Math 160 Fall 2023
Series and Multivariable Calculus

Section A: MTWF 8:00-8:50AM Lovejoy 203
Section B1: MTWF 9:00-9:50AM Lovejoy 203

Professor:	Evan Randles
Email:	evan.randles@colby.edu
Phone:	(207) 859-5834
Office:	Davis Science Center 209
Office Hours:	10:00AM-11:00AM Tuesday, 2:00-4:00PM Wednesday, 1:00-2:00PM Friday, and by appointment
Course Website:	web.colby.edu/ma160
Personal Website:	TBA

Teaching Assistants:	Aidan Hogan	ahogan26@colby.edu
	Daniel Lyu	clyu26@colby.edu
	Kelly Putnam	kdputn24@colby.edu
	Kenzie Burns	keburn26@colby.edu

(TAs can be found in Davis 301 Sunday-Thursday from 7:00PM-Midnight)

It is impossible to be a mathematician without being a poet in soul. – Sofia Kovalevskaya

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Course Description: This second-semester course in calculus focuses on two major topics, both connected under the umbrella of approximation. The first major topic, for us, is multivariable calculus, which is an entire subject in its own right. In this study, we will take the ideas of single-variable calculus into a multidimensional setting (e.g., the real world!) and explore familiar notions of limits, continuity, derivatives and integrals for functions of several variables. We will also discuss several real-world applications of multivariable calculus. The second topic, infinite series, explores an essential and powerful method to approximate functions (of one variable) by polynomials. Through this study, we are led to the concept of power series, that is, functions defined by infinite sums of monomials. There we will confront some delicate questions surrounding what it means to consider infinite sums of functions (and numbers) and study conditions under which these infinite sums make sense; this is the notion of convergence. Together we will study the essential ideas behind this subject and its major theorems while taking a glimpse into the subject's myriad applications.

Course Objectives:

- Understand and perform basic operations on vectors, including the dot product (for vectors in $\mathbb{R}^n$) and cross product (for vectors in $\mathbb{R}^3$).
- Understand the utility of basic vector operations for doing geometry in $\mathbb{R}^n$, e.g., the computations of angles, areas of parallelograms, volumes of parallelepipeds and equations of planes

- Be able to sketch and interpret graphs and contour diagrams of functions mapping from $\mathbb{R}^2$ to $\mathbb{R}$
- Understand (and be able to define) what it means for a function of several variables to be continuous and differentiable
- Understand and calculate partial derivatives, directional derivatives and gradients of functions of several variables
- Understand and be able to apply the chain rule
- Use the tools of multivariable calculus to solve optimization problems (derivative tests and Lagrange multipliers)
- Understand and be able to calculate double and triple integrals using Riemann sums, iterated integrals and change of variables.
- Understand what it means for a sequence to converge and be able to calculate limits of common sequences
- Understand what it means for a series to converge (as the limit of partial sums) and be able to determine whether or not certain series converge using several convergence tests
- Be able to calculate the sum of certain convergent series
- Be able to approximate common functions by their Taylor polynomials and determine the accuracy of approximation (via the remainder)
- Be able to compute the Taylor series for common functions and determine their intervals of convergence.

Textbooks:

1. Multivariable Calculus[1] by Hughes-Hallet et. at., 7th edition.
2. A Short Book on Long Sums: infinite series for calculus students[2] by (our very own) Professor Fernando Gouvêa.

Grading: Your grade will be calculated as follows:

Class participation:	5%
Weekly homework assignments:	20%
Writing assignments:	10%
Quizzes:	10%
Minimum of Midterms 1 and 2:	15%
Maximum of Midterms 1 and 2:	20%
Final Exam:	20%

[1]There are several different options for this book listed through the Colby Bookstore. Any one of them (including the e-book versions) will be sufficient.

[2]I will provide you with a copy of this text when we get to the material on series. There is no need to worry about procuring it at the beginning of the semester

Exams: This course will have two midterm exams and a final exam. The midterm exams will be cumulative, though they might have a stronger focus on material presented in the several preceding weeks. The final exam will be cumulative. To do well on exams (and quizzes), you will need to understand the material at a conceptual level. Though you will need to be able to calculate quickly and accurately, the exams will test your understanding of the material at a level which goes well beyond simple computation. The exams will be at the following dates and times:

Exam	**Date and Times**	**Location**
Midterm 1	**Wednesday, October 18th from 7:00-9:00PM**	Keyes 105
Midterm 2	**Tuesday, November 15th from 7:00-9:00PM**	Keyes 105
Final Exam	TBA	TBA

It is crucial that you reserve these time slots for these exams. In the event that you are unable to attend a midterm exam, you must let me know **at least two weeks prior** to the exam date.

Quizzes: We will have weekly quizzes administered at the beginning of class on certain Fridays. The quizzes will be limited to one or two problems each and they will parallel, in content and style, the problems seen in the homework. There are **no** make-up quizzes.

Homework: Homework is the most important part of this course. It is where you will grapple with new ideas, come up with creative solutions and communicate your thoughts and understanding to others (your peers, your TAs and me). Consequently, it is crucial that you take homework very seriously. You should start homework early, work diligently and talk to your peers and teaching assistants. If you are having substantial difficulty with a particular problem, please email me or come talk to me during office hours. I am here to help! You are permitted and encouraged to discuss homework with your classmates and to consult other textbooks, however, I discourage you from searching for solutions on the internet – such behavior will only hinder your learning experience. What you turn in must be your own.

Homework Structure and Schedule: Assignments will be posted to the course website and are due at noon on Thursday in the approprate box outside my office door (Davis 209A). It is crucial to keep up with the homework in this course. Therefore, short of the circumstances discussed in the attendance policy above, late homework will not be not accepted. To account for one legitimate illness/absence, your lowest homework score will be dropped on the condition that you attend one Mathematics department colloquium (held on Mondays at 3:30) and write a brief summary (which can be submitted to me via email anytime before the last day of classes).

The homework assignments will generally be broken into two distinct parts. The first part of the homework will consist of problems you should do (and I'll expect you to do) but you needn't turn in. This group of problems will generally be computational in nature and mostly consist of odd-numbered textbook problems. As these problems will not be graded, if you would like help with them or just want to make sure you're doing them correctly, you should (always) feel free to come to office hours (mine or those of the TAs). The second part of the homework will be more conceptual in nature. You are expected to solve and write up all of the problems in the second part of the homework. There is an essential difference between writing up a problem and just writing down the answer. I expect your solution to each problem to be written out correctly and your work should

follow a coherent logical structure making use of complete sentences whenever possible. Please do not submit solutions containing incoherent and unstructured calculations. You should be proud of the material you turn in!

Homework Policies:

1. All write-ups are to be submitted in hard copy. They should be single-sided with no more than one problem per page, i.e., if a homework assignment has 5 problems, you should turn in at least 5 pieces of paper.

2. Each paper you turn in should have your name and the due date printed clearly at the top.

3. Your write-ups should be paper-clipped. You should staple all papers corresponding to a single exercise together, but please paper-clip (not staple) the group of exercises together. It is your responsibility to make sure that your homework is complete and all pages are accounted for.

4. If in the rare case that I've asked you to use technology in the solution of a problem, please provide a complete printout showing all code, inputs and outputs in sequence, and annotate the printout with comments explaining what is being done in each step.

Writing Assignments/Projects:
In addition to homework, there will be a number of writing assignments/Projects assigned throughout the semester. For these assignments, you will practice mathematical writing while attacking longer and more challenging problems - think of them as mathematical essays. As with the homework, I expect the solutions to the writing assignment problems to be correct, well-written, and presented in good mathematical prose. Your grade will depend on the correctness of your solutions and the quality of your writing. This means that your writing should follow a coherent logical structure which makes use of complete sentences and follows standard rules of grammar. These are different than homework problems in the following ways: You must work on them individually (with the exception of one group project). There are far fewer of them. For each assignment, you will be able to turn in one draft for feedback and a chance to edit and revise before the assignment's official deadline. Finally, more is required for a perfect grade beyond merely a correct answer. After the beginning of the semester, you will be given a specific write-up concerning these writing assignments, including grading policies and a thorough description of my expectations for them.

Attendance and Class Participation: You are required to attend each class session. This means that you need to be on time to class, seated, and ready to learn (take notes, participate, discuss, and engage). To learn mathematics, it is essential to discuss it with others and ask questions. Thus, you will be required to participate in class discussion and you will frequently be called on during lecture. It is for this reason that your on-time attendance is required.

With this being said, I also know that things come up that are outside of your control. To accommodate this, you are allowed 4 'free passes' this semester that can be used for missing class, arriving late, or leaving early. Absence for religious reasons or for official Colby activities does not count as using a free pass as long as you communicate with me clearly beforehand. Using more than your 4 free passes will result in a reduction of final course grade.

Office Hours: You are strongly encouraged to attend office hours and do so regularly. Office hours are the perfect venue for asking questions, getting help, and having real one-on-one time with me. For my office hours to be most beneficial to you and fair to your peers, my office-hour policies are as follows:

- If you are attending office hours to get help with a "turn in" homework or writing assignment problem, you must first have spent a considerable amount of time ($\geq$ 30 minuets) thinking about/attempting to solve the problem. In particular, you must have parsed through the definitions (e.g., know the vocabulary), compared the problem against what we've done in class and similar examples from the textbook, and made an earnest attempt at solving the problem and be prepared to show me your attempt.
- To be most effective in helping students with "turn in" homework or writing assignment problems, I will help students individually and so please be prepared to wait your turn. During these one-on-one meetings, you are not permitted to take notes (or pictures) of any kind.
- For all other questions about the course (including general questions on the material and "do not turn in" problems), I'm very happy to talk to groups of students and students should feel free to take notes at these times.

TA Help Sessions/TA Office Hours: For the duration of the semester, Davis 301 has been reserved for MA160 from Sunday-Thursday from 7:00PM-Midnight. There, you will find many TAs assigned to the course who are able to help you with the course material (these TAs may be from your section or from other sections, but all TAs are available to help). You should plan on attending these help sessions regularly and be ready to ask questions and help/collaborate with your peers. There is one notable caveat to the times listed above: During the month of September, from 7:00-8:00PM on Tuesday, Wednesdays, and Thursdays, there will be another dedicated help session going on in Davis 301 for MA125/130 to accommodate for "Math in Davis" happening in the second floor. During these times in September, please be prepared to move around with the 160 TAs.

"Math in Davis": On Tuesday, Wednesday, and Thursday evenings from 7-10 PM, the mathematics department is hosting "Math in Davis" on the whole of the second floor of Davis. Math in Davis is a dedicated time/event for all students of mathematics (including for our course) to get together and work collaboratively on mathematics in an environment designed specifically for it. We have also asked for your TAs to attend "Math in Davis" and so you'll have some folks around who can help out if you get stuck. Please plan to regularly attend these co-working sessions!

My Email Policy: I love talking about mathematics and I always prefer to do it in person. For this reason, I like to, whenever possible, reserve email for logistical things. However, when you are stuck and cannot come see me in person, please feel free to email me. I am here to help!

As my life is busy and I have many responsibilities, I usually only check and respond to email once per day and sometimes not at all on weekends. For this reason, I try to uphold the following 24-48 hour rule: If you send an email Sunday through Thursday, I will do my best to respond within 24 hours. If you send an email on Friday or Saturday, I will do my best to respond within 48

hours. If I do not respond within these windows, feel free to email me again as I may have missed it.

Academic Integrity: Honesty, integrity, and personal responsibility are cornerstones of a Colby education and provide the foundation for scholarly inquiry, intellectual discourse, and an open and welcoming campus community. These values are articulated in the Colby Affirmation and are central to this course. You are expected to demonstrate academic honesty in all aspects of this course. If you are clear about course expectations, give credit to those whose work you rely on, and submit your best work, you are highly unlikely to commit an act of academic dishonesty.

Academic dishonesty includes, but is not limited to: violating clearly stated rules for taking an exam or completing homework; plagiarism (including material from sources without a citation and quotation marks around any borrowed words); claiming another's work or a modification of another's work as one's own; buying or attempting to buy papers or projects for a course; fabricating information or citations; knowingly assisting others in acts of academic dishonesty; misrepresentations to faculty within the context of a course; and submitting the same work, including an essay that you wrote, in more than one course without the permission of the instructors.

Academic dishonesty is a serious offense against the college. Sanctions for academic dishonesty are assigned by an academic review board and may include failure on the assignment, failure in the course, or suspension or expulsion from the College.

The Colby Affirmation

Colby College is a community dedicated to learning and committed to the growth and well-being of all its members.

As a community devoted to intellectual growth, we value academic integrity. We agree to take ownership of our academic work, to submit only work that is our own, to fully acknowledge the research and ideas of others in our work, and to abide by the instructions and regulations governing academic work established by the faculty.

As a community built on respect for ourselves, each other, and our physical environment, we recognize the diversity of people that have gathered here and that genuine inclusivity requires active, honest, and compassionate engagement with one another. We agree to respect each other, to honor community expectations, and to comply with college policies.

As a member of this community, I pledge to hold myself and others accountable to these values.