**Math 050: Analytic Geometry and Calculus**

**Instructors:** Tarik Aougab, Shamil Asgarli

**Office:** Tarik: Kassar House, Room 116. Shamil: Kassar House, Room 020.

**Class Time/ Location:** 2:30-3:50 PM in BH 157

**Office Hours:** TBD (we will decide this based on what works best with students' schedules)

**Course website:** https://sites.google.com/a/brown.edu/tarikaougab/teaching/math-050-fall-2018

**Textbook:** Thomas' Calculus: Early Transcendentals. Students are **not** required to purchase this book, although homework problems may be assigned from the book. If obtaining a copy is difficult for any reason (e.g. it's too expensive), we can make a copy available and we will certainly make the homework problems available online.

**Course Description and objectives:** Calculus is truly everywhere! In essence, you could say that calculus is a science of **balance**: understanding how competing and sometimes contradictory forces will combine to produce a particular outcome. Examples:

(1) You're a political scientist trying to understand a new and exciting plan for universal basic income (UBI). The basic idea is that each person automatically receives a baseline income, hopefully enough to cover the essentials. Ideally, people will have enough money to liberate them from some of the most oppressive aspects of capitalism (e.g. being forced to work a terrible/degrading job for low pay). The question is how the government will pay for the plan. If people aren't being given enough to refuse terrible working conditions, the plan fails. On the other hand, give people too much and the plan gets very hard to pay for, so to compensate the government ends up cutting back on other important social service and welfare programs. Is there a balance? If so, how do you find it? (key words: limits, derivatives)

(2) You're a biologist studying the impact of insulin, which helps to regulate the amount and circulation of glucose in the blood stream. But it turns out there's a hugely complicated pathway from insulin to glucose regulation, involving dozens of other hormones and compounds! It's not too difficult to get a feel for how each compound interacts with each of the others (e.g. "the more of compound A there is, the less of B", or "compound C requires compound D as fuel"), but piecing this information together to understand how the entire cast comes together is another story... (key word: differential equations)

(3) Earth is on a collision course with a giant asteroid and our last hope is a rag tag team of drillers who need to land on the asteroid, drill into it and bury a bomb so that it blows up before impact. You're on the shuttle design team. The fundamental problem in rocket science is fuel: rockets need fuel to get anywhere, but the more fuel you put on the rocket, the more weight the ship needs to haul while escaping Earth's gravity, the more power required to actually take off (and that means you need a larger and more complicated ship). The team needs some time on the asteroid in order to complete the mission, so from that perspective, we want the rocket to go out pretty far and meet the asteroid while it's still a ways out. But if we make our ship too big and complicated, it'll be difficult to land it on a relatively small and moving target. What do we do?? (key words: related rates, derivatives).

Calculus is also at the heart of some of the deepest philosophical questions ever pondered by humankind: what is infinity? What is zero? Is zero "smaller" than infinity is "big"? Does

that even make any sense to ask? The purpose of this course is to get a feel for the basics of calculus: functions, limits, and derivatives. The hope is that students will feel comfortable with these ideas and how to apply them by the end of the semester.

**Growth, not ability:** There is a very prevalent belief that you are either "good" or "bad" at math, and if you are "bad" at it, then you will always be bad at it no matter how hard you try. **This is extremely false, and the mathematics community bears a lot of responsibility for perpetuating this myth**. In reality, mathematics is just like any other discipline or skill: you can improve more and more with practice. I (Tarik) am absolutely confident in this, because:

(1) I've seen it happen dozens of times with students in the past;
(2) I myself was once "not a math person".

I actually failed math one year in elementary school! I did fine in high school, but I could never think of myself as someone who was "good" at math. I was a believer in the myth that you are born with a certain ability in math, and having done poorly in a class, even though it was years in the past, proved that I didn't have what it took. When I got to college, I was lucky enough to have had a professor who convinced me of how ridiculous this belief is. Just knowing that I was capable of growth, allowed me to grow. So: **we are all capable of growth in mathematics. You should measure your success in this class by how much your understanding of the concepts have improved over the course of the semester. Also, math is very hard, so you should expect to struggle with the material! When you struggle, you are learning and growing. If you find that you are not struggling at all, this might not be the right course for you and you should consider a more advanced calculus sequence.**

**Prerequisites:** Basic algebra: solving algebraic equations of one variable.

**Credit Hours:** There is no official policy on attendance, and we acknowledge that (1) everyone learns differently, and (2) different people have different access to time; especially if students are balancing their course work with a job, it would be unfair for us to make attendance an official part of the grade. We will do our best to make out-of-class resources available to those who need or prefer to use them. If you are unable to come to class for this or a related reason, **please let us know!**. Even though everyone learns differently, our experience tells us that there is a **very** positive correlation between coming to lecture and succeeding in the class. Therefore, **we'll be paying attention to who is coming to lecture and in the absence of any explanation about not being able to come to lecture due to work study/family obligations/etc., we reserve the right to take attendance into consideration for borderline grade decisions.**

**Examinations will be in-class, and we will be having a 5-10 minute quiz once a week, also in-class** (see directly below to learn more about quizzes).

**Quizzes:** We acknowledge that we don't all come to this class with the same academic background or experience with highly pressurized test-taking. My goal is not to assess how good of a test-taker you are, and we know that it is possible to really understand material and still perform poorly because you're having a bad day. In order to mitigate this, we will be having once-a-week quizzes, in class, so that students have a chance to test their own knowledge of the material in an environment that simulates an in-class exam. The quizzes will count for a minor percentage of the grade. We arrived at this policy after reading

some studies which suggested that this was an easy way to make mathematics courses more inclusive and accessible.

**If you miss a quiz due to absence, you will be allowed to take a makeup during office hours anytime during the next week. After 1 week passes, no makeups will be allowed.**

**Instructor absences:** As undergrads, we remember knowing nothing about our own instructors' lives or jobs. This made it very difficult for us to understand some of the choices they would make, and ultimately this made it harder for us to learn from them. **As mathematicians, our job is to both teach and to conduct our own research in math**. And travel is a part of doing research: despite some of the math stereotypes of the "lonely isolated recluse", mathematics is actually an extremely social and interactive human activity. So doing mathematics means traveling to other places and talking about it with other people.

Tarik has 2-3 trips planned for the semester but he scheduled them so as to miss the minimum amount of class (probably only 2 lectures). We are lucky to have two instructors for the course (more on that below) so between the two of us, we should be able to cover all of our combined absences.

**Two instructors??** Having two instructors is a huge advantage for a number of reasons:

(1) Reducing the instructor-to-student ratio. We'll each be holding our own office hours so there will be twice the opportunity to receive help outside of lecture.
(2) We'll be taking turns lecturing, so students will hopefully get the benefit of seeing two different presentation styles.
(3) We'll each be attending all of the lectures as audience members. This will allow us to chime in, ask questions about common misconceptions, etc.

**Homework:** Mathematical proficiency requires practice, and a lot of it. The concepts we are going to learn aren't easy to grasp and we expect that they will require a good deal of contemplation outside of class to really understand. So, there will be a lot of homework. **Students should expect to spend at least 5-7 hours a week on outside homework assignments**. Homework will also be weighted quite heavily in comparison to many other mathematics courses; this is another way of taking some of the pressure off of in-class examinations.

**Homework will be assigned once a week, and will be due one week later. Students can either turn in the homework at the beginning of lecture on the due date, or anytime in Tarik's mailbox in Kassar House before that lecture, but not after.** It's important that we have all homework assignments by the lecture on the due date so that we can hand them off to the grader. **Late assignments will not be accepted; however the lowest two homework grades will be dropped when computing the final grade**.

**Course policies and recommendations for homework:** If you're not interested in truly learning the material, then

(1) ultimately, that's fine; we don't know your life and so we're not passing judgment. Really learning something takes time, and we don't all have access to the same amount of time in our lives.
(2) There's really nothing we can do to force you to absorb the material.

If you're intent on taking short-cuts on the homework, cheating, plagiarizing, etc., you will probably find a way to do it that we won't be able to detect. That's ultimately your decision and we're too busy to play the disciplinarian and to keep tabs on all of you. As an adult, your education is your own responsibility. But the bottom line is that if you don't take the homework seriously, you won't learn this material. If you want to understand calculus, take the homework as seriously as possible.

**We encourage students to work together on the homework assignments**. Collaboration is an incredibly important aspect of mathematical science and so you should think of the homework assignments as an opportunity to practice the skill of working well with others. On the other hand, it is very easy to "trick" yourself into thinking you understand something when working with a group of peers who come to an answer collectively. So, be sure that you are writing up your own solutions and that you understand the ins and outs of each problem. **If you do work in a group for the homeworks, you must turn in your own assignment, written in your own words. You must also mention who you worked with on your assignment so that the grader can be sure that everyone is turning in their own work.**

**Respecting each other**: We are not all coming to this class with the same privileges, resources, time, and knowledge. It's really important to keep this in mind when working with each other on homework assignments and during lecture. **It is my strong belief that as a community, mathematicians and scientists need to do a much better job of making our disciplines more accessible to people of all races, genders (including gender non-conforming folks), sexual identities, and class backgrounds**. While this is a priority for us in the classroom, we do not claim to know how to best honor this commitment, and so **we are very open to feedback from students when it comes to making the course more accessible and inclusive to all identities**.

It's also important to think about how to respect one another when working together on homework assignments. It's not equally easy for all of us to speak up in a large group, and the voices of historically underrepresented/marginalized students are most easily drowned out in group work. So please keep this in mind when working together. Here are some concrete examples of positive collaborative behavior:

(1) Making sure everyone who wants it has the opportunity to speak frequently. This can mean checking in with each other to make sure everyone is following along and contributing when they have an idea.
(2) Respecting people's pronouns and other aspects of their identity.
(3) Making sure that everyone's ideas are acknowledged when writing up the final solution to a problem. When working in groups, solutions often evolve organically; an idea might pop into your head and you may think it's yours and yours alone, but perhaps you only arrived there because of something else that someone already said. Pay attention to what people are saying and try to learn from one another.

We will do our best to check in with folks periodically during the semester. **If at any time in the semester you want to be working in a group but do not have a group of students to work with, please let us know and we will help you find a working group. If at any time in the semester, you find yourself in a group of students for which the above behaviors aren't being practiced and people aren't feeling respected, please let us know as well.**

**Grading:**

(1) Quizzes. Weekly, in class (5% of the final grade)
(2) Homework. Weekly assignments (20 % of final grade)
(3) Midterm 1 (20 % of final grade)
(4) Midterm 2 (20 % of final grade)
(5) Final Project (10 % of final grade) (OPTIONAL)
(6) Final exam (25 % of final grade or 35 % depending on final project)

We do not like for any one test to count for more than a quarter of the final grade. So in order to take some of the pressure off of the final exam, we are offering students the opportunity to submit a **final project**. The project will be due during reading days, and it will consist of a detailed write-up/summary of a real-world application of calculus. For any student who completes the final project, the final exam will be worth 25 % of the grade. For a student who does not complete the final project, the final exam will be worth 35 % of the grade.

The final project should:

(1) be at least 5 pages long (standard font size and margins, single-spaced,);
(2) include figures that can either be computer generated or hand-drawn, depending on the student's preference;
(3) Not be plagiarized! Please be sure to cite all sources used and to put everything in your own words;
(4) include a model example of the application, in which the student cooks up an *original* hypothetical situation with specific numbers, and then uses the application to solve some problem related to the example.

The topic of the final project has to be submitted to, and approved by us, by class on **Dec 6**.

**Resources:** When struggling with a concept or with the homework in course, you can:

(1) Come to office hours. We'll each be holding two office hours every week;
(2) Go to recitation section with the grader. This will take place once each week;
(3) Go to the Math Resource Center on weeknights, where you can work on your homework in the presence of tutors who can help with any confusion. Here is the website: http://www.math.brown.edu/mrc/
(4) Check out the Office of Co-Curricular Advising and Tutoring for a drop-in tutoring session. Website: https://www.brown.edu/academics/college/support/tutor
(5) We are working on getting some tech set up for the class– this includes having the lectures video-taped. Hopefully, you will be able to access the lectures on the course website in order to review and study.
(6) If all else fails, please don't hesitate to email either or both us. We prefer not to answer mathematical questions over email (although we might do this in a pinch) because it's difficult to communicate that way, but if you message us and you are not free to come to office hours, we can set up a time and place to meet and discuss the issue in person.

**Lecture Schedule:** CAVEAT: please take the schedule below with a grain of salt. It is very difficult to predict the pace of the course before meeting any of the students; there could be snow days or other unplanned cancellations; etc. This is only meant as a vague

guide. I will be updating the course website after each lecture to summarize what we actually ended up covering on each day. The only dates that should be taken very literally are the in-class mid terms (unless of course that exact class is cancelled due to weather or some other emergency).

Thurs, Sept. 6: Course policy, musings on math, functions

Tues, Sept. 11: Functions cont'd.

Thurs, Sept.13: Graphs of functions, shifting, scaling.

Tues, Sept. 18: Exponential functions.

Thurs, Sept. 20: Exponential functions cont'd, intro to inverse functions.

Tues, Sept. 25: Inverse functions cont'd, logarithms.

Thurs, Sept. 27: Practice problems and review of Chapter 1.

Tues, Oct. 2: Rates of change, tangents to curves

Thurs, Oct. 4: Rates of change and tangents to curves, cont'd.

Tues, Oct. 9: Limits!

Thurs, Oct. 11: Limits cont'd.

Tues., Oct. 16: Precise definition of a limit and one-sided limits.

Thurs., Oct. 18: **Midterm 1, in class**

Tues., Oct. 23: Continuity

Thurs., Oct. 25: Limits involving infinity, asymptotes of graphs.

Tues., Oct. 30: Practice problem and review of chapter 2.

Thurs., Nov. 1: Tangents and the derivative at a point, Derivatives as funtions, differentiation rules.

Tues., Nov. 6: Derivative as a rate of change, the chain rule.

Thurs., Nov. 8: Implicit differentiation, derivatives of inverse functions and logs.

Tues., Nov 13: Related rates!

Thurs., Nov. 15: Practice problems and review of Chapter 3.

Tues., Nov 20: **Midterm 2, in class**

Thurs., Nov. 22: No class (Thanksgiving recess)

Tues., Nov. 27: Extreme values of functions

Thurs., Nov 29: Mean Value theorem

Tues., Dec. 4: Monotonic functions and the first derivative test

Thurs., Dec. 6: Concavity and curve sketching

Tues., Dec. 11: Review