

# MATH 2551 MULTIVARIABLE CALCULUS

Syllabus

Lecture G; Studios G01, G02, G03, G04, G05, G06

Fall 2025

## 1 Course Information

**Course Title:** Multivariable Calculus

**Lecture Meeting Times:** TR 12:30 pm - 1:45 pm

**Lecture Meeting Location:** Howey Physics L4

**Studios Meeting Information:**

Studio	Time	Room	Teaching Assistant
G01	MW 2:00 - 2:50 pm	Skiles 246	Xiying Du
G02	MW 12:30 - 1:20 pm	Skiles 368	Owen Huang
G03	MW 12:30 - 1:20 pm	East Architecture 309	Xiying Du
G04	MW 2:00 - 2:50 pm	Skiles 156	Yucong Liu
G05	MW 2:00 - 2:50 pm	Clough 423	Haoran Yan
G06	MW 12:30 - 1:20 pm	Eng. Sci. & Mech. 201	Yucong Liu

### 1.1 Course Content

Math 2551 is an introduction to multivariable calculus. Topics include:

- Vectors and the geometry of space, vector calculus, parametric curves and motion
- Functions of several variables, visualization and partial differentiation, gradients, linear approximation, tangent planes, differentials, optimization, Lagrange multipliers
- Double and triple integrals, geometric and spatial applications, change of variables
- Vector analysis including the theorems of Green, Gauss, and Stokes

## 2 Instructor and TA Contact Information

**Instructor:** Dr. Hunter Lehmann

**Instructor Office:** Skiles 218C

**Instructor Email:** hlehmann3@gatech.edu.

**Instructor Drop-In Hours:** TBD

Or booked by appointment

**TA Contact Info:**

Teaching Assistant	Email	Office	Office Hours
Xiying Du	xdu90@gatech.edu	Clough 280	
Owen Huang	ohuang9@gatech.edu	Clough 280	
Haoran Yan	yucongliu@gatech.edu	Clough 280	
Yucong Liu	hyan82@gatech.edu	Clough 280	

## 3 Pre-Requisites

- Calculus II: At least one of MATH 1552 or MATH 1X52

- Linear Algebra: At least one of MATH 1553, MATH 1554, MATH 1564, MATH 1X53, MATH 1X54

## 4 Textbook

Thomas, Calculus: Early Transcendentals 15th edition by Addison-Wesley (Pearson). The textbook is not required for the class; many good references for the material of MATH 2551 can be found online or at the campus library.

A few online resources are listed below in no particular order:

- OpenStax Multivariable Calculus
- APEX Calculus
- Active Calculus - Vector Calculus
- Diana Davis' Multivariable Calculus
- Paul's Online Notes
- Khan Academy Multivariable Calculus

## 5 Learning Targets

The learning targets that you will need to show competency in by the end of the semester are listed below. There are **seventeen** content learning targets, plus **two** mathematical practices learning targets, listed first.

- **PPP: Preparation, Participation, & Practice.** I consistently engage with mathematics to build understanding: through preparation by watching pre-lecture videos and responding to pre-lecture activities, through participation by attending lecture and studio, and through practice on the web homework problems.
- **T: Technology.** I can use appropriate technology to visualize curves in two and three dimensions, surfaces, the graphs of functions of two variables, contour plots, and solids.
- **G1: Lines and Planes.** I can describe lines using the vector equation of a line. I can describe planes using the general equation of a plane. I can find the equations of planes using a point and a normal vector. I can find the intersections of lines and planes. I can describe the relationships of lines and planes to each other. I can solve problems with lines and planes.
- **G2: Calculus of Curves.** I can compute tangent vectors to parametric curves and their velocity, speed, and acceleration. I can find equations of tangent lines to parametric curves. I can solve initial value problems for motion on parametric curves.
- **G3: Geometry of Curves.** I can compute the arc length of a curve in two or three dimensions and apply arc length to solve problems. I can compute normal vectors and curvature for curves in two and three dimensions. I can interpret these objects geometrically and in applications.
- **G4: Surfaces.** I can identify standard quadric surfaces including: spheres, ellipsoids, elliptic paraboloids, hyperboloids, cones, and hyperbolic paraboloids. I can match graphs of functions of two variables to their equations and contour plots and determine their domains and ranges.
- **G5: Parameterization.** I can find parametric equations for common curves, such as line segments, graphs of functions of one variable, circles, and ellipses. I can match given parametric equations to Cartesian equations and graphs. I can parameterize common surfaces, such as planes, quadric surfaces, and functions of two variables.
- **D1: Computing Derivatives.** I can compute partial derivatives, total derivatives, directional derivatives, and gradients. I can use the Chain Rule for multivariable functions to compute derivatives of composite functions.
- **D2: Tangent Planes and Linear Approximations.** I can find equations for tangent planes to surfaces and linear approximations of functions at a given point and apply these to solve problems.

- **D3: Optimization.** I can locate and classify critical points of functions of two variables. I can find absolute maxima and minima on closed bounded sets. I can use the method of Lagrange multipliers to maximize and minimize functions of two or three variables subject to constraints. I can interpret the results of my calculations to solve problems.
- **I1: Double & Triple Integrals.** I can set up double and triple integrals as iterated integrals over any region. I can sketch regions based on a given iterated integral.
- **I2: Iterated Integrals.** I can compute iterated integrals of two and three variable functions, including applying Fubini's Theorem to change the order of integration of an iterated integral.
- **I3: Change of Variables.** I can use polar, cylindrical, and spherical coordinates to transform double and triple integrals and can sketch regions based on given polar, cylindrical, and spherical iterated integrals. I can use general change of variables to transform double and triple integrals for easier calculation. I can choose the most appropriate coordinate system to evaluate a specific integral.
- **A1: Interpreting Derivatives.** I can interpret the meaning of a partial derivative, a gradient, or a directional derivative of a function at a given point in a specified direction, including in the context of a graph or a contour plot.
- **A2: Integral Applications.** I can use multiple integrals to solve physical problems, such as finding area, average value, volume, or the mass or center of mass of a lamina or solid. I can interpret mass, center of mass, work, flow, circulation, flux, and surface area in terms of line and/or surface integrals, as appropriate.
- **V1: Line Integrals.** I can set up and evaluate scalar and vector field line integrals in two and three dimensions.
- **V2: Conservative Vector Fields.** I can test for conservative vector fields and find potential functions. I can state and apply the Fundamental Theorem of Line Integrals.
- **V3: Generalizations of the FTC.** I can state and apply Green's Theorem, Stokes' Theorem and the Divergence Theorem to solve problems in two and three dimensions. I can choose which theorem is appropriate for different integrals. I can compute curl and divergence of vector fields.
- **V4: Surface Integrals.** I can set up and compute surface integrals for scalar and vector valued functions.

## 6 Course Requirements & Grading

### 6.1 Grading Structure

This course will be graded differently than you are likely used to from your other college courses. **There will be no points assigned**, nor any partial credit given. Instead, each problem on your assessments will be marked with one or more of the learning targets listed above, and you will receive a mark of **Success** or **Not Yet** for each attempted problem, along with detailed feedback about the errors you made. You will have multiple opportunities (at least three, and usually four or five) to show your understanding of each learning target, and can learn from mistakes on early attempts.

This feedback loop represents and supports the way that people learn: by trying things, making mistakes, reflecting on those mistakes, and then trying again. You can make mistakes without penalty as long as you eventually demonstrate evidence of skill.

Each learning target has two levels of mastery associated with it:

- **Competent (C)**, achieved after one mark of **Success** on a problem for a content learning target (**GX, DX, IX, VX, or AX**) or as detailed below for the Mathematical Practices learning targets.
- **Mastered (M)**, achieved after two marks of **Success** on a problem for a content learning target (**GX, DX, IX, VX, or AX**) or as detailed below for the Mathematical Practices learning targets.

The number of learning targets at Competent and Mastered levels will determine your final grade in the course, according to the descriptions below. Your grade is the **highest** grade level for which **all** the requirements listed have been met or exceeded.

To earn an:

- **A.** Have at least **15** learning targets **Mastered** and at least **2** more learning targets at **Competent or higher**.
- **B.** Have at least **11** learning targets **Mastered** and at least **4** more learning targets at **Competent or higher**.
- **C.** Have at least **7** learning targets **Mastered** and at least **6** more learning targets at **Competent or higher**.
- **D.** Have at least **2** learning targets **Mastered** and at least **10** more learning targets at **Competent or higher**.

Canvas will nicely display to you all of the learning targets that you have **Mastered** in the Learning Mastery Gradebook. Learning targets that you have earned a **Competent** in you have to count yourself; although you can see your **Success** marks on learning targets that are not yet **Mastered**. A helpful worksheet for keeping track of your current achieved grade in the course can be found on Canvas.

### 6.1.1 CIOS Incentive

I strongly value your feedback about the course. Each semester I make adjustments to my courses, taking into account feedback from students on the course surveys and from my fellow faculty during teaching observations.

If at least 85% of all MATH 2551 Gstudents complete CIOS evaluations by the time of our final, then the number of required **Success** marks will be reduced by 1. This means grades will be determined as given in the list below.

- **A.** Have at least **14** learning targets **Mastered** and at least **3** more learning targets at **Competent or higher**.  
**OR**  
Have at least **15** learning targets **Mastered** and at least **1** more learning target at **Competent or higher**.
- **B.** Have at least **10** learning targets **Mastered** and at least **5** more learning targets at **Competent or higher**.  
**OR**  
Have at least **11** learning targets **Mastered** and at least **3** more learning targets at **Competent or higher**.
- **C.** Have at least **6** learning targets **Mastered** and at least **7** more learning targets at **Competent or higher**.  
**OR**  
Have at least **7** learning targets **Mastered** and at least **5** more learning targets at **Competent or higher**.
- **D.** Have at least **1** learning targets **Mastered** and at least **11** more learning targets at **Competent or higher**.  
**OR**  
Have at least **2** learning targets **Mastered** and at least **9** more learning targets at **Competent or higher**.

## 6.2 Preparation, Participation, and Practice Learning Target

Points towards the **PPP** learning target are earned in three ways:

- Preparation: watching pre-lecture videos and completing their associated pre-lecture quizzes
- Participation: attending and actively working during lecture and studio
- Practice: completing weekly web homework assignments

More details about each of these components are below.

**Preparation:** We have 26 lecture days during the semester. Each will have an associated pre-lecture video and quiz worth 5 points, for a total of 130 available points.

**Participation:** Besides our 26 lecture days, there are also 28 studio days. Attendance will be taken each day in lecture and in studio. Each day of attendance in lecture is worth 3 points. Each day of attendance in studio is worth 8 points, split into 4 points for attending and 4 points for actively working on mathematics. This gives a total of 302 available participation points.

**Practice:** Practice points are earned by completing homework problems in our online homework system WebWorK. Each week will have homework sets corresponding to one to three learning targets available, due on Friday evenings. There are a total of 230 homework points available in the course. All homework due dates are posted already in WeB-WorK and the course calendar. After the posted due date, WebWorK problems can be completed for half credit.

You do **not** need to do all of this work to master the **PPP** learning target! There are **672 total PPP** points available, but only **230 are needed to earn Competent** on this learning target and **440 to earn Mastered**. We all learn differently and need different amounts of different kinds of reinforcement of our learning, so you are able to master the **PPP** learning target without engaging fully with all of the ways of earning these points. Because of this, **except in extreme extenuating circumstances, no extensions or credit for missed PPP points will be given.**

### 6.3 Technology Learning Target

The **Technology** learning target is all about using computer technology to aid in your understanding of mathematics. In this class, we will focus on the use of computer graphing utilities to plot objects in three-dimensions, since this is a new skill, hard to do by hand, and highly useful for understanding the computations we perform on paper.

This learning target will be assessed via **Tech Demo** assignments on Canvas. There will be four of these throughout the semester. To complete a **Tech Demo** assignment, you will record yourself using your preferred computer graphing utility to produce a requested plot, narrating what you are doing, and submit this recording to Canvas. Detailed instructions for this will be on Canvas.

At the end of the semester, if you have completed **any one Tech Demo**, you will have earned **Competent** for this learning target. If you have completed **at least two Tech Demos**, you will have earned **Mastered** for this learning target.

### 6.4 Content Assessments

- **Quizzes:** We will have a 10-minute quiz assessment **most Wednesdays in studio**. Each quiz will typically assess one learning target. No books, notes, calculators, cell phones, or other electronic devices are allowed on quizzes.
- **Checkpoints:** We will have three checkpoint assessments during the semester. These will each be 25 minutes in length and allow you to attempt up to three learning targets each; these will take place **during studio** on the following dates:
  1. Wednesday, September 10
  2. Wednesday, October 8
  3. Wednesday, November 19
- **Exams:** We will have four exams during the semester. Three of these will be 75 minutes in length and allow you to attempt all learning targets covered in the course so far; these will take place **during lecture** on the following dates:
  1. Tuesday, September 16
  2. Tuesday, October 21
  3. Tuesday, November 25

The last exam is during our assigned final exam slot, on Monday December 8 from 11:20 am to 2:10 pm in TBD (most likely our usual lecture hall). This will be an opportunity to assess again any content learning target you have not yet mastered. For the full final exam schedule, see [the registrar's schedule](#). **Only under extreme**

**extenuating circumstances** will you be able to take the final celebration of knowledge at a different time or date. Early travel plans (including already-purchased tickets) are **not** an acceptable reason for this. Please note that exam 3 is on the Tuesday before Thanksgiving break. Early travel for break is not an excused absence for this exam. You may bring one page of notes to each exam, but again no books, calculators, cell phones, or other electronic devices are allowed.

- **Getting Feedback:** All assessment problems will be graded through Gradescope. Each problem attempt will be given detailed feedback through comments or annotation so that you can learn from your mistakes. The result for each learning target **Success** or **Not Yet** will then be displayed in Gradescope as well as in Canvas in the Learning Mastery Gradebook. In general, you will receive feedback on your work no later than a week after your assessment.

## 7 Course Websites

**Course Website:** [gatech.instructure.com](http://gatech.instructure.com)

Canvas will be used for course grades, lecture videos, announcements, and course-related documents.

Links to the other websites in this section can be found on Canvas as well.

**PollEverywhere:** <https://pollev.com/drhgt>

PollEverywhere will be used every day in lecture to help us engage with the day's mathematics as a class. Answering at least one PollEverywhere poll each day will give you credit for the 3 lecture participation points for the day for your **PPP** standard. You will need a smartphone, laptop, or tablet each day to answer these polls.

**Ed Discussion:** <https://edstem.org/us/courses/81142/discussion>

The Ed Discussion forum is our platform for asking the questions about the math we are learning together that we will all have throughout the semester. Rather than emailing questions to the TAs or myself, I ask that you post your questions on Ed Discussion if they are not about personal matters. This lets us answer you and all of the other students in the class who also have the same question at once - and no one every has a unique question about math! You may post on Ed Discussion anonymously to your fellow students if that makes you more comfortable. Everyone in class should feel absolutely free to ask questions, discuss, help, comment, explore, and exchange ideas on Ed Discussion. The more you answer other students' questions, the better your own mastery of the mathematics we are learning will be!

**WeBWorK:** We will use the free homework platform WeBWorK for basic skill development and computational homework in this course. You will access WeBWorK through Canvas. Some information about entering answers into WeBWorK can be found online here, or you can ask on Ed Discussion if you are having difficulty with the format of any answer.

**Gradescope:** Grading of all Quizzes, Checkpoints, and Exams will be done on Gradescope. You will access Gradescope through Canvas.

**Dr. H's Personal MATH 2551 Webpage:** <https://hunterlehmann.github.io/teaching/MATH2551/>

This page is meant to publicly collect resources for MATH 2551 at Georgia Tech from my time teaching the course. Most or all of these are also available on our Canvas site.

## 8 Course Expectations & Guidelines

### 8.1 Missed work policy

If you have to miss class on a day when a checkpoint or celebration of learning is scheduled for any of the following reasons or any other personal emergency, I will work with you to make up the assessment, as long as you are in communication with me in a timely manner.

- **University-approved absences:** Please give me notice by the second Wednesday of the semester, or as soon as possible once your absence has been approved.
- **Religious holiday:** By the second Wednesday of the semester, you should notify me of any classes (including studio) you will miss due to religious holidays.
- **Illness:** Except under extenuating circumstances, you should notify me *in advance* and for cases where you are ill enough to need medical care, provide the Office of Student Life with appropriate documentation, so that they can confirm it with me. Illnesses such as COVID, colds, flu, or other such illnesses where you feel unwell and don't want to infect others but do not feel ill enough to visit a doctor do not need documentation.
- **Family or personal emergency:** Notify me as soon as possible and when applicable (for extended absences) provide the Office of Student Life with appropriate documentation, so that they can confirm it with me.

**If you do not communicate with me about your absence to set up a make-up opportunity within a week, missed quizzes and missed exams result in a Not Yet mark on all assessed learning targets.**

In the case of an excused absence for a quiz or checkpoint, you will be able to take a make-up assessment if this make-up occurs within a week of the assessment itself.

If you have an excused absence for an exam, then you may take a make-up exam at the listed alternate time on the course calendar.

Any assessment for which no paper is received will be marked **Not Yet** on all assessed learning targets.

## 8.2 Students with Disabilities and/or in need of Special Accommodations

Georgia Tech complies with the regulations of the Americans with Disabilities Act of 1990 and offers accommodations to students with disabilities. If you are in need of classroom or testing accommodations, please make an appointment with the Office of Disability Services to discuss the appropriate procedures. More information is available on their [website](#). Please also make an appointment with me to discuss your accommodation, if necessary.

## 8.3 Statement of Intent for Inclusivity

As members of the Georgia Tech community, we are committed to creating a learning environment in which all of our students feel safe and included. Because we are individuals with varying needs, we are reliant on your feedback to achieve this goal. To that end, we invite you to enter into dialogue with us about the things we can stop, start, and continue doing to make the classroom an environment in which every student feels valued and can engage actively in our learning community.

## 8.4 The Honor Code and Academic Dishonesty

Do not cheat! Abide by the [honor code](#) at all times. See <http://honor.gatech.edu> and [here](#).

Any evidence of cheating or other violations of the Georgia Tech Honor Code will be submitted directly to the Office of Student Integrity. Cheating includes, but is not limited to:

- Using a calculator, books, or any form of notes on checkpoint or celebration assessments.
- Copying directly from any source, including friends, classmates, tutors, internet sources, or a solutions manual.
- Allowing another person to copy your work.
- Taking a test or quiz in someone else's name, or having someone else take a test or quiz in your name.
- Asking for a regrade of a paper that has been altered from its original form.

Cheating does not include working together with your friends and classmates on your homework. You may use AI and other tools to help you get started on your homework, but relying heavily on these will likely result in poor performance on quizzes and exams if you do not develop your own understanding of the material. AI tools may sometimes make mathematical errors, so be careful in applying them.

## 8.5 Email policy

I will respond to emails within one to two business days. Emails sent after 5:00 pm will not receive a response until the next day. Emails sent on the weekend will not receive a response until Monday.

For questions relating to course structure, please check the syllabus first. Exam dates, policies, etc. are available on the syllabus.

Let's not discuss grades by email. Any questions about grades should be asked during office hours or in an appointment scheduled outside of office hours. **In particular, do not send me emails at the end of the semester asking for your grade to be changed. They will not help and I will not respond to such emails.**

Let's not discuss math by email. Let's discuss mathematics on Ed Discussion instead! This will open the question to the entire class, including all TAs and other students who may be able to provide insight. We can also discuss questions during office hours, or at a scheduled appointment outside of office hours.

## 8.6 Attendance in lecture and studio

You are expected to come prepared and actively participate in every lecture and studio session.

Class disruptions of any kind will not be tolerated and may result in your removal from the classroom. Please show courtesy to your fellow classmates and instructor by adhering to the following class rules: keep use of electronic devices focused on class-related activities, come to class on time and stay for the entire class period, refrain from conversing with your fellow students about non-mathematical topics during class, and put away any reading materials unrelated to the course.

In the event of an absence, you are responsible for all missed materials, assignments, and any additional announcements or schedule changes given in class.

## 8.7 Digital Learning Days:

In cases where campus may be physically closed due to events such as inclement weather, a digital learning day may replace in-person classes. Should this event occur on a lecture day, then lectures will either be streamed live, or a recording will be posted for students to watch asynchronously. Should this event occur on a studio day, then studios will be streamed live if possible or a recording will be posted for students to watch asynchronously (possibly after the digital learning date); studio sections may be combined if there are TAs who are unable to stream class live. No studio participation will be counted on a digital learning day and classwork points will be adjusted accordingly. If a digital learning day occurs on a midterm exam date, then class lectures will meet online or asynchronously instead, and that exam will be rescheduled to the next lecture day.

## 8.8 Additional resources and tutoring

**Additional Help in the Math Lab:** Asking questions is a key to success! Free “walk-in” help is available Monday-Friday in the “Math Lab” for 1000-3000 level courses. You can view the schedule at <https://tutoring.gatech.edu/drop-in/>. The Math Lab is located in Clough 280.

**1-to-1 and Small Group Tutoring with UTAs:** Free 1-to-1 and Small Group Tutoring in-person is available for 1000 and 2000 level classes. Tutoring is available with any UTA by appointment here:

[UTA Tutoring](#) and will be located in Skiles 230.

We also have [PLUS sessions](#). A comprehensive list of tutoring resources is available [here](#).