

MATH MB

Introduction to Functions and Calculus II

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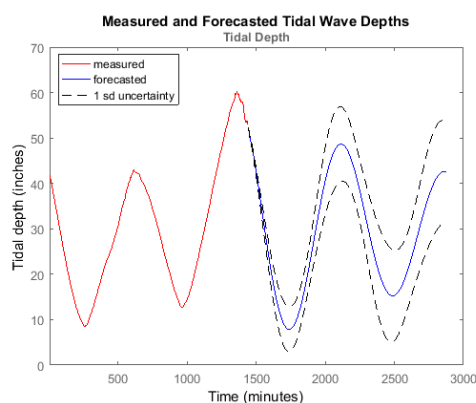
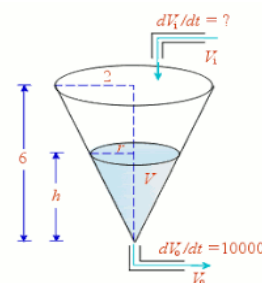
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Welcome (back) to Math Mb!

In Math M we study functions and their rates of change. In Math Ma, we started discussing the ideas of calculus immediately, weaving in background material about functions when we needed it. This approach continues in Math Mb, and together gives us an entire year to reinforce the most important concepts and skills and to see mathematics as a sense-making activity that can be used to model the world we live in. Our goal in Math M is to help you gain a solid, deep, and portable understanding of single-variable calculus as well as its applications in other fields. In this semester we ramp up to assure you a successful launch into your studies. We will study five main topics this semester in Math Mb:

Differentiation:

In Math Ma, you learned about the derivative and its interpretation as the slope of a tangent line or an instantaneous rate of change. A derivative is a powerful tool for analyzing functions and for solving practical problems such as optimization problems. In Math Mb, we'll add some sophistication to our differentiation, opening up new worlds for us. These techniques will allow us to analyze relationships among multiple rates of change.



Trigonometry:

In Math Ma, you learned about linear functions (which underlie all of calculus), as well as higher degree polynomials, exponential and logarithmic functions. These were all useful for modeling different types of phenomena. In Math Mb, we'll study trigonometric functions, which are useful for modeling periodic behavior such as tides, seasonal phenomena, sound waves, and the like. They are also instrumental in navigation, surveying, and architecture, among other things.

As we study trigonometric functions, we will revisit and reinforce the main ideas of differential calculus.

Limits Revisited:

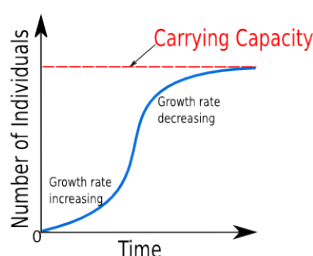
Limits are central to calculus. We will gain more sophistication with limits and dealing with indeterminate forms.

Integration:

As you know, a derivative can be interpreted as an instantaneous rate of change. For example, the derivative of a position function is a velocity function. In integral calculus, we look at a closely related question: if we have a rate of change function (such as velocity), can we figure out the "net change"? (How far did we go?) We'll discover the *Fundamental Theorem of Calculus*, which describes a deep connection between integral and differential calculus.

Differential Equations:

Differential equations are equations that model rates of change; they are used extensively throughout the natural and social sciences. Differential equations are studied in depth in Math 1b; our treatment in Math Mb will give you a preview, with an emphasis on modeling and real-world applications.



Course Goals

In addition to teaching you the content of single-variable calculus, our goals as a teaching team this semester are for you to:

- ♦ Improve your problem-solving skills and mathematical habits of mind. This includes developing:
 - the ability to *break a problem down into smaller problems*.
 - the ability to *see the underlying structure of a problem*.
 - the ability to *have flexibility in problem solving*. (How can I solve this most efficiently? What is the best tool to use?)
 - the ability to *make connections among different topics and strategies*.
 - the ability to *check your own work for consistency*.
- ♦ Be able to use mathematics as an aid to understanding the world. Be able to apply the skills, concepts, and problem solving strategies from this course to problems that you may encounter in the future.

Reading

We will continue to use materials from *Calculus: An integrated Approach to Functions and their Rates of Change*, by Robin Gottlieb.

This book is not sold at the COOP; you can find a free copy to download on our Canvas course site, or a hard copy for purchase on Amazon.

Readings from the textbook may be assigned as part of your problem sets. These readings will help you complete the homework problems. You should come to class prepared to discuss what you have read and with any questions you have.

Calculators

Calculators and computers can be quite useful as problem solving tools. They allow us to quickly do many things that previously would have been quite onerous. Feel free to use a calculator or computer to check or investigate problems for homework. However, *you should not rely on computers and calculators to the extent that you lose fluency with the material and do not develop your own computational skills*.

Calculators will not be allowed on any examinations. We will make sure that problems on the exams require minimal

- ✦ Become more skillful in communicating about mathematics through speech, writing, and graphics - explaining the "why" and "how" behind mathematical procedures, not just the "what".
- ✦ Learn metacognitive skills and study skills to stand you in good stead in your further studies.
- ✦ Develop fluency with ideas and skills from Math M that you can carry forward.
- ✦ Increase your confidence and independence as a learner of mathematics. Develop strategies for learning mathematics on your own and making best use of available resources.

All of these are skills which you can carry with you and adapt to your future activities, whether in sciences, social sciences, or other disciplines.

About the Course

Course Head: Matthew Cavallo SC 209.4 mcavallo@math.harvard.edu

Enrolling

If you decide to take Math Mb, here are things you need to do:

1. [Submit your section time preferences](#) (see info on the home page of the course website)
2. [Officially enroll in the course](#) through my.harvard by November 8th, 2023.

The link above to the sectioning form is also posted on the Math Mb Canvas page. If you have trouble sectioning, please contact Matthew Cavallo by email.

Class Logistics

Like Math Ma, Math Mb is taught in small classes in order to promote active engagement with the material. This format will give you lots of opportunities to interact with your Teaching Fellow and classmates, engage in mathematical dialogue and both ask and answer questions. **Take advantage of the small section size by being an active participant.** All of us on the teaching team are eager to work you!

Sections meet three times per week: Monday/Wednesday/Friday at 9am, 10:30am, 12pm, 1:30pm or 3pm

Engagement in Section

Fully engaging and participating in section is a necessary component of success in Math Mb. During section, you are expected to engage:

- ✦ With the material.
- ✦ With your peers - by listening to and supporting the understanding of your entire group.

- ♦ In supporting one another as a learning community.

Working with others is a great and often essential way to learn new material and solve difficult problems. Everyone is fully capable of mastery, and it is each of our responsibility to ensure that every section is a welcoming, inclusive, and productive learning environment for all.

Homework

The only way to learn math is by doing math, so homework is an essential part of Math Mb. Mathematics is an active, creative, and sense-making activity. It is virtually impossible to learn the material and to do well in the course without working through the homework problems thoughtfully. Don't just crank through computations and write down answers; think about the problems posed, the strategies you employ, the meaning of the computations you perform, and the answers you get. It is often in this reflection that the greatest learning takes place. One of the major goals of college-level mathematics education is to move students from computational processes to conceptual thinking. Your instructor will prepare you to do the homework but will not show you how to do your homework. Learning occurs when you can move yourself into unknown territory. Therefore, you should expect homework problems to look different from the problems discussed in class. This is intentional; the only way to develop a deep and flexible understanding of the material is to constantly practice applying it in different contexts. Homework also gives you a chance to practice communicating your reasoning, a skill that faculty in other departments have told us they value highly. When writing up your work, we expect you to explain your thought process; your final answer is less important than the reasoning you used to reach it. As a rule of thumb, if you're not using any words when writing up the problems, you probably aren't giving enough explanation. It may help to imagine that you're writing to a fellow student to explain how to solve the problem; this will help you include the right level of detail.

Generally, three problem sets will be given per week to be submitted on Gradescope (there is no Edfinity this semester). This means that you will have homework due every day of class. All due dates should be clear from the course Canvas site and Gradescope. Homework is expected to be submitted on time. The lowest 3 PSET scores will be dropped.

Late Days for the Written Portion

We understand that occasionally things may come up that prevent you from giving full attention to homework. Therefore, we'll give you 3 "late days" for the semester. In addition, we'll drop your three lowest problem set score when computing your homework average. Each late day extends the due date of an assignment by 24 hours. You may use at most two late days on a single assignment; to be fair to your CA, who is grading your written work, and to enable us to post solutions to the course Canvas site, no work will be accepted more than 48 hours after the deadline. You don't need to let us know when you use a late day; simply submit the assignment as usual. If you use more than 3 late days during the semester, you'll receive a deduction of 20 percentage points on the assignment for each extra late day you use. (This deduction won't show up in Gradescope; we'll apply it when we calculate your grade at the end of the semester.) Late days are meant to give you some flexibility. For example, if you forget to upload your homework or you're very busy with other courses, use a late day. But if you're dealing with more

extenuating circumstances, please see the FAQ on the course Canvas site. Finally, we understand that technology issues do arise. So, if your written homework is submitted to Gradescope less than 15 minutes late, we won't count that as a late day; anything later than that automatically uses a late day.

Collaboration and Academic Integrity

We encourage you to collaborate with other students currently taking Math Ma; you're welcome to discuss, brainstorm, and work through problems together. However, you must write up your work independently and in your own words, and you should only submit work that you feel comfortable explaining to another student or to a TF. Writing up homework independently gives you a chance to probe your own understanding of the strategies used. If you receive help from any source other than the course TFs and CAs, you must acknowledge that help; your homework score will not be affected by this. Of course, it is always unacceptable to copy a solution from any source.

Generative artificial intelligence (GenAI) tools such as ChatGPT can be a useful tool for developing your understanding of a concept, but you should not ask such tools to solve your homework problems.

Here are some examples of acceptable and unacceptable things to ask a source (whether that's a GenAI tool, person, website, etc.):

Examples of acceptable questions:

- What's the definition of the definite integral?
- How do you approximate an area by slicing?
- How do I visualize a related rates problem?

Examples of unacceptable uses of support:

- Asking a person, GenAI tool, or other source to solve a specific homework problem for you.
- Asking another student to show you their homework
- Copying a solution from any source

Finally, you may not share any course materials (worksheets, homework, and so on) with anyone not enrolled in Math Mb, with the exception of a peer tutor.

Workshops

You will participate in a 75 minute workshop on Tuesdays each week. Workshops will be an integral part of the course; attendance is required. Each workshop is built around a set of problems designed to help you reinforce and expand your understanding of course material, as well as to:

- ♦ Build fluency and flexibility.
- ♦ Build your confidence in your ability to explore and solve more complicated problems.

- ♦ Build your communication and collaboration skills as you work with other students without relying on the authority of an instructor or a solution key.
- ♦ On some weeks, lead you to make conjectures and discoveries that you will bring to class the next day.

These workshops are a required component of the course and active participation is worth **5% of your final grade** in Math Mb.

About our Support System

We want you to feel supported in your work in this course. Problem solving is often challenging; that is its nature. You are not expected to be able to whiz through all of the problems you are given. Be patient with yourself. Give yourself enough time to play with the problems before you have worked out a solution and also to reflect upon them afterwards. Talk with your classmates; you will find that you yourselves are excellent, and often underused, resources.

Other help is also available without appointment:

Office Hours

Office hours are a great place to start with any questions you have. Each section leader will have two office hours each week. You don't need to make an appointment; just stop by! You are encouraged to attend the office hours of any Math Mb TF - see the Canvas site for times and locations. Most office hours will be held in SC 229.

The Math Question Center

The MQC is a place for you to drop by to work on homework or study with other Math Mb students. The MQC is held in Science Center 229, 7:30-10:30pm, from Sunday to Thursday each week. Between 7:30-10:30pm, the MQC is staffed with Math Mb Course Assistants who can answer questions and provide guidance.

Study Groups

In addition to these formal resources, you are encouraged to form study groups with your classmates. This is a wonderful way to learn the material, and it can make studying more fun. Discussion helps solidify the ideas as well as increasing fluency in the language of mathematics. Even if you think you already know the material, you can always understand a concept in a deeper way by explaining it to others.

Coaching

The Coaching Program is a support resource for introductory math courses. Some members of the Math Mb teaching team will work with students throughout the semester in small group coaching sessions to build strong foundations. For example, early in the semester we have a skills check on material from Math Ma and the Chain Rule. We will use the results from this assessment to invite students to the Coaching Program, which will be a consistent source of support in the form of small group sessions (up

to 4 students) to shore up skills on your road to mastery. All students who struggle on a Skills Check will be offered an opportunity to revisit the material on a similar assessment to increase their score.

The Algebra Study Group from Math Ma will continue with new opportunities to join if this is an area that you feel could use some strengthening.

Our goal is to support you leaving the course with a solid, strong, and portable mathematical foundation.

Assessments

There are three distinct types of assessments (and a total of six) during the course of the semester. We will have three Skills Checks, two midterm exams, and one final exam. Problems on the skills checks will be distinct from problems on the midterms and final. Skills checks will focus more on fundamental mechanics and fluency and will have similar types of problems to the Skills Checks conducted on Edfinity in Math Ma, whereas the midterms and final will assess the ability to synthesize and apply content across multiple lessons and units. Please read below for the dates of each exam as well as a description of their goals, structure, and content.

Skill Checks: Building fluency in a particular skill set

We will use the Math Ma+Chain Rule, Trigonometry, and Integration and Skills Checks to assess specific skill sets critical to succeeding in this course and beyond. Similar to Skills Checks in Math Ma, only your final answers will be graded, not your work, so if you earn 85% or more on a skills check, we will record your grade as 100%; if you score less than 85%, we will record your grade as a percentage of 85% (for instance, we'll record an 80% as $80/85 \approx 94\%$).

Students who score below a certain percentage on these assessments will be connected to support resources. After each skills check, you will have the opportunity to take a second skills check (a "skills recheck") on the same material, and we'll keep the higher of your two scores.

- **Math Ma + Chain Rule Skills Check: Thursday February 1st, 5:30-6:30pm in SC Hall C and Hall E**

This Skills Check covers material from Math Ma, as well as Chain Rule, which will be taught at the start of Math Mb.

- *Revisit (if necessary): Thursday, February 15th, 5:30-6:30pm in SC Hall C and Hall E*

- **Trigonometry Skills Check: Tuesday March 5th, 5:30-6:30pm in SC Hall C and Hall E**

We will cover trigonometric functions and their derivatives in class, as preparation for this skills check.

- *Revisit (if necessary): Thursday, March 28th, 5:30-6:30pm in SC Hall C and Hall E*

- **Integration Skills Check: Thursday April 18th, 5:30-6:30pm in SC Hall C and Hall E**

We will cover antiderivatives and the definite integral in class, as preparation for this skills check.

- *Revisit (if necessary): Thursday April 25th, 5:30-6:30pm in SC Hall C and Hall E*

Major Exams: Evaluating your progress on course objectives

This course will have two midterm exams and a final exam. Recall that one of our course goals is for you to leave Math Mb with a solid, flexible, and portable foundation in calculus. Research shows that in order to get material to stick, it is necessary to have practice retrieving it over time. The act of studying for an exam, when done well, is a learning experience. We want to prepare you to learn to study for understanding and retention. There is a quite a bit of research about effective and ineffective ways of studying (see the page on [learning strategies](#) on the Canvas site), many of which are not intuitively obvious.

Throughout this semester, we will be providing several resources to help prepare you for cumulative assessments. These will include study tips and strategies, review sessions, and multiple practice assessments for each exam. However, we want this preparation to lead to both fluency and flexibility of knowledge, as this flexibility will lead to being able to apply concepts in different courses and situations. Therefore, there will be variety between the individual practice exams and the final assessment.

Midterm Exam 1: Thursday February 29th, 5:30-7:30pm in SC Hall C and Hall E

Midterm Exam 2: Thursday April 4th, 5:30-7:30pm in SC Hall C and Hall E

Final Exam: Date, time and location TBA (date, time and location finalized by the Registrar's office)

Accommodations

Exam Conflicts

Please keep exam dates clear of conflict. If you have a planned conflict with an exam or Skills Checks, **you will be required to fill out a form on the course website at least a week in advance**. Once this form is filled out, a member of the teaching team will reach out to schedule an alternative testing time. We schedule these alternate exams for University sponsored classes, games, and performances, but not rehearsals or practices. **We do not give late exams**, so any exam taken out of sequence must be taken before the date and time listed above.

If there is a documented serious illness or personal circumstance (such as a death in the family) which prevents you from taking an exam at the scheduled time, please contact Matthew Cavallo (mcavallo@math.harvard.edu). In those cases, please supply appropriate documentation, i.e. a note from a doctor (if for medical reasons) or Resident Dean (if for personal reasons).

Absences and Harvard-sponsored Activities

If you miss a class or workshop, you are still responsible for all of the material covered, as well as for turning in any associated homework. If you are involved in a Harvard-sponsored activity that will result in you missing multiple classes (e.g. varsity sport), have your supervisor or coach contact the course head Matthew Cavallo (mcavallo@math.harvard.edu) as soon as possible.

If you cannot complete or turn in a problem set due to illness, let your Teaching Fellow know as soon as possible. Appropriate documentation, i.e. a note from a doctor or University Health Services (if for medical reasons) or Resident Dean (if for personal reasons) should be provided.

Disabilities Requiring Accommodation

If you require accommodations or assistance for a documented disability, please contact the course head Matthew Cavallo (mcavallo@math.harvard.edu) as soon as possible so we can make whatever arrangements are needed.

Course Grade

Your participation in each class and workshop will be graded on this scale:

| | |
|-------------|--|
| Full credit | You arrive on time and prepared, and you stay on task and engaged in class activities for the entire class period. |
| Half credit | You are on task and engaged for most but not all of the class (for example, because you arrive late, leave early, or aren't focused on class material for part of the time). |
| No credit | You are on task and engaged for less than half of the class period. |

| Component | Scheme 1 | Scheme 2 | Scheme 3 | Scheme 4 |
|---------------------|-------------|-------------|-------------|-------------|
| Class Participation | 10% | 10% | 10% | 10% |
| PSETs | 20% | 10% | 15% | 15% |
| Skills Checks (3) | 15% | 15% | 15% | 15% |
| Workshop Attendance | 5% | 5% | 5% | 5% |
| Midterm 1 | 15% | 15% | 20% | 10% |
| Midterm 2 | 15% | 15% | 10% | 20% |
| Final Exam | 20% | 30% | 25% | 25% |
| Total | 100% | 100% | 100% | 100% |

| You will guarantee yourself a grade of at least... | ...by earning a numerical score of at least... |
|--|--|
| A | 93 |
| A- | 90 |
| B+ | 87 |
| B | 83 |
| B- | 80 |
| C+ | 77 |
| C | 73 |
| C- | 70 |
| D- | 60 |

We will excuse one workshop absence and two class absences for the semester. If you need to miss class or workshop because of a Harvard-sponsored event like athletic travel, a serious illness, or an extenuating circumstance, we can excuse additional absences; please see the FAQ on the course Canvas site.

Your course grade (out of 100 points) is determined by one of the four breakdowns shown below. We will use the following table to convert your numerical score to a letter grade, with the caveat that you must score over 50% on the final exam to guarantee yourself a C- or above. We will automatically choose whichever scheme is to your benefit. After each person's numerical grade is computed in the manner that most favorably represents their performance, the raw numeric score will be converted to a letter grade according to the scheme below.

Important Dates

- January 22nd: First Class, in section
- February 1st: Math Ma+Chain Rule Skills Check, 5:30-6:30pm in SC Hall C and Hall E
 - Revisit (if necessary): February 15th, 5:30-6:30pm in SC Hall C and Hall E
- February 29th: Midterm Exam 1, 5:30-7:30pm in SC Hall C and Hall E
- March 5th: Trigonometry Skills Check, 5:30-6:30pm in SC Hall C and Hall E
 - Revisit (if necessary): March 28th: 5:30-6:30pm in SC Hall C and Hall E
- April 4th: Midterm Exam 2, 5:30-7:30pm in SC Hall C and Hall E
- April 18th: Integration Skills Check, 5:30-6:30pm in SC Hall C and Hall E
 - Revisit (if necessary): April 25th, 5:30-6:30pm in SC Hall C and Hall E
- Final Exam Period: Final Exam, time and location TBA by the Office of the Registrar