Calculus 2

MATH 136-02, Fall 2023

MTWF 09:00 - 09:50 am, Swords 302

Dr. Margaret (Maggie) H. Regan

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Office Hours: Monday 1 - 2 pm in Swords 331 (my office); Tuesday 1 - 2 pm in Swords 331 (my office); 7 - 8 pm in Swords 328 with Matt, one of our TAs; Wednesday 1 - 2 pm in Swords 331 (my office); Thursday 5 - 6 pm in Swords 302 with Annie, one of our TAs; Friday 7:30 - 8:30 am in Swords 331 (my office); or by appointment.

Textbook: *Calculus Volume 2*, a free open-source textbook produced by OpenStax (a hard copy is available on reserve in the Science library). We will also be using the free online homework platform called WeBWork.

Website: I will be using Canvas to post all homework assignments, computer projects, lecture notes, worksheets, exam materials, useful links, and other important information. The course should be viewable from your Dashboard once you log onto Canvas.

Is this the right Calculus course for me? This course is required for students majoring in either Mathematics, Physics, Chemistry, or Economics. It is no longer required for the Biology major or students interested in the health professions. If you have taken Calculus 1 previously or scored a 4 or 5 on the AB advanced placement exam, then this is the appropriate course for you. If you took a strong calculus course in high school, but didn't receive a 4 or 5 on the AP exam, this still may be the correct placement since most of Calculus 1 will be review for you. For more information, see the Math/CS Department's webpage.

Course Description: Considers the calculus of real-valued functions of one variable for students who are planning further course work in mathematics, a major in the social or physical sciences, or the premedical program. Emphasis is placed on a conceptual understanding of the calculus, presenting material from symbolic, numerical, and graphical points of view. Course content includes the theory, evaluation, and applications of integration, sequences and series including Taylor polynomials and series, and an introduction to ordinary differential equations. This course is the prerequisite for Mathematics 241. This course meets four hours per week.

Students who have earned credit for a course equivalent to Calculus 2 or above cannot enroll in MATH 136. Intended for students who have completed one year of Calculus at the high school level.

Course Objectives:

- Develop an understanding for the techniques, theory, and applications of integral calculus.
- Build confidence in your mathematical abilities and problem-solving skills.
- Become proficient at making clear and coherent mathematical arguments.
- Work and communicate with your peers.
- Have FUN while learning calculus!

Course Content: The main focus of this course is to study integration of real-valued functions of a single variable. Applications of the integral, such as volume of revolution, arc length, and probability theory will also be featured. We will discuss infinite series and make a brief foray into the field of differential equations at the end of the course. The subject will be approached from both a conceptual and a computational viewpoint. Rather than just learning a set of formulas, techniques and algorithms, the theory and applications of calculus will be central to our study. Many of the exercises require a solid understanding of concepts as opposed to a cursory "plug-and-chug" approach.

A tentative outline of the course is given below. We will cover much of the material in the text from Chapters 1 through 6.

- Course introduction, finding area under a curve, Riemann sums (3 classes)
- The definite and indefinite integral, integration formulas (3 classes)
- The Fundamental Theorem of Calculus, net change, u-substitution (6 classes)
- Exam I
- Applications of integration: average value, area between two curves, volumes of revolution, cylindrical shells, arc length, exponential growth and compound interest (9 classes)
- Techniques of integration: integration by parts, trigonometric integrals, trig substitution, partial fractions (7 classes)
- Exam II
- Numerical integration, improper integrals, probability density functions (4 classes)
- Infinite sequences and series: convergence, geometric series, convergence tests (nth term test, p-series, integral, comparison, ratio) (7 classes)
- Power series, Taylor and Maclaurin series (3 classes)
- Exam III
- Differential equations: simple examples, separation of variables, Newton's Law of Cooling, continuously compounded interest (3 classes)
- Differential equations: slope fields, Euler's method, the logistic equation (3 classes)
- *Review* (last class)
- Final Exam

The (Partially) Flipped Classroom: Most of our classes this semester will consist of problems and worksheets for you to complete in groups with mini lectures mixed in. For these classes there will not be a full traditional lecture, but rather the class is "flipped" so that active student learning is the primary focus. I have found that this style of teaching is more effective. You will be expected to prepare for these classes by completing a few problems on WeBWork and/or reading the text beforehand.

Attendance/Recording: I expect you to attend class regularly. Please notify me in advance if you need to miss class. The College Excused Absence policy is posted on the Canvas page for the course. Since most classes will involve group work, I do not plan to record classes. However, if you have an accommodation that requires the recording of class sessions, please contact me so that we can make arrangements. See the College's Requests for Reasonable Accommodations policy for more information.

Homework: Homework will be due every Wednesday except for weeks when there is a midterm exam. Assignments will consist of two parts, a written portion and an online set of problems to be completed using WeBWorK. All assignments will be posted on Canvas and you will be expected to submit **one PDF file** of your written solutions electronically.

While you are allowed and encouraged to work on homework problems with your classmates, the solutions you turn in to be graded should be your own. If you use the Internet for help on homework, be sure to cite the website(s) visited. Take care to write up solutions **in your own words**. Plagiarism will not be tolerated and will be treated as a violation of the Departmental Policy on Academic Integrity.

While I am open to extensions on the homework due dates, I will make two notes: (1) getting behind on assignments can be a slippery slope and potentially lead to a delay in learning the material/an inability to catch-up; (2) **extensions must be requested PRIOR to the assigned deadline** – if requested afterwards, the extension will not be granted. Please send me an email to request any extensions.

Computer Projects: Certain classes will involve the use of technology to illustrate and explore some aspect or application of calculus. These will be days of collaborative learning involving the use of mathematical software such as Maple. You will be asked to complete 3–4 computer projects working in small groups.

Quizzes and Exams: There will be weekly quizzes, three midterm exams, and a comprehensive final at the end of the semester. The exam schedule is given below. Please make a note of these dates and plan accordingly. Any conflicts must be legitimate and brought to my attention well before the exam is scheduled.

If you have any specific learning disabilities or special needs and require accommodations, please let me know early in the semester so that your learning needs may be appropriately met. You will need to obtain approval from the Office of Student Accessibility Services (Hogan 505, x3693).

Exam Schedule:

Exam 1	**Weds., Sept. 27**	**In Class**
Exam 2	**Weds., Nov. 1**	**In Class**
Exam 3	**Weds., Nov. 29**	**In Class**
Final Exam	TBA	2.5 hours

Grades: The way grades will be assigned in this course is likely different than what you have experienced in previous courses. Instead of a percentage system, your grade will be calculated based on how well you display mastery of specific mathematical tasks called **standards**. There will be approximately 30 standards that will be assessed during the semester (see list at the end of the syllabus). Standards may be added or revised depending on the specific material covered, and some standards may be deleted if we are unable to cover all of the material in a timely fashion.

For each standard, you will be assigned a grade between 0 and 4 as follows:[1]

- 4: Exemplary. The task can be completed in familiar and new situations with no mistakes.
- 3: Meets expectations. Understanding/completion of the standard is evident, with few mistakes.

[1]This grading approach and assignment of points is based on Sharona Krinsky's *Precalculus* syllabus, Spring 2017.

- 2: Approaches expectations. Partial understanding is evident, but significant gaps remain.
- 1: Does not meet expectations. The work contains significant errors or omissions.
- 0: No assessment could be made.

Your score on a particular standard depends on *continued* mastery. Each standard will be tested multiple times throughout the semester (e.g., on a quiz, a midterm, and the final exam) and your score will be updated regularly. **Your running score on a standard will be the best score of your two most recent attempts.**

Re-assessment: At any point during the course, you may retake a particular standard by attempting a similar problem. This will take place outside of class during special "make-up" office hours or by appointment. The re-assessment will typically take the form of a short make-up quiz. **Note: You are allowed to retake at most three standards per week.**

Here is how the scores on the standards will be converted into a letter grade at the end of the semester:

- To earn an A, you should achieve 4's on 90% of the course standards and have no scores below a 3. In addition, you should have a final homework/project average over 90%.
- To earn a B, you should achieve 3's or higher on 80% of the course standards and have no scores below a 2. In addition, you should have a final homework/project average over 85%.
- To earn a C, you should achieve 3's or higher on 70% of the course standards. In addition, you should have a final homework/project average over 75%.
- To earn a D, you should achieve 2's or higher on 70% of the course standards. In addition, you should have a final homework/project average over 65%.

Plus and minus grades (A-, B+, etc.) will be assigned based on proximity to full letter grades. Your homework/project average will be computed as a weighted average of your written homework, WeBWorK scores, and computer projects.

The advantages of this grading system are (1) it takes the pressure off quizzes and exams by giving you multiple attempts to achieve a good score on a standard, (2) it focuses on *mastery* of the material rather than partial or transient understanding, and (3) it is a very transparent grading system; you know exactly what is expected to achieve a particular grade and how you can improve your standing in the course. Please feel free to contact me if you are unsure about how you are doing in the course at any time.

Disclaimer: Changes to the grading system above are possible during the semester, yet would be properly communicated and discussed as a class.

Academic Integrity: The Department of Mathematics and Computer Science has drafted a policy on academic integrity to precisely state our expectations of both students and faculty with regards to cheating, plagiarism, academic honesty, etc. You are required to read this policy and sign a pledge agreeing to uphold it. A violation of the Departmental Policy on Academic Integrity will result in a 0 for that assignment or exam, and a letter describing the occurrence of academic dishonesty will be sent to your Class Dean.

Diversity, Equity, and Inclusion: We live in a wonderfully diverse world. Acknowledging and listening to the perspectives and experiences of people from a different cultural background than your own (e.g., different gender, race, sexual orientation, nationality, religion, socioeconomic status) is a vital part of the learning process and your personal development. It is my intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of the classroom, and that the diversity students bring to this class be viewed as a resource, strength, and benefit. All voices need to be heard. I welcome and appreciate any suggestions you have pertaining to diversity, equity, and inclusion, and commit to listen reflectively to your concerns, without defensiveness, in recognition that receiving honest feedback is a necessary step in improving the inclusiveness of our academic environment.

Climate Goals:

- *Axiom 1.* Mathematical potential is distributed equally among different groups, irrespective of geographic, demographic, and economic boundaries.
- *Axiom 2.* Everyone can have joyful, meaningful, and empowering mathematical experiences.
- *Axiom 3.* Mathematics is a powerful, malleable tool that can be shaped and used differently by various communities to serve their needs.
- *Axiom 4.* Every student deserves to be treated with dignity and respect.

Mental Health and Wellness: If your mental health concerns and/or stressful events negatively affect your daily emotional state, academic performance, or ability to participate in your daily activities, there are resources available to you. College of the Holy Cross encourages all students to access these resources, particularly as we navigate the transition and emotions associated with this time. Counseling and Psychological Services (CAPS) offers a range of psychological services to meet the mental health needs of students, with the primary goal being to support students negotiating their transition into adulthood. CAPS is open Monday through Friday, 9 a.m.-noon and 1-5 p.m. and can be reached by calling 508-793-3363. If you are in distress and need to speak with someone urgently, an on-call crisis counselor can be reached 24/7 at the following numbers:

- Holy Cross 24-hour Crisis Center number (855-418-7282)
- National Suicide Help Line (800-273-8225)

In addition, managing daily stress and self-care are also important to well-being. There are resources to help with this in the form of peer tutoring, academic skills and success coaching, and more at the Office of Academic Services and Learning Resources. The campus recreation center and student wellness education are also available to support the wellness of your mind, body and soul so you can thrive during your time at Holy Cross.

How to do well in this course:

- ATTEND CLASS, PARTICIPATE and ASK QUESTIONS.

  I take pride in my classes and will work hard to get you to master the course material. However, this will not be of much use to you if you don't attend class. Furthermore, it is up to you to come prepared for class. Taking some initiative beforehand will result in a better learning experience for you. Do not take for granted the privilege you have of attending college. Value your time here and I will make it worth your while.

- DO YOUR HOMEWORK REGULARLY.

  The best way to learn mathematics is to *do* mathematics. This means mastering the material to the point where you could explain it to your classmates and friends. "You don't really learn the subject until you teach it," is a common adage amongst mathematicians. It is not enough to know how to mimic an algorithm. A strong student should be able to follow and propose arguments as to why an algorithm is working or not working.

- WORK WITH YOUR CLASSMATES.

  Some of the best assets available to you are the knowledge and abilities of your peers. Learn to explain mathematics to your classmates. Mathematics can be fun and rewarding when there are people around you who enjoy figuring out problems as much as you do. Take advantage of this opportunity and organize study groups outside of class.

- ASK FOR HELP WHEN NECESSARY.

  Ask for help when you need to. One of the stumbling blocks for many math students is being afraid to ask for help. Just do it! It's actually ok to admit that you don't understand something. Some might even characterize it as a strength.

List of Standards

Note: Some standards may be revised or ignored as the semester progresses depending on the material covered.

Integration

1. I can approximate the value of a definite integral using left-hand, right-hand, and midpoint sums.
2. I can find the exact value of a definite integral using geometry.
3. I understand the Fundamental Theorem of Calculus, Part 1, and can use it to evaluate derivatives of integrals.
4. I understand the Fundamental Theorem of Calculus, Part 2, and can use it to evaluate definite integrals.
5. I can apply basic integration formulas (power rule, exponential and logs, trig and inverse trig) to evaluate definite and indefinite integrals.
6. I understand that the integral of a rate of change gives the net change and I can apply that idea in different settings.

Applications of Integration

7. I can use definite integrals to calculate the area of a region bounded by one or more functions, including integrating with respect to either axis.
8. I can calculate volumes using slicing or cylindrical shells.
9. I can use definite integrals to calculate the length of a curve.
10. I can solve applied problems (e.g., compound interest) involving exponential growth and decay.

11. I understand the meaning of a probability density function (PDF), can verify that a given function is a PDF, and evaluate a definite integral of a PDF to calculate the probability of a particular event occurring.

Techniques of Integration

12. I can evaluate integrals using the method of u-substitution.
13. I can recognize when the method of integration by parts applies and correctly apply the parts formula to evaluate an integral.
14. I can evaluate and simplify integrals whose integrands contain powers of $\cos x$ and $\sin x$.
15. I can use the method of trigonometric substitution to evaluate integrals containing terms of the form $\sqrt{a^2 - x^2}$, $\sqrt{x^2 + a^2}$, or $x^2 + a^2$.
16. I can evaluate integrals whose integrands contain rational functions using the method of partial fractions.
17. Given an integral, I can identify which methods apply and then evaluate the integral using one or more of the above techniques.
18. I can approximate definite integrals using the midpoint, trapezoid, and Simpson's rule and can recognize whether a given rule produces an over- or underestimate of the actual value.
19. I understand the meaning of an improper integral. I can determine whether an improper integral converges or diverges, and find its value should it converge.

Sequences and Series

20. I understand the meaning of sequences and infinite series and what it means for each of them to converge or diverge.
21. I can identify an infinite geometric series, find its ratio, and compute the sum when it converges.
22. When appropriate, I can apply the nth term test to show that an infinite series diverges.
23. I can apply the integral test to determine whether an infinite series converges or diverges.
24. Given an infinite series, I can apply an appropriate test (e.g., p-series, integral, comparison, ratio) to determine whether the series converges or diverges.
25. I can use the ratio test to determine the radius and interval of convergence of a power series.
26. I understand what a Taylor series is and why it is useful, and can compute the Taylor and/or Maclaurin series of a given function.

Differential Equations

27. I understand the meaning of a differential equation, including the difference between the general and particular solution, and can verify whether a function is a solution to a given differential equation or initial-value problem.
28. I understand the meaning of a slope field and can sketch or recognize the slope field for a given differential equation.
29. I can apply Euler's Method to approximate the solution to an initial-value problem.
30. I can use separation of variables to solve separable differential equations, including for certain applied settings (e.g., Newton's Law of Cooling).