# Math 112 — Fall, 2016

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Hours: TBA

**Textbook:** Stewart, *Single Variable Calculus*, Seventh Edition.

**Important Dates:**

| | |
|---|---|
| Thu 15 Sep | Test 1, 7:45–9:30 a.m. |
| Thu 29 Sep | Basic Skills Test, 8:00–9:30 a.m. |
| Thu 6 Oct | Test 2, 7:45–9:30 a.m. |
| Thu 27 Oct | Test 3, 7:45–9:30 a.m. |
| Thu 1 Dec | Test 4, 7:45–9:30 a.m. |

**Course Content:** Mathematics 112 is the second semester of first-year calculus. The main topics are the analysis of exponential, logarithmic, and inverse trigonometric functions; methods of integration; indeterminate forms; improper integrals; polar coordinates; infinite sequences and series; power series; and differential equations.

**Course Goals:** Building upon Calculus I, students should know and/or demonstrate:

(1) A basic understanding of derivative, of anti-derivative, and of limit.
(2) Use the rules of differentiation as they apply to algebraic and transcendental functions.
(3) Evaluate a variety of limits and appropriately interpret findings.
(4) Sketch graphs of transcendental functions by building on concepts from Calculus I.
(5) All variations for the $u$-substitution method of integration, definite and indefinite integrals.

Additional goals for Calculus II, students should know and demonstrate:

(6) New methods of integration (parts, trigonometric substitution, partial fractions) for typical indefinite, definite, and improper integrals.
(7) Be able to graph and to find area using simple polar coordinate expressions.
(8) Determine convergence of appropriate infinite series by giving logical arguments.
(9) A basic understanding of power series and be able to determine the domain of appropriate power series.
(10) Be able to derive a power series expression for specified transcendental expressions using a geometric series or Taylor's Theorem.
(11) Be able to solve simple first-order differential equations (separable, exact, linear).

**Grading:** Grading will be based on the following written work:

| | |
|---|---|
| Tests (4 @ 100 pts) | 400 points |
| Quizzes | 200 points |
| Final | 200 points |
| Total | 800 points |

The plus/minus system will be used. A rough guide to grades: A: $\geq$ 700 pts. B: 600–700 pts. C: 500–600 pts. D: 400–500 pts. F: $<$ 400 pts.

**Classes:** The student is responsible for what is covered and what is announced in class. To prepare for class you should learn the definitions and study the formulas, theorems and examples If possible, attempt two or three homework problems of different types. Write down any questions to ask in class at the appropriate time. See the Schedule of Classes below for the homework exercises, and the important definitions, theorems and examples to know.

In addition to the regular class meetings, there will be optional SI sessions and help sessions. There will also be several tests scheduled on Tuesday or Thursday mornings. (See proposed calendar below).

**Tests:** There are four tests. Calculators will not be allowed on tests.

You are expected to take tests at the scheduled times. Any conflicts or problems will be handled on an individual basis. If you have an excuse deemed legitimate by your instructor, arrangements will be made for you to take a test **prior to** the testing time.

**Basic Skills Tests:** There will be a basic skills test for students who need a little extra encouragement to master the technical skills needed to apply calculus to solving problems.

**Quizzes:** Quizzes may be announced and are usually in-class. Calculators are not allowed on quizzes. The student must be present in class to take each quiz. If a quiz is to be done out of class, special instructions may apply. Up to one quarter of the quizzes will be dropped. Each quiz will count the same amount, the average per cent being used to calculate the number of points. For example, a 94% quiz average at the end of the course would result in $2 \times 94 = 188$ points out of the 200. Normally an excused absence during which a student misses a quiz may not be made up; it will be dropped.

**Homework:** Exercises in the handouts should be completed and studied as we cover them in class. Other assignments may be given as well. Homework usually will not be collected but are for your benefit. It is important that you complete assignments as they are assigned and that you not wait until a few days prior to a test to do homework. Collaboration is encouraged as discussion of the concepts often leads to their clarification. **However be sure that you can solve problems unaided.** Use good style on your homework. In general you need to spend at least 6-8 good hours per week on study not counting the time spent taking quizzes and reviewing for tests.

**Excuses:** Excuses deemed legitimate by the instructor will be handled according to the individual circumstances and college policies.

The student is expected to take all tests and exams at the scheduled times. For legitimate excuses arrangements will be made to take a test **prior to** the testing time. Any student who needs special accommodations must provide documentation of the needed accommodation and make appropriate arrangements with the instructor several days in advance. There will be no make-up tests given after the testing time.

**Written style:** Thoughts are expressed by sentences: just so in mathematics. Pay attention to your textbook: it is written in sentences. **Your written work must be in complete sentences.** Note "$1 + 1 = 2$" is a complete sentence (it has a subject "$1 + 1$", verb "$=$" and predicate "2"). Use mathematical symbols wherever appropriate. Your work also needs to be neat and orderly to be intelligible. See the essay, "Clean Writing in Mathematics," from *Calculus: A Liberal Art*, by W.M. Priestley and the "Calculus Style Guide." Practice good style in all your work, including uncollected homework.

**Support:** Students should use **office hours** to come by and ask specific questions related to this course. There is a study area outside Pierce 122, the "Math Center," for you to use.

The course website may be found on Blackboard (https://classes.emory.edu). It will contain important handouts, announcement, etc. Students are expected to check in regularly.

**Email** is an official means of communication at Emory. Students are expected to so organize their life so that they receive and read Emory email daily. Occasionally the instructor needs to tell an individual student or the class something important via email.

The **SI program** is a program of optional, organized study sessions. The sessions are not meant to be tutoring sessions. The SI leader is Alina Ulezko, a student who has taken the course before, has a good understanding of the material (but probably not as complete as the instructor!), and knows how to be a successful student.

**Help sessions** will be scheduled as there is demand for them. Attendance is optional.

**Tutoring** takes place in the The Math Center (http://mathcenter.oxford.emory.edu).

**Study groups** organized by students are highly recommended. For these to be profitable, the meetings should be scheduled weekly and should be part of a regular weekly routine.

**All Questions Answered:** Knuth: In every class that I taught at Stanford, the last day was devoted to "all questions answered." The students didn't have to come to class if they didn't want to, but if they did, they could ask any question on any subject except religion or politics or the final exam. I got the idea from Richard Feynman, who did the same thing in his classes at Caltech, and it was always interesting to see what the students really wanted to know. [Donald Knuth, "All Questions Answered," *Notices of the AMS,* **49**(3), March 2002, p. 318]

**Honor Code:** The Honor Code of Oxford College applies to all work submitted for credit in this course. By submitting such work, you pledge that the work has been done in accordance with the given instructions and that you have not condoned any Honor Code violations in the conduct of the assignment.

You may always ask your instructor any question about an assignment. He will answer at his discretion.

**Test preparation:**

Here are some criteria for "studying hard" and "being prepared" for a test:

- **Be present.** One can hardly claim to be prepared to take a test if one does not show up.
- **Be well rested.** A tired brain is not reliable, especially if a test demands *thinking.* Studying all night is not preparing for the test. *Plan* to be prepared.
- **No questions when the test starts.** You know you are ready when you are comfortable bringing only your pencils to the test.
- **Be ready to take the test the day before it's given.** That is, the night before is literally review and running through the material, just to hone your memory and confirm your understanding of the material.

Accomplishing these things is not easy. The trick is to not get behind and keep working at it. Tests are performances, similar to those by athletes, musicians, and dancers. Prepare for them in similar ways. Begin practicing for them weeks in advance.

When you are ready for and receptive to advice, your instructor, your adviser, and the counseling center are willing to help you.

**Practice and insight:** Richard Hamming said the purpose of calculation is insight. Insight is an understanding into why things work the way they do. This should be the goal of working out problems. Know **why** each step is correct and **why** each step was the right step to take. This is more than knowing **that** each step is correct. This is like the three *wheres* of grammar: *whence,* where you came from; *where,* where you are; and *whither,* where you're going. You need to achieve the intended insight from doing your homework and other studying.

**Hard work and the difficulty of the calculus:** In general the student will need to study six to ten good hours per week exclusive of the time spent on review for tests.

"Difficult" is rarely an appropriate description of a textbook problem. Either you can solve the problem or you cannot solve it. When you can solve it, it is not difficult but "easy." When you cannot solve it, it is also not difficult but "impossible." What is difficult is **learning — learning how to solve** the problem, learning **how to figure out how to solve** the problem, learning **how to learn**. These are increasingly higher levels of learning. Learning calculus is hard. It is certainly "difficult." It takes work: reading, asking the right questions, and, most of all, solving problems. It is difficult to learn everything you need to learn so that all the problems become easy. But every year many people do it, and SO CAN YOU!!!

**Mathematical knowledge:** A few remarks about the proper attitude the mind should have toward the course content might help the student to study better. The basic elements of mathematics are the axioms, definitions and theorems (including all propositions and formulas). The basic method of learning, aside from studying these elements, is **to solve problems**.

- Axioms: These with the definitions "create" the subject. Calculus is based on many years of algebra and analysis developed in school. By now, the axioms are so familiar and long used that they have been forgotten or perhaps even hidden. Roughly they are those of the real number system as a continuum and those of analytic geometry.
- Definitions: Each creates an idea. They are exact and slight changes can have disastrous consequences. To know a definition is more than an exact memory of its statement.
  - Know the statement.
  - Know examples:
    - ⋆ The basic examples illustrating the definitions.
    - ⋆ For each condition in the definition, an example that does not satisfy that condition while satisfying any other conditions.
- Theorems: These show how the ideas relate. Again, to know a theorem is more than an exact memory of its statement. Most theorems consist of a hypothesis or hypotheses and a conclusion.
  - Know the statement.
  - Know examples:
    - ⋆ An example illustrating each of three possibilities for the hypothesis and conclusion:

| | Hypothesis | Conclusion |
|---|---|---|
| 1 | True | True |
| 2 | False | True |
| 3 | False | False |

    - ⋆ If the hypothesis is composed of multiple conditions, an example for each condition showing why it is necessary.
  - Know the proof (except when not required). Even when the proof is not required, the student should have in mind some idea of why the theorem is true; for without an account of why something is true, there is not really an understanding.
- Problems: Examples, either ones presented or ones solved, are the primary resource of the student. What does it mean to understand a solution to a problem? A solution is a sequence of steps that begin with what is given in the statement of the problem and leads logically to what was to be found or shown. There are three things to be known about these steps:
  - To know the correct steps.
  - To know why each step is valid (its justification, where it comes from).
  - To know why each step was taken (its purpose, what it leads to). These are the three aspects of understanding a solution. They involve relating the mathematical elements above. Moreover, finding a solution involves another important mathematical skill, guessing.
- Guessing: Skill in guessing and other forms of inductive reasoning consitute an important part of mathematical knowledge. Guesses come from analogy with similar problems, patterns in examples calculated, and recognizing alternatives. For further hints and practical advice about "heuristic," the art of discovery, see G. Polya, *How to Solve It*, Princeton (2004). These remarks are meant to give a hint to the student about how to learn mathematics. The important roles of examples should be evident. The most important examples will be the problems the student has figured out for herself or himself.

| Date | Topic | Section |
|---|---|---|
| Wed 24 Aug | Mathematics | |
| Thu 25 Aug | Limits and derivatives | §2.1f |
| Fri 26 Aug | Limits and integration | §5.2 |
| Mon 29 Aug | Derivatives | §3.1f |
| Wed 31 Aug | Applications of derivatives | §§3.9/10, 4.1 |
| Thu 1 Sep | Limits — Growth and vanishing | |
| Fri 2 Sep | L'Hôpital's Rule | §4.4 |
| Mon 5 Sep | *Labor Day* | *No class* |
| Wed 7 Sep | Graphing logarithmic and exponential functions | §4.5 |
| Thu 8 Sep | Graphing logarithmic and exponential functions | |
| Fri 9 Sep | Antidifferentiation | §4.9 |
| Mon 12 Sep | Definite Integrals | §5.5 |
| Wed 14 Sep | Review | |
| Thu 15 Sep | **Test 1 — 7:45–9:30 a.m.** | *No class* |
| Fri 16 Sep | Integration by parts | §7.1 |
| Mon 19 Sep | Trigonometric integrals | §7.2 |
| Wed 21 Sep | Trigonometric substitution | §7.3 |
| Thu 22 Sep | Partial fractions | §7.4 |
| Fri 23 Sep | Partial fractions | §7.4 |
| Mon 26 Sep | Limits — Review of all types | |
| Wed 28 Sep | Improper integrals | §7.8 |
| Thu 29 Sep | Arc length and surface area | §8.1/2 |
| Fri 30 Sep | Integral review | |
| Mon 3 Oct | Infinite sequences | §11.1 |
| Wed 5 Oct | Review | |
| Thu 6 Oct | **Test 2 — 7:45–9:30 a.m.** | *No class* |
| Fri 7 Oct | Infinite sequences | §11.1 |
| Mon 10 Oct | *Fall Break* | *No class* |
| Wed 12 Oct | Infinite series | §11.2 |
| Thu 13 Oct | Infinite series | §11.2 |
| Fri 14 Oct | The n-th term test | §11.3 |
| Mon 17 Oct | Integral test, p-series | §11.3 |
| Wed 19 Oct | Comparison tests | §11.4 |
| Thu 20 Oct | Comparison tests | §11.4 |
| Fri 21 Oct | Alternating series | §11.5 |
| Mon 24 Oct | Ratio and root tests | §11.6 |
| Wed 26 Oct | Review | |
| Thu 27 Oct | **Test 3 — 7:45–9:30 a.m.** | *No class* |
| Fri 28 Oct | Review of infinite series | §11.7 |
| Mon 31 Oct | Review of infinite series | §11.7 |

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|---|---|---|
| Wed 2 Nov | Power series | §11.8 |
| Thu 3 Nov | Power series | §11.8 |
| Fri 4 Nov | More power series | §11.9 |
| Mon 7 Nov | More power series | §11.9 |
| Wed 9 Nov | Taylor and Maclaurin series | §11.10 |
| Thu 10 Nov | Taylor and Maclaurin series | §11.11 |
| Fri 11 Nov | Review of power series | |
| Mon 14 Nov | Review of power series | |
| Wed 16 Nov | Polar coordinates | §10.3 |
| Thu 17 Nov | Polar coordinates | §10.3 |
| Fri 18 Nov | Differential equations | §9.3 |
| Mon 21 Nov | Differential equations | §9.5 |
| Wed 23 Nov | *Thanksgiving break* | *No class* |
| Thu 24 Nov | *Thanksgiving break* | *No class* |
| Fri 25 Nov | *Thanksgiving break* | *No class* |
| Mon 28 Nov | Review | |
| Wed 30 Nov | Review | |
| Thu 1 Dec | **Test 4 — 7:45–9:30 a.m.** | *No class* |
| Fri 2 Dec | Review for the final exam | |
| Mon 5 Dec | All Questions Answered | Syllabus |