Mathematics 111
Spring, 2017

Instructors: Drs. Jonathan Hulgan and Michael Rogers
Office: The Mathematical Park at Oxford College
Text: James Stewart, *Single Variable Calculus*, Seventh Edition
Canvas: canvas.emory.edu
Hours: TBA

Important Dates:

Thu 9 Feb	Test 1	at 7:45 a.m. - 9:30 a.m.
Thu 23 Feb	Gateway Test 1	at 8:15 a.m. - 9:30 a.m.
Thu 2 Mar	Test 2	at 7:45 a.m. - 9:30 a.m.
Thu 16 Mar	Gateway Test 2	at 8:15 a.m. - 9:30 a.m.
Thu 30 Mar	Test 3	at 7:45 a.m. - 9:30 a.m.
Thu 13 Apr	Gateway Test 3	at 8:15 a.m. - 9:30 a.m.
Thu 20 Apr	Test 4	at 7:45 a.m. - 9:30 a.m.

Course content: Mathematics 111 is the first semester of single-variable calculus. The main topics are the limits, differentiation, and integration of functions and the applications of these processes; they include the analysis of algebraic and elementary transcendental functions. A calendar of topics is attached to this syllabus.

Course goals: By the completion of this course, the student should be able to:

(1) Evaluate limits and interpret the results in relation to the graph of a function.
(2) Define the derivative and relate this definition to the graph of a function and to the concept of "rate of change."
(3) Give proofs of some of the basic theorems, those that require only elementary algebra, geometry, and induction.
(4) Differentiate algebraic, trigonometric, logarithmic and exponential functions.
(5) Apply the derivative to the graphs of functions, to optimization situations and to related rate problems.
(6) Define the definite integral and its relationship to area and to volume.
(7) Evaluate definite and indefinite integrals using algebraic techniques and the method of substitution.
(8) Write mathematics clearly and cogently.

In general, each student should be able to calculate derivatives, to evaluate limits and to evaluate integrals (both definite and indefinite). Students should be able to apply appropriately their calculations and evaluations. In addition, students should understand the concepts of limit, continuity, derivative, anti-derivative, and have a beginning understanding of proof. The primary purpose of this course is to provide a solid foundation for success in Mathematics 112.

Prerequisites: Mathematics 111 is a beginning course. No prior exposure to calculus is needed! A good, solid background in algebra, logarithms and exponents, and trigonometry and the skill in applying them to analyze and solve problems are extremely important.

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 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 Thursday mornings. (See proposed calendar below).

Homework: Homework is assigned almost every day of class. These exercises usually will not be collected but are for the benefit of the student. Solving problems and practicing their solution is only good way to learn mathematics. Students may ask questions about the homework, and quizzes based on the homework may be given. The instructor may ask to see a student's homework.

Although the homework exercises are not graded, it is important for the success of the student that they be completed as soon after covering the material as possible. Calculators ought to be used when appropriate, but the student should keep in mind that they are not permitted on the tests. Collaboration is encouraged, but each student should be sure that he or she ultimately can **solve problems unaided by notes, the textbook, a calculator, or other people**.

Quizzes: (200 points.) 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.

Gateway exams: (50 points.) In order to pass this course the student must pass an examination on derivatives at a rate of 100%. Each re-test will be different but very similar to the original test. The exam must be passed by the last day of classes. The student will be allowed three opportunities to pass it.

Tests: (400 points.) There are four tests. Calculators will not be allowed on tests.

Final examination: (250 points.) A cumulative final examination will be given at the time scheduled by the Registrar.

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

Tests (4 @ 100 pts)	400 points
Quizzes	200 points
Gateway Exam	50 points
Final	250 points
Total	900 points

Rough cutoffs for letter grades: $900 \geq A \geq 810 > B \geq 720 > C \geq 630 > D \geq 540 > F$. The plus and minus may be applied to letter grades near the cutoffs.

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 several days in advance of the needed accommodation so that appropriate arrangements may be made. 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 **Canvas** site that will contain important supplementary 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 that they receive and read Emory email daily. Occasionally the instructor needs to tell an individual student or the class something via email.

The **SI program** is a program of optional, organized study sessions. The sessions are not meant to be tutoring sessions. The supplemental instructor (SI) is a student who has taken the course (or a similar 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.

The schedule for **tutoring** in the Math Center will be announced when available. See

http://www.oxfordmathcenter.com

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.

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, perhaps in order of importance.

- **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 all 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 begins with educing 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 constitute 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.

SCHEDULE OF CLASSES

Date	Section	Definitions	Theorems ⋆ = know proof	Examples
Wed 11 Jan	**Precalculus**			
	NTF	Even/odd symmetry, increasing, decreasing		
			Transformations of functions (shifts, stretching and reflecting); factoring difference of powers; Binomial Theorem.	
				Functions: linear, quadratic, polynomial, rational, square root, algebraic, transcendental; sine, cosine, tangent, cotangent, secant, cosecant; exponential, logarithmic; arc sine, arc cosine, arc tangent, arc cotangent, arc secant, arc cosecant; absolute value; power, 1/x, x^(1/3), x^(2/3); piecewise–defined functions. These and their combinations form the material of the subject.
Fri 13 Jan	**Induction**			
	Prob. Solving	Induction		
Mon 16 Jan	***Martin Luther King, Jr. Holiday* (*no class*)**			
Wed 18 Jan	**Tangent line, velocity and other rates**			
	Preview (pp. 2f), 2.1	Instantaneous velocity		
				Tangent problem, velocity problem, area problem
Fri 20 Jan	**Limits – definitions**			
	2.2	Approaches, one–sided and two–sided		
			One and two sided limits [3]	
Mon 23 Jan	**Squeeze theorem**			
	2.3		Limit Laws, equal functions => equal limits, limit comparison, The Squeeze Theorem.	
				Limits of these functions at the boundaries of their domains: x/|x|; 1/x, 1/x^2, etc.; sin(x), sin(x)/x, sin(1/x), x sin(1/x); x/(x^2+1)^(1/2); [sqrt(x)−1]/[x−1]; tan(x), etc.
Wed 25 Jan	**Limits and composition**			
	2.5			
Fri 27 Jan	**Comparison of functions (order of growth and vanishing)**			
	2.6	Limit at infinity (pos./neg.), horizontal asymptote.		
Mon 30 Jan	**Continuity**			
	2.5	Continuous at a (in terms of three conditions), cont. from the left/right, cont. on an interval, removable discontinuity.		
			Continuity of elementary functions, limit of a composition, continuity of a composition. Diff. implies cont.⋆	
				Application of continuity to limit examples above; complete suites of examples for theorems.
Wed 01 Feb	**IVT – Bisection, secant methods**			
	2.5		The Intermediate Value Theorem	
Fri 03 Feb	**The derivative**			
	2.7, 2.8	Tangent line, (instantaneous) rate of change, derivative. Differentiable, second derivative etc.		
				Derivatives of |x|, x/|x|, x^(1/3), x^(2/3), x sin(1/x), x^2 sin(1/x), x^n, 1/x^n
Mon 06 Feb	**Differentials, Vanishing, Newton's method**			
		Differential		
Wed 08 Feb	**Review**			
Thu 09 Feb	**Test 1 at 7:45 a.m. – 9:30 a.m.**			
Fri 10 Feb	**Derivatives – general formulas and rules**			
	3.1, 3.2		Derivative rules (constant function, power, const. multiple, sum, difference, product, quotient)⋆.	
Mon 13 Feb	**Derivative rules – trigonmetric functions**			
	3.3		Limits of sin(t)/t⋆, (cos(t)−1)/t⋆ at 0; derivatives of sine and cosine; derivatives of tan(x), cot(x), sec(x), csc(x).	
Wed 15 Feb	**Derivative rules – chain rule**			
	3.4		Chain Rule⋆	
Fri 17 Feb	**Implicit differentiation**			
	3.5			
Mon 20 Feb	**Derivatives of elementary functions**			
	3.6			
Wed 22 Feb	**Rate problems**			
	3.9			
Thu 23 Feb	**Gateway Test 1 at 8:15 a.m. – 9:30 a.m.**			

Fri 24 Feb	**Approximation**	
	3.10	Tangent line approximation, linearization, differential.
Mon 27 Feb	**Extrema**	
	4.1	Absolute (global) maximum, absolute (global) minimum, critical number.
		Extreme Value Theorem, Fermat's Theorem⋆
		Max./min./crit. nos. over appropriate intervals of: x^2, x^3, |x|, x^(1/3), x^(2/3), 1/x, appropriate piecewise−defined functions.
Wed 01 Mar	**Review**	
Thu 02 Mar	**Test 2 at 7:45 a.m. – 9:30 a.m.**	
Fri 03 Mar	**MVT**	
	4.2	Rolle's Theorem⋆, Mean Value Theorem, f'=0 implies f const.⋆, f'=g' implies f = g+C [7]⋆.
Mon 06 Mar	***Spring Break*** **(*no class*)**	
Wed 08 Mar	***Spring Break*** **(*no class*)**	
Fri 10 Mar	***Spring Break*** **(*no class*)**	
Mon 13 Mar	**Monotonicity and concavity**	
	4.3	Concave up/down, inflection point.
		f'>0 implies f incr.⋆, f'<0 implies f decr.⋆, 1st Derivative Test, concavity test, 2nd Derivative Test.
Wed 15 Mar	**Graphing I**	
	4.5	
Thu 16 Mar	**Gateway Test 2 at 8:15 a.m. – 9:30 a.m.**	
Fri 17 Mar	**Graphing II**	
	4.5	
Mon 20 Mar	**Optimization Problems**	
	4.7	
Wed 22 Mar	**Antiderivatives and substitution**	
	4.9	Antiderivative.
Fri 24 Mar	**Differential equations**	
	9.3	Differential equation and solution, initial condition, initial−value problem, separable equation, orthogonal trajectory.
		Substitution.
Mon 27 Mar	**Summation and area**	
	5.1	Inscribed/circumscribed rectangles, upper/lower sums, partition.
Wed 29 Mar	**Review**	
Thu 30 Mar	**Test 3 at 7:45 a.m. – 9:30 a.m.**	
Fri 31 Mar	**Integration**	
	5.2	The definite integral, integrable. Riemann sum, integral sign, integrand, limits of integration.
		The integral as a limit of a sequence of Riemann sums, integrability, properties.
Mon 03 Apr	**FTC**	
	5.3	Fundamental Theorem(s) of Calculus, part 1⋆ and part 2⋆ [prove two ways].
Wed 05 Apr	**Substitution**	
	5.5	
Fri 07 Apr	**Net change**	
	5.4	Indefinite integral, net change.
Mon 10 Apr	**Area**	
	6.1	
Wed 12 Apr	**Volume**	
	6.2, 6.3	
Thu 13 Apr	**Gateway Test 3 at 8:15 a.m. – 9:30 a.m.**	
Fri 14 Apr	**Volume**	
	6.2, 6.3	
Mon 17 Apr	**Average value**	
	6.5	Average (mean) value of a function.
		Mean Value Theorem for Integrals⋆.

Wed 19 Apr	**Review**
Thu 20 Apr	**Test 4 at 7:45 a.m. – 9:30 a.m.**
Fri 21 Apr	**Review**
Mon 24 Apr	**Review**