

MATH 212: MULTIVARIABLE CALCULUS

SPRING 2022

INSTRUCTOR: SUBHADIP CHOWDHURY

Welcome to Math 212! You can call me Prof./Dr. Chowdhury. I am the instructor for this course, and I am glad to have you here!

WHAT IS THIS CLASS?

Calculus III or Multivariable Calculus is kind of like a greatest hits compilation from Calculus I and II, but a remixed version for higher dimensions! In real life, most processes depend on more than one input - if you have ever filled a tax form, you know how many inputs it requires. The same is true all the way from quadratic equations to rocket science. So, whether we do optimization using differentiation or calculate volume using integration, it's all for functions of more than one variable. To ensure the new analogues make sense, we define some new ideas such as vectors and parametric curves along the way. Finally, everything comes together to like an IKEA furniture and culminates in the idea of vector calculus, which ties all of Multivariable Calculus together into several neat little theorems.

Please make use of my office hours and plan to work hard. My classes have a high workload (as all math classes usually do!), so make sure that you stay on top of your assignments and get help early. Remember that part of doing real math is productive failure: You'll try things that don't work; learn something from that failure; and try something new that works a bit better. And... after a while, you will figure it out, and come out with a much stronger understanding of the structure of mathematics.

I WANT TO KNOW MORE ABOUT:

- [Learning Goals](#)
- [Assignments and Grades](#)
 - [How do I earn a grade?](#)
 - [Edfinity Homework and Tokens](#)
 - [Checkpoint Quizzes](#)
- [Policies](#)
 - [Attendance and Absences](#)
 - [Early and Late Work](#)
 - [Other Policies](#)
- [How to get help?](#)
- [Academic Integrity and Collaboration](#)
- [Learning Targets](#)
- [Tentative Course Schedule](#)
- [FAQs](#)

KEY INFORMATION

Class meetings

MWF 11:00 – 11:50 AM, Taylor 207
Th 1:00-2:20 PM, Taylor 302

Note the different location for the lab day.

Office Hours

See Moodle for Up-to-date hours.

I will adjust these based on your feedback.

You can also stop by any time my door is open, or [email me](#) to set up an individual meeting.

How to contact me

Email: schowdhury@wooster.edu

Phone: 330-263-2473

Office: Taylor 307

Be sure to read my [email responses](#) policy.

Textbook

We will mainly use lecture notes and activities written especially for this class.

Reference textbook: [Calculus Volume 3 - OpenStax](#)

The text is open-source and freely available online.

Computer Software

Mathematica (for your personal computer)

You will need this to complete labs.

Wooster students get free access. [See here.](#)

Class materials and announcements

Available on: moodle-2122.wooster.edu/

Check Moodle and your Wooster email at least once before and after each class

Additional college policies are listed in a separate document called Academic Policies, Procedures & Support Services.

This Syllabus repeats some of the same information in separate places. If something is not mentioned here, check Moodle first!

LEARNING GOALS

CATALOG DESCRIPTION

This course covers analytic geometry of functions of several variables, limits and partial derivatives, multiple and iterated integrals, non-rectangular coordinates, change of variables, line and surface integrals and the theorems of Green and Stokes. [MNS, Q, QL]

Prerequisites: MATH-10500, MATH-11000, MATH-11500, MATH-12000, and MATH-12500, minimum grade C-

COURSE OBJECTIVES

The emphasis of the course will be on developing an understanding of the calculus of functions of two and three variables, as well as the geometry of associated curves and surfaces in two and three dimensions. Multivariable calculus is a fundamental pillar for many other things:

- It *extends single variable calculus to higher dimensions*. You will see that the structures are much richer than in single variable and that the fundamental theorem of calculus generalizes to higher dimensions.
- It *provides vocabulary* for understanding fundamental processes and phenomena. Examples are planetary motion, economics, waves, heat, finance, epidemiology, quantum mechanics or optimization.
- It *teaches important background* needed in social sciences, life sciences and economics. But it is rigorous enough that it is also suited for students in core sciences like physics, mathematics, or computer science.
- It *builds tools for describing geometrical objects* like curves, surfaces, solids, and intuition which is needed in other fields like linear algebra or data analysis. Geometry is currently an extremely popular topic: tomography methods in medicine, computer games, Google earth, social network analysis all use geometry.
- It *relates to culture and history*. The quest for answering questions like "where do we come from", "what will future bring us", "how can we optimize our time in between" all use calculus. The history of calculus contains fascinating stories, starting from Archimedes, 2300 years ago up to the modern times, where new branches of multivariable calculus are developed to understand the structure of nature.
- It *develops problem solving methods*. Examples are optimization problems with and without constraints (which is the bread and butter for economics), geometric problems, computations with scalar and vector fields, area, and volume computations.
- It *makes you acquainted with a powerful computer algebra system* which allows you to see the mathematics from a different perspective. Such systems are more and more needed for visualization, experimentation and to build laboratories for your own research.
- It *prepares you for further study in other fields*. Not only in mathematics and its applications, but also in seemingly unrelated fields like game theory, probability theory, discrete mathematics, sociology, or number theory, where similar structures and problems appear, even in a discrete setting. Without geometric intuition and paradigms learned in calculus, it is rather hard to work in those fields.
- It *improves thinking skills*, problem solving skills, visualization skills as well as computing skills. You will see the power of logical thinking and deduction and why mathematics is timeless.

WHAT ASSIGNMENTS WILL THERE BE?

More details are given in the rest of this document. Click each link below for details.

See [“How do I earn a grade?”](#) for an explanation of how these contribute to your final grade.

PRACTICE AND ENGAGEMENT (PE)

Staying involved with others in the course and building your skill by practicing with the basics are both crucial pieces to success in Math 212. To keep you on track, you'll earn Practice and Engagement (PE) Credits by completing tasks related to this goal throughout the semester.

- **Edfinity Homework (One set for every LT):** To meet the needs of all students in a fair, equitable, and safe way, we will be using Edfinity for most homework assignments this semester. These are online homework assignments, to help build your computational skills. There will be at least one Homework set per learning target. *The deadline will be set as May 6 midnight for all Edfinity homework.*
- **Concept Quizzes (almost daily):** At the beginning of each class, we will start with one or two MCQ questions (mostly conceptual, not numerical) to be completed *in the first five minutes*. You will be able to answer the quiz using phone (more details will be discussed in class), and you will be graded based on participation only. These will help me keep track of your conceptual understanding.
- **Lab Reports (around 8-10 over the semester):** During some lab periods, you will work collaboratively in groups to complete a lab assignment in Mathematica. As a member of a group, you are responsible not only for your own learning but also for the learning of the other members of your group. This means that when the work is completed and submitted, every member of the group should be able to explain how to answer all the questions. You will be required to submit a completed lab report *before the next class session*.
- **Bonus PE Credits:** There will be bonus opportunities to earn PE credit, for example through class engagements, or attending Math colloquium talks. You can also get bonus PE credits by using leftover tokens ([more on tokens below](#)).

CHECKPOINT QUIZZES (EVERY 2 WEEKS):

Rather than any midterm or final exams, we will have checkpoint quizzes periodically. You will have multiple opportunities to get fluency on the major objectives in our class, without penalty for needing multiple attempts. Click the link for details.

Generally, on a learning objective, I recommend working on the homework first. Homework is both your chance to practice, show your best performance (when you have a lot of time to work on it), and your chance to get feedback on what your mistake might be. Homework will tend to be longer, more difficult, and have more interesting problems that require some pondering or multiple attempts.

The quiz will have fairly straightforward questions, and will *not* focus on hard problems, since it's timed. A quiz is your chance to prove that you can handle the fundamentals of each objective on your own.

HOW DO I EARN A GRADE?

Our course is graded by a methodology called Learning-Based Grading system, also called standards-based or mastery-based grading, in which most graded work do not have a point value or percentage. Instead, you earn your grade by showing **appropriate engagement** with the course (by completing CQs and homework) and **demonstrating evidence of skill on the learning objectives** that describe the major ideas covered by each assignment. These objectives are listed in [Appendix A](#) and will be updated throughout the semester.

When you submit most work, I will evaluate it relative to quality standards made clear on each assignment. If your work meets the standard, then you will receive credit for it. Otherwise, you will get helpful feedback and, on most items, the chance to reflect on the feedback, revise your work, and then reassess your understanding.

This feedback loop represents and supports the way that people learn. Learning happens over time, as we revisit ideas and reflect on them. In this class, your final grade will reflect how well you *eventually understand* each topic. You can make mistakes without penalty, as long as you *eventually* demonstrate fluency of the topic.

HOW PE CREDIT IS SCORED

- **Edfinity Homework (One set for every LT):** Getting 90% or more on an Edfinity homework counts as 1 PE credit, anything less counts as 0. Since you get infinitely many attempts on each homework, I expect that everyone will get full score on this part.
- **Concept Quizzes (almost daily):** Each CQ you participate in, whether your answer is *correct* or *incorrect*, will earn you 0.25 PE credits.
- **Lab Reports (8-10 over the semester):** Each lab report will be graded based on completion out of 2 PE credit. Since we will be working together during lab session on these, you essentially get full score if you attend the class.

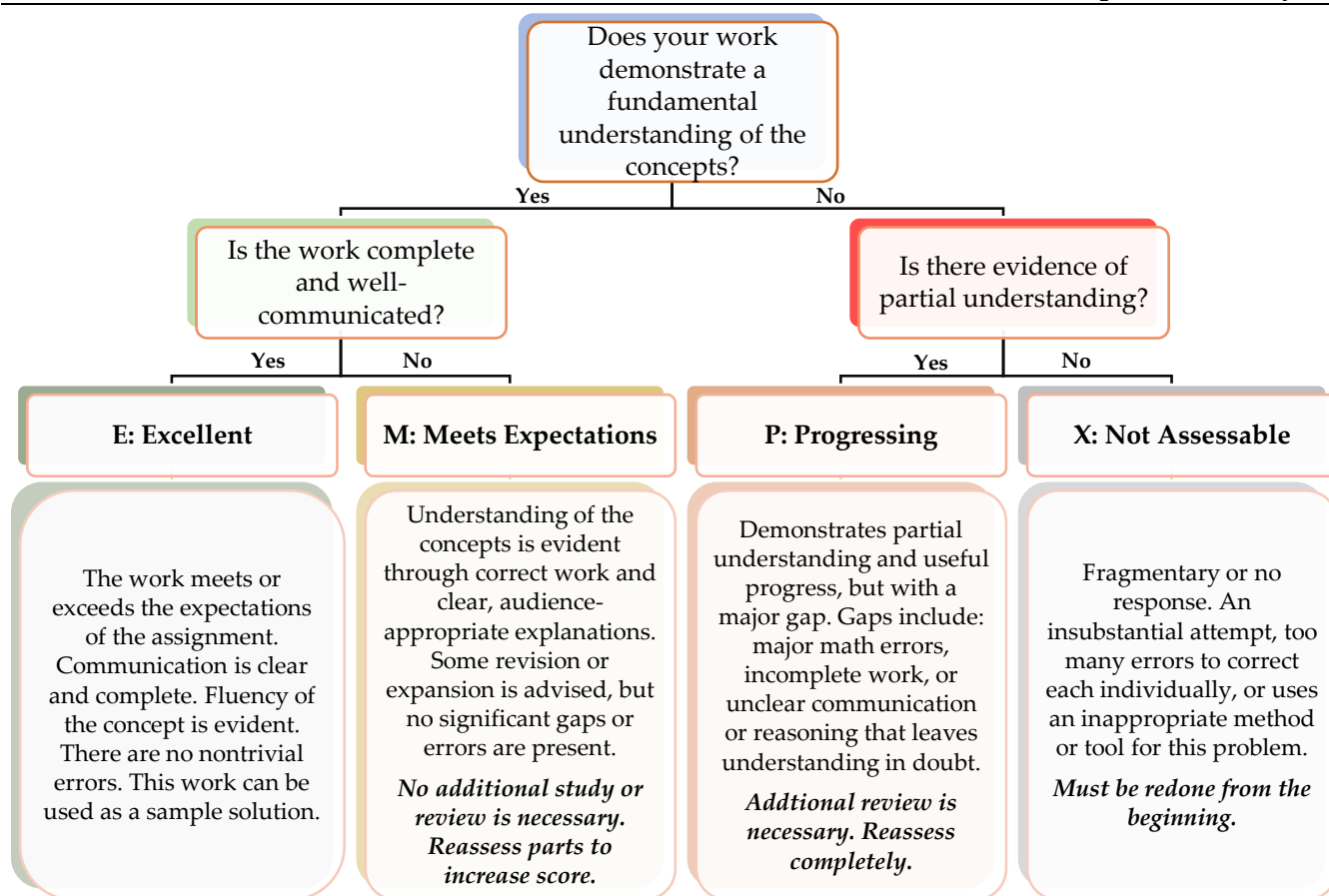
HOW ARE LEARNING TARGETS SCORED?

Learning Target Categories

The LTs are divided into two categories – Core and Supplemental. These are **separate** grade categories. The core LTs cover the bare minimum amount of knowledge you should learn out of this course. The supplemental LTs are extra topics that might prove useful for specific higher-math courses.

The EMPX scale

In quizzes, each [Learning Targets](#) (LT) will be assessed using one or more questions. **For each LT**, you'll earn a score in the EMPX scale (based on [The EMRN Rubric \(rtalbert.org\)](#)). Here is what these letters mean:



Quick Fixes (P*)

You may sometimes earn a **P*** in a Quiz. This mark indicates work that contains an error which I think is minor, but I need to talk with you about it. **Come to my office to discuss a P* within 1 week after it is returned.** If you can convince me that the error was minor and explain how to fix it, then I will update the **P*** to an E or M for free - it does *not* use up a reassessment attempt. After one week, a **P*** automatically becomes a **P** and must be reassessed as usual (and uses up your weekly attempt).

HOW YOUR FINAL GRADE IS DETERMINED

Your grade for the semester is not based on points because most items in the course don't carry point values. Instead, your grade will be based on the quantity and quality of evidence you can provide of across-the-board fluency of Math 212 - the basic skills found in the Learning Targets, and your daily work and engagement.

To determine your course **base grade** (the letter A/B/C/D/F without plus/minus modifications), use the following table. To earn a grade, you must complete all the requirements in the column for that grade; your base grade is the **highest grade level for which all the requirements have been met or exceeded.**

Category	D	C	B	A
PE Credit	60%	70%	80%	90%
Core LTs (14)	E or M on 9 of the LTs	E or M on 11 LTs, none with an X	E or M on all (14) of the LTs, at least one-thirds (5) with an E	E or M on all (14) of the LTs, at least two-thirds (10) with an E
Supplemental LTs (4)	E or M on 2 of the LTs	E or M on 3 of the LTs	E or M on 3 of the LTs, at least 1 with an E	E or M on 3 of the LTs, at least 2 with an E, none with an X

If you do not meet all of the criteria for a D, your grade will be an F.

I will set +/- grades based on how close you are to the next higher (or lower) letter grade. For example, if you meet all criteria for an A except for one or two PE credits, that may be an A-. If you are instead missing something bigger, like one homework LT, that may be a B+. I will communicate details of this on Moodle towards the end of the semester.

REASSESSMENTS

Checkpoints

Each LT will show up on more than one checkpoint quizzes. In this way, if your work on a problem in a Checkpoint doesn't meet the standard, you can just try it again at a later Checkpoint.

Retakes in Office Hours

You may attempt to improve your mark on **at most two different LTs every week**. There are two ways to do this:

- Make an appointment with me (preferably, but not necessarily, during office hours) to attempt one or two new problems that address that specific LT. You can reassess your marks on both a quiz and homework this way. The process is as follows:
 - Complete at least one set of problems on the LT from when it showed up in a checkpoint or homework. You can use the ZI, the TA, or my help for this part.
 - Bring your work to the meeting and I will give you new problems to attempt. These may be on paper or at the blackboard.
 - This can be any LT, no matter where we've assessed it. I may ask you to explain the meaning of the LT as well.
 - You will need to fill out a short cover sheet (available in Moodle) to finalize the process (and help me keep track of the reattempts).
- Revise problems from a quiz by re-doing any parts marked with **P***. This does not take up a reassessment attempt. This must be done in-person at my office.

Note: A week for this course is defined as the period of time starting at 12:01am EST on Monday and ending at 11:59pm EST the following Sunday.

One important thing to keep in mind during this class is that you should not be discouraged if you don't earn "E" on a LT the first time. That's normal. I'm only interested in what you can show me you can do by the end of the semester. However, *it's almost always better to immediately reassess rather than waiting for a future opportunity to improve your mark.* That's because, while many objectives will probably appear more than two times on later quizzes, I can't guarantee it will happen. You don't want to end up waiting until the end of the semester and then having to reassess 5 objectives, when there's only one week left.

EDFINITY HOMEWORK

WHAT IS EDFINITY?

Edfinity is an online homework system. To meet the needs of all students in a fair, equitable, and safe way, we will be using Edfinity for most homework assignments this semester. You will access your Edfinity assignments through Moodle and you can see more info on the Edfinity Homework tab on our Moodle course page.

HOW DO I USE EDFINITY?

Do not create an account on the Edfinity website directly, as it needs to be connected to your Moodle account. When you select an assignment in Moodle, a new window will open taking you to the assignment on the Edfinity site. You will never need to access the Edfinity website directly without going through Moodle.

The very first time you open an Edfinity assignment from Moodle, you will be prompted to enter your access code. You will need an access code to register for the course on Edfinity. These cost **\$25**. You can purchase one directly from the Edfinity site or from the Wilson Bookstore. I recommend against buying the codes from the bookstore as they add a considerable amount of surcharge. However, if you are using financial aid to purchase books, then you must purchase the access code from the bookstore. Any student who needs financial assistance outside of your own financial aid should contact the [Dean of Students Office, dos@wooster.edu](mailto:dos@wooster.edu).

GRADES

As mentioned in the last section, **getting 90% or more** on an Edfinity homework counts as 1 PE credit, anything less counts as 0. Since you get infinitely many attempts on each homework, I expect that everyone will get full score on this part.

COLLABORATION

Collaboration is allowed on Edfinity homework. For a definition of what “collaboration” means, see the section on [Academic Integrity](#).

SOLUTION AVAILABILITY

Over the last years, some students have been frustrated with the lack of worked out example in Edfinity. This is by design. If you want to look at worked out examples, attend the class or read the textbook. If you can't figure out a problem on Edfinity, come talk to me or the ZI. Complete solutions for Edfinity homework are not available otherwise.

TOKENS

Each student starts the semester with **4 tokens**, which can be used to *purchase* exceptions to the course rules. The token *menu* is below. To spend a token, send me an email. Everything listed here costs 1 token:

- Extend the deadline on a Lab report by 24 hours. *Deadline extensions must be requested prior to the original deadline.*
- Reassess three different Learning Targets in the same week.

Please note that tokens may not be “*stacked*”; for example, you aren’t allowed to spend 2 tokens and extend a deadline for 48 hours instead of 24 or assess four Learning Targets in the same week.

Tokens cannot be used to extend deadlines on Concept Quizzes.

I will update the number of remaining tokens per student as they are used. Any leftover token at the end of the course will be added to your PE credit score (1 token = 1 credit).

EARNING EXTRA TOKENS

There will be occasional **bonus challenge problems** that you can answer to earn extra tokens over the semester.

CHECKPOINT QUIZZES

Rather than midterm exams, we will have an in-class checkpoint quiz roughly every other week. These quizzes will cover essential topics from previous classes. Topics will be announced several days in advance.

TIMING

There will be a quiz approximately every other week during the lab period. Most weeks the quizzes will take all of class, with any remaining time used to discuss questions and homework problems.

CONTENT

Generally, quizzes will focus on computations and usage of each LT. See the LT list for details on what concepts are covered.

GRADES

The goal of these quizzes is to ensure that you are fluent on the core ideas in class. You will need to complete one or more problems to demonstrate competency on one quiz LT. These targets will be clearly stated on the quiz and announced in advance. You will earn an E, M, P, or X for each target. The requirements to show competency on each LT will be clearly noted in the quiz. See "[How do I earn a grade?](#)" for a description of each mark.

If you don't demonstrate fluency of a topic, you can reattempt a related problem on a future quiz or during a scheduled reassessment attempt (see [Reassessments](#) for details).

COLLABORATION

Quizzes are individual assessments. See the section on [Academic Integrity](#) for details.

POLICIES

ATTENDANCE AND ABSENCES

Attendance is crucial to success in this class. Your best chance to discuss new material, ask questions, and avoid confusion is during class. So, don't miss class! You are responsible for all material and announcements from class, even in case of absence. Much of this information will be available on Moodle. Please check in with me and with your classmates when you are back.

That said, life happens. We get the flu. Relatives need your help. When this happens, do what you need to do. I trust that you are an adult and will make the best choices that you can. I appreciate it if you can notify me in advance of an absence, if possible.

If you think you will miss *more than one class in a row*, you should contact me beforehand to let me know, and meet me afterwards to discuss how you can catch up and move forward in the course. If you miss *an entire week*, I will send out an academic alert. If you miss *more than two weeks* of classes, you should contact the Dean Jen Bowen and/or Amber Larson, Director of the Academic Resource Center. They can help you consider options for completing or dropping the course.

EARLY AND LATE WORK

Early Work

Checkpoint Quizzes: You can arrange to take a quiz early if you contact me **at least 2 days in advance**. See me with special cases.

Make-up Work

Concept Quizzes cannot be turned in late.

Edfinity Homework cannot be turned in late.

Lab Reports can be turned in late up to one day using a [token](#).

Checkpoint Quizzes may *not* be taken late, but since they are based on getting fluency on objectives, you may have an opportunity to assess the same objectives on a later quiz with no penalty. If you have *significant* extenuating circumstances that cause you to miss multiple assignments (even with tokens), see me to discuss arrangements.

OTHER POLICIES

Special Accommodations

The Academic Resource Center, which is in APEX (Gault library) offers a variety of academic support services such as time management and class preparation, ELL peer tutoring, coordinating accommodations for students with diagnosed disabilities, etc. Please see the Academic Policies, Procedures & Support Services document for further details or go to the [ARC website](#).

Email Responses

I do my best to reply to emails promptly and helpfully. However, I receive a lot of email. To help both you and me, here are some specific expectations about emails:

- If you email me between 8:00 am and 6:00 pm on a *weekday*, I'll reply to you on the *same* day.
- If you email me in the evening or overnight (after 6:00 pm), I will reply to you the *next weekday*.
- **If your email asks a question that is answered in the Syllabus or on Moodle** (such as in an announcement or an assignment sheet), I may reply by directing you to read the appropriate document.
 - If you've read the relevant document and still have questions about it, please make this clear in your email, by describing what you've already read, and which specific part of it you have a question about.
- Often, it's much easier to discuss questions in person. I may ask you to meet with me in my office (at a time that works for both of us) rather than answering directly in an email.
- On homework, please include photos, PDFs, or links if possible.

HOW TO GET HELP

MY OFFICE HOURS

Please come see me during my office hours if you have questions or just want to discuss something from class. These will be most effective if you have spent some time formulating your questions beforehand - often you will answer your own questions during that process! You can also contact me via Email or MS Teams with your questions. See the [email response section](#) above for my 'business hours'!

See Moodle for office hour times and further instructions.

TEACHING ASSISTANT OFFICE HOURS

Luke Wilson (class of '24) is your TA for this course. He will not be present during classes but will hold weekly office hours outside the classroom. You can ask him for help with Edfinity homework and for going over **past** checkpoint quizzes.

See Moodle for his office hour times and further announcement from him.

ACADEMIC INTEGRITY AND COLLABORATION

In this class, your primary goal in this course is to develop a deep *personal* understanding and expertise in Multivariable Calculus. Collaboration and cooperation are extremely helpful in the learning process, and we will have many opportunities for collaborative work. However, there are some portions of our class that must be done independently.

The College's understanding and expectations regarding issues of academic honesty are fully articulated in the Code of Academic Integrity as published in [The Scot's Key](#) and form an essential part of the implicit contract between the student and the College. The Code provides framework at Wooster to help students develop and exhibit honesty in their academic work. You are expected to know and abide by these rules.

In this class, we will use the following definition of plagiarism:

***Plagiarism** is the act of submitting the work of someone else as if it were your own. Specifically, this action misleads the instructor to think that the work is the result of learning and understanding by the student named on the paper, when in fact the understanding truly belongs to someone else. This may apply to an entire solution, or individual parts of a solution.*

In Math 212, collaboration is permitted and even encouraged in some circumstances! However, **you may only collaborate with students currently enrolled in Math 212.** In all cases where collaboration has occurred, you must acknowledge this clearly:

Acknowledging collaboration: In *all* work, you must clearly state the name(s) of the person(s) you collaborated with on each problem.

Specific academic honesty expectations

It is often unclear what exactly "collaboration" means when working on homework. The following section should clarify what my expectations are regarding this and give guidelines for avoiding plagiarism in assignments. The list is intended to be helpful but not exhaustive. If you are unsure about the appropriateness of some form of assistance on an assignment, you should always ask me.

- **Edfinity Homework:** On homework problems, every step of every solution should be one that you understand yourself and that you have generated on your own. You are permitted to discuss big ideas and hints with your classmates and your TA.

*All collaboration on homework exercises should occur when your collaborator is at essentially the same stage of the problem solution as yourself. In particular, if you have not yet started problem #4 and you ask a friend (who has already completed it), "How did you do problem 4?", **this counts as plagiarism.** The resulting work is not and **cannot** be considered your own.*

- **Concept Quizzes:** On most class days, you will receive one concept quiz on the topic you read about or learned in last class. You will get credit for these for attempting, whether correct or incorrect, and as such these exercises will help yourself assess your performance in class at any point. Working independently on these helps to ensure that you can solve key problems yourself later in checkpoint quizzes. In these exercises, the only help allowed is consultation with me.
- **Lab Reports:** You will be divided into groups during lab sessions to work on a lab assignment. You are permitted to work within that group only. However, lab reports are graded for completion, as such you should

not need to work on them outside the classroom as long as you attend the lab session. You may work with your classmates, me, or the TA to complete a lab report.

- **Outside resources in general:** On all work, unless directly stated otherwise, the only resources you may use are our class notes (including CQs and activity worksheets) and the approved textbook (see the first page). You are not permitted to go looking for completed solutions to problems in other texts or resources. *In particular, use of internet resources is completely off limits for completing homework problems.* Often, full solutions for our homework problems can be found online. If you see such a solution prior to submitting homework, there is essentially no way that you can claim to have an original solution. Evidence of using internet sources in your work will result in a **minimum** penalty of earning a 0 (or X) on the relevant objectives.
- **Copying:** Copying a solution, or any part of a solution, from any source (friend, internet, book, etc.) in any setting, constitutes **plagiarism**.
- **Past students:** On any assignment, basing your work on the efforts of another student who previously completed this course, or one like it, is considered **plagiarism**.
- **Other instructors, the Math Center (ZIs), and TA:** You are *not allowed* to discuss any Checkpoint Quiz problem with the ZIs in the Math Center, our TA, or seek the help of an instructor or tutor (other than me) *before the deadline*. You are *encouraged to seek their help after you have submitted an assignment* and need help checking or understanding a concept. *If you seek their help before submission, this will be considered plagiarism.* I am always willing to discuss any aspect of the course with you.

Consequences of academic dishonesty

Evidence of dishonest behavior on any assignment will be grounds for a minimum penalty of earning an X on all relevant objectives for that assignment. Other penalties may include permanently failing the relevant objectives (regardless of other work) or, in severe cases, failure of the course. Peers who willingly assist others in acts of plagiarism are equally guilty and will suffer similar penalties. In all cases, the guidelines established in [The Scot's Key](#) will be followed. I reserve the right to discuss the nature and origins of any assignment with any student prior to assigning a grade.

A POSITIVE NOTE

Remember that I want you to be successful. That is, I want you to develop a deep, personal understanding of the material we study so that you become a better student of mathematics who can go on to do well in all of your future endeavors. Every part of this course structure – including both collaborative work *and* restrictions on collaboration – are intended to help you with this. You will often struggle, and that's intentional – struggle (and eventual success!) is essential to learning. Indeed, productively failing (and learning from it) is part of your final grade.

In all aspects of the course, please understand that I am generous with hints and am always willing to discuss problems with you. I will never simply give you an answer, but I will offer direction and guidance that will assist you in coming up with a solution on your own. This is by far the most satisfying way to solve a problem, and the difficulty is well worth it. You are always welcome to discuss your questions or concerns with me at *any* time.

APPENDIX A: MATH 212 LEARNING TARGETS

The star () marked Learning Targets are supplementary, others are core.*

- ❖ **L1: Vector operations.** Addition and scalar multiplication of vectors, dot products, cross products, angle between vectors
- ❖ **L2: Lines and Planes.** Find the equation of a line or plane satisfying given conditions.
- ❖ **L3(*): Surfaces and level curves.** Draw rough graphs of planes, cylinders, and quadric surfaces; draw level curves and surfaces of multivariable functions.
- ❖ **L4: Gradient and directional derivatives.** Geometric interpretation of the gradient and directional derivatives.
- ❖ **L5: Linearization.** Tangent planes, linear approximation.
- ❖ **L6: Tangent vectors to curves.** Compute tangent vectors to parametric curves; velocity, speed, and acceleration.
- ❖ **L7: Polar Curves.** Be able to convert between polar and Cartesian equations and sketch a polar curve.
- ❖ **L8(*): Calculus with curves.** Calculate the arc length of or area under a parametric or polar curve.
- ❖ **L9: Partial derivatives and Chain Rule.** Computation of rate of change using chain rule, gradient, and directional derivative.
- ❖ **L10: Local optimization.** Locate the critical points and classify local extrema of a multivariate function.
- ❖ **L11: Constrained optimization.** Be able to use Lagrange multipliers to find max/min given a constraint.
- ❖ **L12: Double integrals.** Set up and evaluate double integrals as iterated integrals for type I/II regions. Be able to switch the order of integration as necessary.
- ❖ **L13: Triple integrals.** Interpret and evaluate volume integrals as iterated integrals.
- ❖ **L14(*): Change of variables.** Use the Jacobian to transform double integrals. You may not need to compute the integral, but you will need to set it up completely using the new variables.
- ❖ **L15: Flow Lines of Vector Fields.** Know how to graph and recognize graphs of vector fields and their flow lines.
- ❖ **L16: Vector line integrals.** Compute line integrals of a vector valued function along a parameterized curve.
- ❖ **L17: Fundamental Theorem of Line Integrals.** Determine if a Vector Field is conservative, find a potential function, and use the potential function to calculate a line integral using the fundamental theorem.
- ❖ **L18(*): Green's Theorem.** Use Green's theorem to compute line integrals and areas using curl.

APPENDIX B: TENTATIVE COURSE SCHEDULE

Week	Monday	Wednesday	Thursday	Friday
1 (Jan 17 - 21)		Syllabus Overview + 3D Coordinate Geometry	Lab 0 (Intro to Mathematica) + Vectors in 3D	Dot Product, Angle, Projection
2 (Jan 24 - 28)	Cross Product, Area, Volume	Lines and Planes	Lab 1 (Lines and Planes) + Quiz 1	Practice Problems
3 (Jan 31 - Feb 4)	Functions of several variables	Contour Plots	Lab 2 (3D Graphing and Contour Plots)	Conic Sections and Quadric Surfaces - Practice Problems + Linear Functions
4 (Feb 7 - 11)	Practice Problems	Partial Derivatives	Quiz 2	Gradients and Directional Derivatives
5 (Feb 14 - 18)	Local Linearity	Three-dimensional Gradient and Tangent Plane	Lab 3 (Gradient Vector, Tangent Plane, and Directional Derivative)	Practice Problems
6 (Feb 21 - 25)	Parametrized Curves - Straight line, Circle, Helixes	Practice Problems	Quiz 3	Velocity, Acceleration, Equation of Motion
7 (Feb 28 - Mar 4)	Calculus of Parametric Curves	Practice Problems	Polar Coordinate System+ Lab 4 (Parametric and Polar Plotting)	Polar curves

8 (Mar 7 - 11)	Chain Rule	Limit, Continuity, Differentiability	Quiz 4	Local Optimization
11 (Mar 28 - Apr 1)	Constrained Optimization	Global Optimization	Lab 5 (Stationary Points with Mathematica)	Definite Integral of Functions of Two Variables
12 (Apr 4 - Apr 8)	Type I/II regions, Triple Integrals	Double Integral in Polar Coordinates	Lab 6 (Volume Integration)	Lab 6 (Volume Integration) contd.
13 (Apr 11 - Apr 15)	Volume Integration Contd.	Change of Variables - Jacobian	Quiz 5	Practice Problems
14 (Apr 18-22)	Vector Fields	Flow of a Vector Field	Practice Problems	Line Integrals on Parameterized Curves
15 (Apr 25 - 29)	Gradient Fields - Path-Independent	Circulation and Curl	Quiz 6	<i>I.S. Symposium (No class)</i>
16 (May 2 - 6)	Path-Dependent Fields and Green's Theorem	Applications of Green's Theorem	Practice Problems	Quiz 7
<i>No formal final exam. You can schedule meetings to reassess up to two(2) learning Targets.</i>				

FREQUENTLY ASKED QUESTIONS

When you read the syllabus, right click at any point in the document to add a comment and ask a question. I will compile these questions and add them in this section.

GRADING

❖ *Wait so there is no partial credit??!*

Correct, because there is no "credit" to begin with. It's binary: Your work either meets the requirements for an M or E or it does not.

This might be terrifying to those who got through school by gaming the system, leveraging partial credit to use competence in one topic to paper over incompetence in another. But at the college or university level, this is not only unethical but also dangerous. Would you like your heart surgeon or the engineer who built the plane you're riding on to have gotten their degrees this way?

Here in Math 212, we insist on real competence, consistently and across the board. You can't make up for a lack of growth in one key area by growing twice as much in another.

Again, possibly terrifying. But never fear, this is what the revision/reattempt process is for. Work is never one-and-done; if you don't meet the standard, you'll be told explicitly what to work on and given plenty of chances to try again. The motto is high standards, with high support.