

MATH 116 SPRING 2021 SYLLABUS Prof. Sachs

Welcome to Math 116! We will learn calculus, the mathematics of infinity, one of the most profound and most useful parts of all mathematics, indeed all knowledge. Calculus is about infinity in three forms: the infinitely small (infinitesimal) analysis of functions, the infinitely large (the most familiar – ask Buzz Lightyear), and infinite processes (decimal arithmetic for example or bad computer programming in loops). The thinking we do will enable us to understand how to formulate mathematical models of change. Calculus is extremely useful in science, engineering, mathematics, and economics. The mathematics behind calculus is interesting and challenging, needing a long period of time and the contributions of many individuals (some geniuses and many non-geniuses) to reach its present form.

This Course: **Our course is a different style calculus course.** The course design reflects an understanding, based on experience and supporting education research, that effective learning is an active, collaborative process. Problem-solving, skills building, applications of concepts, and open-mindedness are all at the foundation of this class and of genuine, engaged learning, especially in mathematics. This is a process-oriented course designed to further develop the skills learned in previous mathematics and to prepare you for further advanced work in your future academic and professional endeavors. Sometimes this approach is labeled “Inquiry-Based Learning”, especially among mathematicians.

Math 114 vs. 116: I am the professor in charge of this honors course. I have been involved with the Honors College for its entire existence and helped create the honors calculus courses some time ago. The course will cover all the material that appears in Math 114, and we will go further on some topics. There is an assumption that you will do the basic drill work that you need to be fine with routine computations, but then we will collaboratively explore concepts behind those techniques. We are a small class so there is no added recitation hour, giving you extra time outside classes.

Methods of Instruction and Class Principles: This is an **active learning** class, which means that you’ll spend lots of class time working, with guidance and feedback. You’ll get a lot of help and continual feedback on your work this way, but you’ll also be required to take responsibility for your learning. You’ll need to do readings, work problems, watch video clips, formulate questions, and do assigned homework outside of class to prepare you for the things that we’ll do inside of class. **This is not a 100% lecture class** or one that you can succeed in without being present and engaged. Our class sessions will be highly interactive and involve discussion, collaboration, activities, problem solving, computer explorations and writing. They will be hard to follow at times. You will make mistakes and be confused. This is a natural part of learning mathematics in an authentic way. Your classmates will also make mistakes at times. We all will deal with mistakes as learning opportunities and our classroom will be a supportive environment for student inquiry.

Course Prerequisites: You have passed with C or better Math 113 or have AP credit. We will use ideas from previous math courses, especially basic calculus and precalculus. As these come

into play, reminders and refreshers will be given, but only briefly. You are responsible outside of class for meeting with one of us or finding other resources to fill in any gaps in your background. The online homework system has diagnostic items on prior material and will customize homework accordingly.

Textbook: Our textbook is *Thomas' Calculus (Early Transcendentals)* by Hass, Heil and Weir (fourteenth edition, Pearson publisher). We cover most of Chapters 6 to 11. You should use the e-book (the most economical way). **We will also use MyMathLab from Pearson**, which comes bundled with the book in the various formats. If you insist, you can do homework in a notebook instead, but it offers less help and less feedback.

Software: We will be using *Mathematica* software, which is **free for students** under Mason's site license (see below for details), and/or Desmos and/or Geogebra.

Grading: Grading will be fair and impartial. Points used as the basis of the grade may be adjusted (curved): Online Skill Homework or Notebook (50); Ambitious Homework (150) – effort, not answers; Computer Labs and in class computer work write-ups (60); Participation in class (100); Three exams (300); Final (140). **Grades are meant to reflect your apparent achievement of understanding and competency**, which is not based directly on the performance of your classmates. Your high achievement will not “blow up the curve” for anyone else. The grade distribution at the end will be what it is; there is no preset distribution of competency nor is competency distributed randomly, so we do not necessarily expect a bell curve. I don't want your grade to be lower because you chose to do the Honors version of the course.

Gifts: None will be given as grades. **If you need or want a particular grade, you are responsible for earning it.** We will work with you to achieve your goal.

Exam Dates (tentative):

- Exam 1: Wednesday, February 17
- Exam 2: Wednesday, March 30
- Exam 3: Wednesday, April 27
- **Final: May 3, 10:30-1:15 – needs confirmation from Registrar**

Policies: The GMU Honor code is in effect at all times and students are expected to be fully aware of its requirements. Group work may be part of the course and group members will truthfully report on non-contributing members. Homework is graded on evidence of effort and attention. **Absence from exams must be for a valid reason and requires prior notification except in extreme circumstances.**

Office: Not expecting to be on campus officially this term.

Open Student Hours: and by appointment, both online in Blackboard.

Contact Info: My email is rsachs@gmu.edu **Use headers on email to me to avoid spam filters.**

Schedule of Topics: Our pace is not leisurely in this course. Mathematics courses are inherently cumulative, so later topics often use earlier material in a new setting. **DO NOT FALL BEHIND EARLY.** There are many modes of getting help, which will also be given as links to webpages with resources. Roughly the plan is:

- Week 1: Review Calc. 1; Volumes by slicing and disks, shells when rotating (text Sections 6.1, 6.2)
- Week 2: Other integrals – arclength, surface area; briefly – work, force, probability; log as integral (6.3-6.6,7.1)
- Week 3: Differential equations and exponential; Euler’s formula; hyperbolic functions. (Section 7.1, 7.2, 7.3, supplement)
- Week 4: Relative rates of growth (7.4); Review. Exam 1.
- Week 5: Integration by parts; quadratic approximation; Taylor polynomials. (Section 8.1, 8.2, 10.9)
- Week 6: Trigonometric Integrals; Trig Substitution; Partial Fractions (Section 8.3, 8.4, 8.5)
- Week 7: Tables of integrals; Numerical Integration; Improper Integrals (Section 8.6, 8.7, 8.8)
- Week 8: Introduction to First-Order Differential Equations; Review. Exam 2 (9.1-9.3)
- Week 9: Sequences (Section 10.1 and supplement)
- Week 10: Series idea; Integral Test; Comparison (Sections 10.2, 10.3, 10.4)
- Week 11: Ratio Test; Alternating Series and Conditional Convergence. (Section 10.5, 10.6)
- Week 12: Power Series. Review. Exam 2. (Section 10.7)
- Week 13: More Power Series and Gems from History (Section 10.8-10.10)
- Week 14: Parametric Curves and Polar Coordinates (Section 11.1, 11.2, 11.3). Review.

Caveat on schedule: Since our version of the class is experimental and centered on your learning, the schedule may be amended as needed.

Some other information: We are interested in learning how well this version of the course really works out, so there will be occasional classroom visitors, some questionnaires and other research

asked from you, and some releases (voluntary) for these purposes and possibly to illustrate the room in action for later courses. Your cooperation is appreciated, sometimes with bonus points.

Mathematica: As a Mason student, you are entitled to a copy of Mathematica software, the engine behind Wolfram Alpha. Find directions for downloading at <https://cos.gmu.edu/mathematica/> We will use this software at times in class and also for some homework or use Desmos or Geogebra.

A bit about me: I was always interested in mathematics and science and computing and teaching. I learned calculus in a summer program during high school and loved it, especially the theory. My adolescent love has not waned over time – I still love calculus! It is simultaneously: very deep mathematics, yet accessible with effort; extremely useful, sometimes in surprising ways (first proofs of the relative density of prime numbers used calculus!); its history and development involves many contributions from many places and some of the greatest moments in the history of thought (Newton using calculus to understand planetary motion and gravity). Sometimes we lose sight of all this when grinding through exercise problems, just as in my childhood, basketball dribbling around cones had little contact with Michael Jordan and musical scales practice was not typically invoking Mozart. Developing your skills is one of our goals, but it is certainly not the largest or most important of the course outcomes.

Research ongoing: We will be occasionally observed and you will be asked to participate in some research questionnaires (for extra credit with an alternate extra credit available if you do not wish to participate in the research).

Students as Scholars: This course is a Discovery-level course in Mason's Students as Scholars program. You will be developing an understanding of scholarship in STEM and Economics via calculus. Find more information on Students as Scholars at <http://oscar.gmu.edu/> or ask me.

Getting Help in Other Ways: Mason has a Math Tutoring Center. See the webpage <http://math.gmu.edu/tutor-center.php> for hours. There are many online tutoring services for a fee and many private tutors who do face-to-face sessions. Mathematica also sells some tutorial products on calculus and other math courses as apps. Websites abound as well.