Math S165: Analytic Geometry and Calculus I (Class No: 29281)

Meets: MWF 9:00–10:15a in SL 050
Final Exam: Wednesday, December 10, 8:00a – 10:00a

Instructor: Carl Cowen **Office:** LD 224P **Phone:** 278-8846
Office Hours: MWF 10:30 – 11:00a, MW 3:00 – 4:00p, or by appointment
E-mail: ccowen@iupui.edu
URL: http://www.math.iupui.edu/~ccowen/MathS165.html

General Information and Goals

Calculus is one of the outstanding intellectual achievements of the human mind, in addition to being the foundation of many applications of mathematics to physics, chemistry, biology, statistics, economics, and many other natural and social sciences. The roots of calculus go back to Eudoxus, Archimedes, and other Greek thinkers more than 2000 years ago, but the calculus as we know it began with the work of Isaac Newton, Gottfried Leibnitz, and other mathematicians of the 17th century with many improvements in understanding, development of applications, and refinements and extensions of the theory in the 18th and 19th century. Much more recently, beginning in the second half of the 20th century, machines have been developed that, with human guidance, can solve calculus problems. In this course, we will keep all of these threads in mind as we learn about calculus and try to connect it to areas that are of interest to each of you.

Math 165 here at IUPUI forms the mathematical foundation for many majors in Science and Engineering but is taken by many other students as well. The course is open to all students who have the appropriate mathematical background in algebra and trigonometry, equivalent to a grade of "C" or better in Math 159.

This course, Math S165, is a special 'Honors' version of Math 165 designed for students in the Honors Program or for students with a desire for a better understanding of the background for the material and a deeper understanding of why the mathematics presented in the course is correct. While this course is open to all students with the appropriate mathematical background in algebra and trigonometry, it will require more independence and is intended to build on and to develop stronger mathematical skills than the standard course in Math 165. If you have interest in the course but have questions or concerns about it, please contact the instructor by email or in person as soon as possible. This course meets at the same time as a section of Math 165, so students can easily more from one course to the other, but the text used in the two courses is different.

The text for Math S165 is

Text: *Calculus, Volume I*, 2nd edition(1967), by Tom M. Apostol (Wiley)

and we expect to cover, approximately, the Introduction and Chapters 1 – 5. This is comparable to the coverage of the usual Math 165, so after finishing this course, students will be able to continue in either Math S166 or Math 166 as they choose.

My goals for you in this course are

Short term goal: That you master the ideas and computations of the course, both theoretical and applied.

Short term goal: That you become proficient in the language of calculus, as it is used both formally and informally in theoretical discussions and in applications to problems from other disciplines.

Short term goal: That you develop your ability to read mathematics and learn from what you read.

Short term goal: That you develop your ability to write mathematics, and begin to develop your skill in creating and writing proofs, which are the explanations of why things in mathematics are true.

Long term goal: That you recognize the uses or ideas of calculus as you see them in your professional or your personal life and that you know or can quickly relearn the computations that are important to you throughout your life.

Long term goal: That you develop and sustain an excitement about mathematics and its connections to problems in the 'real world' generally, especially the mathematics you need in your professional and personal life, and that you can and do communicate that excitement to others.

Class Participation, Attendance, and Homework

Class participation will be an integral part of this course, indeed, class on Fridays will be devoted to presentations by students from the class (see description below). Of course, this means attendance is critical; we can say with a fair degree of certainty, that you will not do well in the course if you do not come to class regularly. Learning mathematics requires steady and persistent effort. Coming to class and making an effort to focus on the material being discussed is critical for success. The homework from the text is aimed at facilitating your practicing the concepts from the course.

It is important to develop your ability to read mathematics and other technical material. With some exceptions (see description of Friday activities below), it will be helpful to read material from the text both before and after coming to class. Reading before will prepare you for the discussion in class and reading after will help solidify your understanding. Reading mathematics books is a skill that will take time to master, but will pay off in your later study both in other math classes, but also in any classes that depend on reading detail. One of the biggest differences between reading mathematics and other kinds of reading is that to be successful in reading mathematics, you must read slowly and pay attention to the details you are reading. If you have trouble with material from the textbook, please ask me about it in class or in office hours. Occasionally, there will be homework problems based on material that we have not discussed in class, but that you will have been assigned to read.

Homework will be assigned regularly and will be collected sporadically with grading mostly to check the work you are doing. Make-up/late homework will **not** be graded for credit.

MAPLE is a 'computer algebra system' (well-known competitors are DERIVE and MATHEMATICA) that is available on many UITS machines on the IUPUI campus, including the lab on the second floor of LD. A computer algebra system is a computer program that recognizes algebraic and other mathematical symbols and can do computations with them in their *symbolic form!* At this time, there are also some hand-held devices that can do symbolic calculations, and there will certainly be many more to follow. These systems

contrast with numeric engines, such as MATLAB, also available on many UITS machines, which can only do numerical computations, giving answers as numbers, and accurate to a fixed accuracy. Depending on the time available, we may do some homework or examples using MAPLE or MATLAB. You may use electronic tools to help you in your homework and study, but pursuant to the Mathematics Department's policy, you will not be using these tools on tests.

The developing schedule for the course will be announced in class, but will also be on the website for the class (see the URL above), updated regularly.

Test, Exam, and Grading Policies

In addition to the Final Exam on December 10, there will be 3 tests during the semester, of which one, Test 3, will be a "mastery test" (see below). Each of Test 1 and Test 2 will contribute about 15% of the grade, Test 3 about 10-12% of the grade, the homework about 8-10% of the grade, the Final Exam about 25%, and class participation (mostly Fridays) will be responsible for the the remaining 25% of the grade.

Test 1 (early October), Test 2 (early November) and the Final Exam will be ordinary tests covering the theoretical and applied parts of the course material and with partial credit granted for answers that are mostly, but not completely correct.

Test 3, on computation of derivatives and integrals (Sections 1.23, 1.24, 1.25, 4.5, 4.10, and 5.7 of the text), covers the most basic and fundamental skills in calculus and will be a mastery test. By "mastery test" I mean that the test will cover material that must be mastered for success in the course and will be graded accordingly. For this test, no partial credit will be given – each answer is completely correct, or it will receive no credit. BUT, the test may be repeated at arranged times until 3pm on December 11 or until a score of more than 90 is achieved. The test will have 25 questions. A perfect score is 115 points, but for each incorrect answer, 8 points will be deducted. That is, on the first day the test is given, you will receive 115 points if you get all 25 questions correct, 107 points if you miss 1 question, 99 points if you miss 2 questions, 91 points if you get only 22 correct, and -37 points if you get only 6 correct. After the first day, 100 points will be the maximum score, given for no wrong or 1 wrong, and otherwise the scoring will be the same. I expect everyone will get more than 90 points on Test 3 after taking the test no more than three or four times because the test will contain no "hard" questions.

The Department of Mathematical Sciences enforces course-wide policies for the Final Exam in Math 165. These same policies will apply for all tests in this course. The most important of these policies is:

- No calculators, cell phones, pagers, ipods, or other electronic devices are permitted to be on during the tests.

General Academic Policies

The work you submit for homework, tests, and the final exam must be your own. For homework you will probably find it beneficial to consult with other students about the material and this kind of conversation and collaboration is encouraged. At the end of the consultation, however, each participant is expected to prepare their own summary of the discussion and their own solutions to the problems. The policies for this class will be those derived from IUPUI's policies on academic conduct and adaptive services. More information about student conduct can be found at `http://registrar.iupui.edu/misconduct.html` More information concerning adaptive services for learning or other disabilities at IUPUI can be found at `http://life.iupui.edu/aes/`

Some Important Dates

August 20	First day of classes
September 1	Labor Day, no classes
October 14	Last day to withdraw with automatic "W" (with permission of advisor)
November 11	Last day to withdraw (requires permission of advisor and instructor)
November 26	Thanksgiving Break!! no classes
December 8	Last day of classes
December 10	Final Exam, 8:00a–10:00a
December 11	Last day to take Test 3 (by 3:00p)

Friday Activities:
A Modified Moore Method Approach to Foundations of Calculus

R. L. (Robert Lee) Moore was a Texan, born in Dallas in 1882, died in Austin in 1974, and taught mathematics for nearly 70 years, most at the University of Texas. By nearly every standard, he was a very successful teacher and many of his students have emulated his style of teaching. This style has been named the "Moore Method". A well known mathematician and author, one of my mentors, Professor Paul Halmos wrote (1987):

> The Moore Method is, I am convinced, the right way to teach anything and everything – it produces students who can understand and use what they've learned. It does to be sure, instill the research attitude in the student – the attitude of questioning everything and wanting to learn answers actively – but that's a good thing in every human endeavor, not only in mathematical research.

It can be argued that no one besides R. L. Moore *really* taught by the Moore Method, but we will be further than many from the Moore Method because the assumptions on which the true Moore Method is based are less true in a calculus course in the 21^{st} century than they were true for Moore or his more faithful followers. Specifically, the Moore Method assumes ignorance of the course material on the part of the students at the beginning and nearly infinite patience in covering the course material. Students today have very often picked up many bits of calculus before taking a college calculus course and the assumption throughout the university, and even outside of our own community, is that a specific collection of material will be covered in the course, precluding nearly infinite patience.

Thus, our course will divided into two parts, the traditional material, covered in a relatively traditional way, on Mondays and Wednesdays and separate foundational material, that will be covered on Fridays, in a Moore Method kind of way. The three tests, the final exam, and the homework from the text will be primarily based on the traditional material and the assessment of this part of the course will comprise 75% of the course grade. The assessment of the Friday work, that is, the assessment of your participation in the Friday work, will constitute the remaining 25% of the grade.

The essence of the Moore Method is contained in the following six points:

1) Students start at the same level.

2) Students create the proofs and justifications on their own. Specifically, students do not discuss their attempts of finding a proof with each other prior to presentation and students avoid reading material in books or otherwise learning of the material prior to discovering their own proof or the presentation of a proof in class by a student.

3) Presentations by every student. The students in the class will be ordered alphabetically by first name, with last names used to break ties among students with the same first name. In that order, continuing from the place on the list of the last presenter, on Fridays, students will be invited to present the proof of any unpresented item that has been assigned to the class.

4) Classmates question and critique. It is the responsibility of the rest of the class to ensure that they each understand the presentation, asking questions if necessary, and making suggestions to ensure that the presentation is acceptably complete and correct.

5) Avoiding hearing a solution. A student who does not wish to see a presentation because he or she is working on the item and has not yet completed it may leave the room while another student presents a solution.

6) Patience! If student solutions run out before the end of the class period, another activity, not related to the Friday material, will fill the remaining time or class will be dismissed early.

Every study of a subject must begin somewhere: while knowledge may be understood as a blob of inter-related ideas, learning is more linear, something is learned first, something is learned second, and so on. In mathematics, it is common to make the starting point fairly explicit, sometimes vaguely by saying we're starting where algebra and trigonometry leave off, sometimes much more explicitly by giving a list of statements, formally called *axioms*, that we all agree we know are true, and starting at that point. A Moore Method course is supposed to start with a list of axioms that are understood by the students. Starting from this point, the instructor presents the students with a list of statements that are claimed to be true and provable from the list of axioms and previously justified statements. Occasionally, the instructor will point to an important idea by giving some definitions, by presenting a consolidation of a just completed sequence of statements, or by challenging students with a question "Is this a true statement?"

In this course, the Friday material will begin with a list of properties of the real numbers (axioms for the real numbers); after all, Math S165 *IS* a course about the calculus of functions defined on the real numbers and having values that are real numbers. From this beginning, the list of statements that the students will be proving will develop some of the foundational ideas on which the calculus is based and which are critical for the deep understanding of the ideas of calculus.

It is expected that each student will try to prepare each of the next few questions on the list so that each time they are called on to present a solution, they will be ready to present a solution of one of the remaining problems. The participation grade will be based on preparedness to present when called on, the correctness of the solutions presented, and, to a lesser extent, the difficulty of the items presented.