

Math 231-01
Calculus III: Multivariable Calculus
FALL 2024

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(This is the best way to contact me.)

Time and Location: MWF 8:30 - 9:45, location: Nutt MECC 260.

Course Website: We have a Moodle Website in the usual place: <https://my.trincoll.edu>.

Office Hours: (See Moodle site for the most up-to-date schedule of office hours): TBA

About this course: We will be using a “flipped class” pedagogical format for this course. What this means is that instead of attending a class and then doing the homework on your own time, we will flip that model. What this means is that I have prepared the lectures in advance in the form of short videos with brief, one-question quizzes after each video. You are expected to complete the videos and associated quizzes **before** each class meeting. In class, we will devote the time to answering questions about the material and working on the week’s assignments. The due dates for the quizzes are set for the start of class for that day’s material (except for the first day of the semester). To get the most out of this class, you should watch the videos in advance, answer the quiz questions, and write down in detail any questions that arise. It would also be helpful if you make note of where in the videos you had a question (write down the number of minutes/seconds where you got lost). You can post your questions in advance on a discussion board that I will set up.

About the subject matter of this course: Calculus is a rich subject, with many useful and interesting applications. Indeed, modern life would be impossible without the technical understanding that calculus brings. In this course, we continue to study the big ideas from first two semesters of calculus—namely, that Calculus is the mathematical analysis of quantities that change. Now however our focus will be on extending the calculus with one independent variable and one dependent variable to the case of many variables, both dependent and independent! Indeed, in most applications, we are lead naturally to consider functions that depend on several variables. We consider the following big ideas:

1. The concept of vectors and coordinate systems to model situations requiring multiple variables.
2. Vector-valued functions of a single independent variable and the calculus of such functions (vectors as outputs).
3. Functions that depend on vectors of independent variables (vectors as inputs), and the calculus of these functions.
4. Vector Fields—vector-valued functions of vectors, and how calculus works in this situation.

Throughout our studies we will focus on how these ideas can be used to solve real world problems through “mathematical modeling” of various phenomena that we observe in the real world.

By the end of this course, successful students will be able to

1. Increase their problem-solving and critical thinking abilities;

2. Increase their ability to communicate mathematical concepts;
3. Solve real world problems involving the calculus of functions involving multiple variables;
4. Develop the ability to choose coordinate systems well-suited to the problem at hand;
5. Use mathematical relationships to understand how to integrate many different functions;
6. Appreciate the usefulness of calculus in solving many practical problems.

Office Hours: Per COVID19 protocols, all office hours may be held over zoom, depending on the current conditions. I will post the link for office hours on the course website when we are on zoom. Otherwise, we *might* be able to meet in my office: 277 Nutt MECC.

In a college-level calculus course, we strive for a deeper conceptual understanding of mathematics than you may have encountered in your previous high school mathematical experiences. Sometimes the strategies and methods of studying that worked in lower level courses or in high school are no longer sufficient for more difficult coursework. It is normal to find yourself wrestling with the material in some way. If you find that you have questions or find that you need some new strategies or approaches to be successful in this class, feel free to come see me during my office hours or make an appointment. This course is sufficiently fast-paced that there will not be regular times set aside for homework questions during the class. It is quite normal for students to regularly make use of my office hours. In office hours, I will help you learn how to do the homework on your own. I will not do any of the assigned homework problems *for* you. I will gladly review similar problems as examples for you to follow, or review general techniques and strategies. I can also suggest strategies or approaches to the material that you may not be employing. It is your responsibility to see me if you are having difficulty with the homework in a timely manner. Being able to effectively manage your time is one of the most useful strategies you can employ to improve your learning.

You may also wish to make use of the tutors in the Aetna Q-Center. Visit the Q-Center website via the portal for information and hours of operation.

Please note: you should start the homework soon enough so that you can take advantage of my office hours. If you wait until the last minute to begin the homework, you will not be able to make use of office hours and you will find yourself forced into turning in an incomplete or badly done assignment. I have carefully scheduled my office hours and the due dates of homework assignments so that you should have ample opportunities to see me about difficulties that arise.

Textbook: *Calculus* by Laura Taalman and Peter Kohn. This text is available both on-line and in print—take your pick! You will be expected to read the assigned sections of the text and work through the examples. In fact, it will often be necessary for you to read the text and examples to do the homework, as we will not have time to explore every wrinkle in the material that might come up in the course of a homework assignment. Reading will be checked via in-class assignments.

Material: Chapters 9 through 14, most sections.

Book buying options:

For this course, you will need either a physical or electronic copy of the textbook. You **will not** need an access code to the on-line homework website.

You can

1. buy a physical copy of the book from the bookstore. If you do so, know It comes packaged already with an access code for the online-website which will cost you extra and we **are not** going to use it!
2. buy access to an electronic book via webassign.net;
3. buy or rent a physical copy of the text from somewhere else.

Which option is best probably depends on what your plans are and what kind of deal you can find on a physical copy of the textbook.

If you prefer a physical copy of the text, then you will need to spend some additional money on a new copy of the text, or a used copy of the text, or rent a text from the bookstore.

Grading: The grade in this course has five components: frequent online homework sets, weekly written homework sets, three in-class exams, and a final. They will count toward the grade as follows.

Videos/Concept Check Quizzes	10%
Attendance/In-class Activities	15%
Written work	35%
In-class Exams	30% (10% each)
Final Exam	10%

The letter grade in this course is based on a straight scale, with the exceptions (1) that I do not decorate D grades with plusses or minuses; and (2) the grade of A+ is reserved for the truly remarkable students—someone whom I would rate in the top 1 percent of all the students I have encountered in my career at Trinity (this is consistent with the policy of the Dean of the Faculty’s latest policy)—consequently, a grade that is a 90 percent but below a 95 percent is an A- and a grade above 95 percent is an A.

Extra credit beyond the above is not available. Late assignments will not be accepted except under extraordinary circumstances that can be documented via the Dean of Students Office.

Attendance and Classroom Deportment: Attendance will be taken and will be taken into account in the calculation of the final grade. If a pattern of non-attendance becomes apparent, midterm grade reports make note of this pattern. The use of cell phones are not permitted during class for any reason, but laptops and tablets may be used for consulting videos/submitting assignments, and working on class activities, provided that they do not become a distraction to other students. If you have questions in class, please ask them, verbally. In the classroom, there are many things that have my attention, and if you just raise your hand without saying anything, I may not see your hand. It is my expectation that you will verbally get my attention if you should need it.

Absences: If you are absent, it is **your responsibility to do the following:**

- To get any handouts or assignment sheets you have missed.
- To get a copy of the class notes from one of your classmates, if necessary. Due to time constraints it is not possible for your professors to repeat, summarize, or recap lectures for absent students. You should obtain and study these notes promptly to stay on top of the material.
- To learn the material that you have missed. (I am, of course, available in office hours to assist you, but you will need come prepared, having studied the notes from the classes you have missed. You should come with detailed questions, and be prepared answer questions on what you do know, so that I can help you as efficiently as possible.)
- To know and keep the **same** deadlines as everyone else.

Written homework assignments: I will also regularly assign problems from the book to be written out and turned in for a grade. This homework is designed to give you feedback about your process, as opposed to just determining whether the answer is right or wrong. On exams, you will be graded on the entire process of answering a question, not just whether or not the answer is right or wrong, so the feedback on these assignments will be particularly valuable in helping you prepare for the exams. **All Written Assignments will be submitted as scanned pdf's. Each homework set should be contained in a single pdf file.** Homework Assignments will be submitted through a website called Gradescope. It is a free service that collates your homework/exam submissions so that I can navigate and grade the pdf's more easily and quickly for grading purposes. It also allows me to provide consistent feedback with specific comments more easily. To gain access to the homework submission website, use the entry code **J37VR3**. on the Gradescope website. You can click on the link outlined in blue in the previous sentence or search gradescope.com via your web browser by hand. You will create a free account on that website and upload your scanned pdf's there.

Exams: There will be three exams, tentatively scheduled for the following dates:

Wednesday, October 5th
Wednesday, November 2nd
Wednesday, November 30th

For exams, we will observe the following rules. Other additions will be made as necessary.

1. No communications devices such as cell phones, ipads, etc. are permitted in the exam. These devices must be turned off. In particular, you may not use the calculator function on any device that can communicate wirelessly or access the internet.
2. No sharing of calculators or other devices.
3. No scrap paper. Scrap paper will be provided to you if you require it.
4. No kleenex. Kleenex will be provided to you if you require it.
5. All books and papers must be stowed in backpacks, bags, et cetera.
6. If you leave the exam room without permission, even if it is for a bathroom break, your exam will be collected graded as is.

There will be no make-up exams. If you suffer from a sudden illness or emergency that prevents you from taking an exam, then you must notify me and the Dean of Students Office by email, telephone message, or other means of communication prior to or during that exam. If your emergency is deemed sufficient to excuse you from the exam, you will not be given a make-up exam—your final exam will simply be lengthened and rescaled to make up for the lost points. A missed exam that has not been excused by the instructor and the Dean will result in a zero score. None of the exam scores will be dropped.

The Final: The final exam is scheduled for Tuesday, December 20th, from noon to 3pm. Make your travel plans accordingly. For obvious logistical reasons, the final cannot be rescheduled for students who make conflicting travel plans. If you cannot take the exam at the usual time, you must apply to the Academic Affairs Committee to determine if you can take the exam at another time, probably at the start of the following semester. Successful applications to have the final exam moved require medical or other documentation of the reason for not being able to take the exam at the scheduled time. In the interim, the student receives a NO GRADE which reverts to an F until the exam is made up.

Expectations: For this course, you should expect to spend an average of 11.5 hours per week studying and completing assignments in addition to classtime. This work may take the form of finishing in-class activities, working on assignments, actively reading the text, and preparing for the exams.

Athletes and Scheduling Difficulties: Athletes and others who have scheduled absences are responsible for notifying me in advance of any scheduling conflicts with deadlines, or exams. In addition, if there are sudden changes in your schedule, due to playoffs or rain-outs, you are responsible for notifying me in advance as well.

Academic Honesty: Academic honesty is highly valued at Trinity. In accordance with the Trinity College Student Integrity Contract, students are expected to abide by the highest standards of intellectual honesty in all academic exercises. Intellectual honesty assumes that students do their own work and that they credit properly those upon whose work and thought they draw. In this course, you may not draw upon internet solutions or the work of others. It is the responsibility of each student to make sure that he or she is fully aware of what constitutes intellectually honest work in every examination, quiz, paper, laboratory report, homework assignment, or other academic exercise submitted for evaluation in a course at Trinity College.

Academic Honesty and Use of AI in this course: The use of an AI (Artificial Intelligence) generator such as ChatGPT, iA Writer, MidJourney, DALL-E, et cetera is explicitly prohibited unless otherwise noted by Professor Sandoval. The information derived from these tools is based on previously published materials. Therefore, using these tools without citing the underlying source material constitutes plagiarism. Additionally, you should be aware that the information derived from these tools is often inaccurate and/or incomplete. It is imperative that all work submitted should be your own work. Any assignment that is found to have been plagiarized or to have used unauthorized AI tools may receive a zero grade and be reported for academic misconduct to the appropriate disciplinary committee.

Students with Academic Accommodations: Trinity College is committed to creating an inclusive and accessible learning environment consistent with the Americans with Disabilities Act. Like many things, the need for disability accommodations and the process for arranging them may be altered by the COVID-19 changes we are experiencing and the safety protocols currently in place. Students with disabilities who may need some accommodation in order to fully participate in this class are urged to contact the Student Accessibility Resource Center, as soon as possible, to explore what arrangements need to be made to assure access. If you have approval for academic

accommodations, please notify me by the end of week two of classes. For those students with accommodations approved after the start of the semester, a minimum of 10 days' notice is required. Please be sure to meet with me privately to discuss implementation. Student Accessibility Resources can be reached by emailing Lori.Clapis@trincoll.edu or SARC@trincoll.edu.

Syllabus

1	W	Sep 4	1	Overview and 3-dimensional Space
1	F	Sep 6	2	Vectors and Vector Algebra
1	M	Sep 9	3	Dot- and Cross- Products of Vectors
2	W	Sep 11	4	The Cross Products and 3-D Planes
2	F	Sep 13	5	Planes and Lines in 3-D
2	M	Sep 16	6	Vector-valued Functions of One Variable
3	W	Sep 18	7	Calculus of Vector-valued Functions of 1 Variable
3	F	Sep 20	8	Calculus of Vector-valued Functions of 1 Variable, ctd.
3	M	Sep 23	9	Functions of Several Variables and their Graphs
4	W	Sep 25	10	Functions of Several Variables, Continued
4	F	Sep 27	11	Limits and Continued of Functions of Several Vars.
4	M	Sep 30	12	Partial Derivatives; The Gradient
5	W	Oct 2	13	Partial Derivatives, Differentiability, Tangent Planes
5	F	Oct 4	14	Exam 1
5	M	Oct 7	15	The Gradient and Directional Derivatives
6	W	Oct 9	16	The Chain Rule and the Gradient
6	F	Oct 11	17	Optimization, part 1
	M	Oct 14		Trinity Day--No classes
6	W	Oct 16	18	Optimization, part 2
7	F	Oct 18	19	Double and Triple Integration over Rectangular Regions
7	M	Oct 21	20	Double Integration over General Regions

7	W	Oct 23	21	Polar Coordinates and Integration over Polar Regions
8	F	Oct 25	22	Double Integration over General Polar Regions
8	M	Oct 28	23	Exam 2
8	W	Oct 30	24	Triple Integration over General Regions
9	F	Nov 1	25	Triple Integration in Cylindrical and Spherical Coords.
9	M	Nov 4	26	Triple Integration in Spherical Coords.
9	W	Nov 6	27	Vector Fields and Their Derivatives
10	F	Nov 8	28	Line Integrals
10	M	Nov 11	29	The Fundamental Theorem of Line Integrals
10	W	Nov 13	30	Surface Integrals, part 1
11	F	Nov 15	31	Surface Integrals, part 2
11	M	Nov 18	32	Green's Theorem, part 1
11	W	Nov 20	33	Green's Theorem, part 2
12	F	Nov 22	34	Exam 3
12	M	Nov 25	35	Integration of Vector Fields, so far
	W	Nov 27		Fall Break--No classes
	F	Nov 29		Fall Break--No classes
12	M	Dec 2	36	Stokes' Theorem, part 1
13	W	Dec 4	37	Stokes' Theorem, part 2
13	F	Dec 6	38	The Divergence Theorem, part 1
13	M	Dec 9	39	The Divergence Theorem, part 2
				Final Exam