Math 145: Calculus II (Multivariable)

Spring 2019

Course Description: This is a second course in calculus. We will extend the study of calculus from functions of the form $y = f(x)$ to functions of the form $z = f(x, y)$ and $w = f(x, y, z)$, which occur much more frequently in real life. We will study how to visualize these functions graphically in higher dimensional space, how to approximate their solutions numerically, and how to represent them analytically using matrices and linear algebra. Single-variable calculus is concerned with derivatives and integrals, and they are related by the Fundamental Theorem of Calculus. The multivariable analogues are partial derivatives, the gradient, and multiple integrals. We will study these concepts, with an emphasis on how to use them when building and using mathematical models of the world. In the real world, you rarely need to do calculations or algebraic simplifications by hand. Thus, we will de-emphasize these topics, and focus on concepts. Additionally, we will study sequences and series (which form a bridge between this class and Math 321) and differential equations (which form a bridge to Math 231).

Class Details:

Instructor:	David White
Office:	Olin 202
Extension:	6644
Email:	david.white@denison.edu
Meetings:	11:30-12:20am MTWF, Section 02, Olin 215
	12:30-1:20 MTWF, Section 03, Olin 215
Drop-In Hours:	Mon 10:30 - 11:20, Tue 9:30 - 10:20, Wed 1:30 - 2:20, Fri 3-4, in Olin 202
Course Assistant:	Fill-In:
Study Session:	Fill-In:
Final Exam:	For Section 02, it's Saturday, May 11, 9-11am, Olin 215
	For Section 03, it's Monday, May 13, 2-4pm, Olin 215
Web Resources:	http://personal.denison.edu/~whiteda/math145spring2019.html, Note Bowl

Course Goals:

1. Practice how to break a complex problem into simple pieces.
2. Develop your analytic thinking skills. Develop the ability to reason abstractly, to understand the importance of proofs, to pay attention to details, and to be methodical.
3. Develop the ability to visualize higher dimensional space and be comfortable solving problems featuring partial derivatives and multiple integrals.
4. Learn the basics of differential equations and linear algebra, as well as the connection between them.
5. Learn how to represent real-world problems mathematically and solve them using calculus, differential equations, and linear algebra.
6. Develop time management skills, group work skills, test-taking skills, computer skills, and the ability to read mathematics slowly and carefully.

Textbook: *Calculus: Early Transcendentals*, 8th edition, by James Stewart. Homework will be collected via WebAssign, so you are encouraged to purchase a copy of the textbook that includes WebAssign support (these are the versions sold by the campus bookstore).

Supplemental: *Linear Algebra: A Modern Introduction*, 3rd edition, by David Poole. We will draw WebAssign problems from this text at the end of the course, but your subscription for the text above will allow you to access this text as well.

Course Evaluation:

Homework	30%	Midterms	30%
Reading Questions	6%	Quizzes	10%
Participation	4%	Final Exam	20%

Keys to Success

- Be able to solve every homework problem quickly prior to exams.
- Learn to apply the basic concepts and do not simply memorize solutions to specific problems. Exam problems which are different from the homework can be solved using the same underlying concepts.
- Read and re-read the textbook, giving particular attention to examples.
- Review the lecture the same day it is given. Find a way to attach this new knowledge to things you already understand.
- Study calculus every day rather than in bursts just before an exam.
- Attempt every homework problem in each assignment. Even if it is confusing, simply trying to write something cohesive down on paper will help you learn much more than watching someone else present the solution.
- Keep a list of key definitions, formulas, and theorems, and commit them to memory throughout the course. Keep a list of key commands in Sage, and example files where you can find examples. Test your memory each week.
- Have a perfect, hand-written copy of each homework assignment within one day after the problems have been discussed in class. Use this to study for exams.

Reading and Homework: We will cover approximately one section per class. You are expected to read the section before class, to try to understand which concepts might be difficult for you *and why*, and to answer the **reading questions**. This way we can focus in class on the things you found difficult. Reading questions will be graded, so it is essential to complete them before class. Class will always begin with a review of the section, and often the reading questions will guide our discussion.

Expect **daily homework problems** on the section most recently covered. Ideally, these problems should be completed before the following class. However, sometimes student schedules are unusually busy on a particular day (e.g. if they have an exam the next day, or a sporting event that night), so there will be a grace period of 2 days for each homework assignment. This flexibility will allow students to do two homework assignments in one sitting, if need be, and thereby get a day without calculus homework. However, there is no grace period on reading questions, because if students do not do the reading then the efficacy of class time will be affected.

Homework will be turned in and graded through the WebAssign system, so make sure to get a copy of the textbook that has a WebAssign code. If you are having trouble getting WebAssign to accept the specific form of your answer, please do not stress. Instead, email the course TA for advice about the way the answer is expected. As a last resort, you can use the WebAssign system to contact me and ask me to manually accept your answer, assuming it is correct. Homework is fairly low-stakes, so it is not worth getting stressed out about. If you are spending more than 1 hour per night on the homework, please seek help (from me, or the TA, or your classmates) and we will find a way to get through it faster. After class is over you should re-read the section to make sure everything is completely clear, then do the homework problems. Expect to spend at least 2-3 hours working on calculus outside of class for each hour the class meets (i.e. 8-12 hours per week).

Collaboration on homework is strongly encouraged, but you should write up your submission yourself, and you should never share answers with classmates who did not work with you to find those answers. I encourage you to come to office hours or seek help from the Course Assistant if you are confused about anything. You will get the most out of this time if you attempt the homework first and come with questions already prepared. **Neither the professor nor the course assistant will give you answers.** In consideration for sickness, personal emergencies, etc. I will drop the two lowest homework grades.

Computer Work: The advent of modern computers has removed the necessity to carry out complicated computations by hand. Just as most people use calculators when doing arithmetic, most in the real world use a *computer algebra system* (such as Sage, Mathematica, or Matlab) to take derivatives and integrals. In 2017, I pioneered a version of this course with weekly labs where students learned the necessary commands to do calculus in Sage. This semester, I plan to teach students the commands to work in Mathematica, because Sage is no longer free, and Mathematica is used across the campus. Rather than assigning labs, I will give students handouts with the relevant commands, and examples of their use. I will explain the content from the 2017 labs, as a way to demonstrate the value of calculus and computer algebra systems in the real world. Lastly, there will be certain homework assignments on WebAssign with problems that can be done by hand or with the computer, but that are much easier with the computer. In this way, I hope students will see the value in using Mathematica, even if you are used to doing things by hand. No background in computer science is expected of students, and we will not do any programming.

Exams: Each exam will cover material presented in lecture, homework, and the textbook. The final exam will be cumulative. All exams will contain questions taken directly from the homework, so be sure you know how to solve all homework problems and that you understand the concepts presented in the textbook and in class. The exam dates are listed on the course webpage. Please mark these dates in your calendar now, so that you will not miss those class meetings.

Participation and Quizzes: Class meetings will be highly interactive and our goal will be to involve all participants. Attending class, answering questions, and asking questions is therefore essential and will be a significant factor in determining your participation grade. Every day you will receive a participation grade between 0 and 3. In order to get a 3 you should ask or answer a question, either in class or one-on-one. There will also be periodic group exercises which will factor into your participation grade, as will your ability to work well with your partner(s). In a class this small, any absence will be detrimental for the group as a whole, so please make your best effort to arrive on time for every class. There will be quizzes where you solve calculus problems similar to the homework. Note that being able to do a homework problem at home with the book in front of you is much easier than being able to solve it under time pressure. The former skill alone is insufficient to pass the class. Thus, quizzes are the best practice for the exam, and when you study for the exam you should try to replicate the quiz environment.

Grading Scale: A standard 10% grading scale will be used. Therefore, 60% is required to pass the class, 70% will be a C-, 80% will be a B-, and 90% will be an A-.

Course Format: Each class meeting is 50 minutes. Please arrive on time or even early, as we will begin promptly. Class will begin with a review of old material and an introduction of new material. Please take advantage of this review time to ask questions on things which are confusing you. We're all in this together and don't want to leave anyone behind. Note however that because we are on a tight schedule specific questions on homework are best asked before class or during office hours. When we cover new material we will often form small groups to work on problems and then share solutions with the class as a whole. Use this time to diagnose which areas to study more carefully before doing the daily homework.

Communication: It cannot be stressed enough how essential communication is to succeeding in this course. After identifying topics that may be giving you trouble, please communicate this information to me. There's no such thing as a bad or unwelcome question. Additionally, please

communicate with each other. I view the class as a team trying to learn the material together. Collaboration will help all parties achieve this goal, as explaining concepts and examples to each other is a great way to learn.

Disability: Any student who feels he/she may need an accommodation based on the impact of a disability should contact me privately as soon as possible to discuss his/her specific needs. I rely on the Academic Support & Enrichment Center to verify the need for reasonable accommodations based on documentation on file in that office.

Academic Integrity: The students and faculty of Denison University and the Department of Mathematics and Computer Science are committed to academic integrity and will not tolerate any violation of this principle. Academic dishonesty is, in most cases, intellectual theft. It includes, but is not limited to, providing or receiving assistance in a manner not authorized by the instructor in the creation of work to be submitted for evaluation. This standard applies to all work ranging from daily homework assignments to major exams. As is indicated in Denison's Student Handbook, available through my.denison.edu, instructors must refer every act of academic dishonesty to the Associate Provost, and violations may result in failure in the course, suspension, or expulsion. (For further information, see the Academic Misconduct and Sanctions sections of the Student Handbook or Section VII.B. of the Faculty Handbook.)

I expect that you will all abide by the honor code in this course. Please do not use resources outside of me, your fellow students, the tutors, and the textbooks. Collaboration on homework with students in this class is permitted, but you are not allowed to share numerical answers and you should make sure you know how to solve all problems yourself (this is the best preparation for quizzes and exams). Collaboration on quizzes and exams is not permitted. All violations of the honor code will be reported.

Appropriate Use of Course Materials: The materials distributed in this class, including the syllabus, exams, handouts, study aides, and in-class presentations, may be protected by copyright and are provided solely for the educational use of students enrolled in this course. You are not permitted to re-distribute them for purposes unapproved by the instructor; in particular you are not permitted to post course materials or your notes from lectures and discussions online. Unauthorized uses of course materials may be considered academic misconduct.

Email: I will frequently send out emails to the class, so I expect you to check your email regularly. I will also check my email regularly, but often not after 7pm. Please consider emailing the course TA with questions.