Math 231-01
Calculus III: Multivariable Calculus
Spring 2026

Instructor: Dr. M. Sandoval, Nutt MECC 219, 860-297-2062, email: mary.sandoval@trincoll.edu. (This is the best way to contact me.)

Time and Location: MWF 8:30 - 9:45, location: MECC 232.

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):

Monday	11–12:30
Wednesday	11–12:30pm
Friday	11–12, 1–2pm
or	by appointment.

If making an appointment, please allow at one business day to arrange a mutually agreeable time. Appointments on Tuesdays and Thursdays are generally not available in person, but possibly could take place via zoom, but availability is extremely limited.

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 the discussion board.

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: These are held in my office, MECC 219. Sometimes we might move to the Math Lounge to use the larger space. 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 class time and 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: An electronic copy of the text is available on our moodle site. It is free. If you want a physical copy of the text, you may get a copy from anywhere: Amazon, the bookstore, or any used textbook supplier.

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 because we will not use it.

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 and Engagement	5%
Written work	35%
In-class Exams	30% (10% each)
Final Exam	20%

- The videos are mandatory. They must be viewed prior to class time on the days that they appear in moodle. Moodle keeps track of how long each video is accessed. The grading system automatically catches attempts to open videos simultaneously in different tabs and does not award credit. A grade will be assigned based on the percentage of the video that was viewed. It is captured automatically by moodle.

- Keep the calculations and work that you do to complete the quizzes in a notebook that you bring to class. The concept check quiz grades are also captured by moodle automatically. I will also spot check quizzes by having you turn in screen shots of the work that you did to arrive at your answer occasionally.

- Attendance and class enagement are recorded by me every day. I will come around at least three times per class to check in with each student indivicually to see that you are engaged in the flipped class activities assigned each day. Lateness will reduce your attendance in a proportional manner, as will time being spent on other activities. You should only be using time to watch videos if you have completed the next assignment or if you need to consult the 3D graphing program, or a video example. Once you have shown me that you have completed all the written problems that have been covered, then you may work ahead, by using class time to engage with the next set of videos. There are no dropped classes or excused absences. In general, a few absences (say, less than 5) won't really affect your final letter grade. More than 5 absences will reduce your final grade.

- The moodle gradebook is not used to keep track of all the components of your grade. If you want to keep track of your grade, you will need to keep track of your own grades and compute a running average via the above formula.

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. No assignments are dropped.

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. You should use headphones/earbuds in class. 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.

The purpose of class time is to be working on the written assignments or working on any quizzes, not watching the videos. You may consult the videos if you need to to help you work on the videos, or watch the videos after you have completed as much as you can on the current written assignment, but only after you have checked your work with me on the written assignment. I will check this.

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 your 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 moodle. No assignments scores are dropped.

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

Wednesday, February 18th
Wednesday, March 25th
Wednesday, April 15th or 22nd (TBD)

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 May 7th at noon. 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. Students with academic accomodations 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 SARC@trincoll.edu.

Syllabus: See moodle for the day-by-day schedule. The list of topics covered is as follows.

- Vectors in two and three-dimensions; coordinates; polar coordinates
- Vectors
- The Dot Product
- The Cross Product
- Equations of Lines and Planes
- Cylinders and Quadric Surfaces
- Vector-Valued Functions of one independent variable and the calculus of such functions.
- Arc length; Velocity and Acceleration of Parametric two and three dimensional curves.
- Scalar-valued Functions of Several Independent Variables
- Limits and Continuity
- Partial Derivatives, Tangent Planes, and Linear Approximations
- The Chain Rule for multiple independent variables.
- The Gradient and Directional Derivatives
- Maximum and Minimum Values
- Iterated Integrals; double and triple integrals over general regions
- Integrals in polar, cylindrical, and spherical coordinates.
- Changes of Variables in Multiple Integrals: the Jacobian
- Vector Fields
- Line Integrals and the Fundamental Theorem of Line Integrals
- Green's Theorem

- Curl and Divergence
- Parametric Surfaces; Surface Integrals
- The Divergence Theorem
