L'Hôpital's rule to evaluate these limits. (4.8)
23. Understand, algorithmically and graphically, how Newton's method is used to find a zero of a function. (4.9)
24. Compute antiderivatives of elementary functions, and use these antiderivatives to solve simple initial value problems. (4.10)

Integration

25. Estimate the area under a curve using a finite sum. (5.1)
26. Understand the relationship between integration and differentiation given in the fundamental theorem of calculus (part 1), and know how to take derivatives of definite integrals. (5.3)
27. Evaluate definite integrals using the fundamental theorem of calculus (part 2) and antiderivatives. (5.4)
28. Simplify integrals of even and odd functions. (5.4)
29. Use the substitution technique to evaluate antiderivatives and definite integrals. (5.5)