MATH 113 FALL 2021 SYLLABUS Prof. Sachs

Welcome to Math 113! 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 Section: Our section is a somewhat 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.

The Instructional Team: I am the professor in charge of this course section. I have many years of teaching experience, but this course is always an evolving design. We have a Graduate Teaching Assistant (Aleyah Dawkins) as well as undergraduate Learning Assistants in class and in recitation. We are all committed to your learning, but **we cannot do it FOR you, only WITH you!** Ms. Dawkins will run our Tuesday recitation sessions, **which you are expected to attend**, with help from the LAs. These provide a greater opportunity for smaller scale interaction. Our Learning Assistants will also help out during class work sessions and have open times for individual and small group questions. Ms. Dawkins and I will also have open times. As well, we will all be answering emails.

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 totally a 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 our placement exam. We will use ideas from previous math courses, especially the concept of function, the algebra of functions, graphs, trigonometric functions, and exponentials and logs. 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). 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.

Software: We will be using *Mathematica* software, which is **free for students** (see cos.gmu.edu/mathematica for details) or open resources like Desmos or Geogebra for plotting and symbolic calculation. Once we are up and running, I will expect enough students to have laptops that table-based groups can do in-class experiments.

Grading: Grading will be fair and impartial. It is based on a mixture of graded homework and classwork, quizzes, class participation, exams and a final exam. Points used as the basis of the grade will be: Online Skill Homework (100); Recitation participation (100); Computer Labs and in class computer work write-ups (100); Written Homework and class work (100); Participation in class (60); Three exams (300); Final (140). Grades are meant to reflect your apparent achievement of understanding and competency, which is not based directly on the achievements nor lack of achievements 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.

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, September 15
- Exam 2: Wednesday, October 20
- Exam 3: Wednesday, November 17
- **Final: Wednesday December 8 - 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. **Absence from exams must be for a valid reason and requires prior notification except in extreme circumstances.**

Office: My office is room 4211 in Exploratory Hall. Note that only the elevator nearest to the bus hub goes up to the fourth floor on account of the greenhouse on the lab side. On that side you need to walk up one flight of stairs from the third floor. Or walk up all the flights if you prefer.

Office Hours: I will survey you this week and then set hours based on your schedules and mine. If you show up at my door at some random time with no appointment, I may or may not be able to see you then due to other work, but I do like students to come by during the scheduled times or to make other arrangements. I am also planning on some times on zoom. The GTA and the LAs will also have hours, to be announced and posted.

Contact Info: My email is rsachs@gmu.edu and my office phone is 703-993-1464. **Use headers on email to me to avoid spam filters**.

Schedule of Topics: I will try to post information about our progress on our Blackboard page and will sometimes be giving you assignments to complete or to try before class: often reading, attempting some challenging problems, watching videos, and posing good questions. Have some friends who can keep you up on class if you need to miss a session. 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: Precalculus review; motivation for limit of a function (text Sections 1.1-1.6; 2.1-2.2)
- Week 2: Limits and Continuity (2.3-2.5); Difference quotient revisited (3.1)
- Week 3: Infinity in limits (2.6); Derivative as Function (3.2)
- Week 4: Derivatives: Algebra, general properties, (3.3); Exam 1.
- Week 5: Trigonometric and exponential functions; derivatives of products and quotients (3.3-3.5)
- Week 6: Composite functions (3.6); differentials and linear approximation (3.11); Euler's formula, supplement; derivatives of inverse functions and logarithms (3.8); inverse trig derivatives (3.9)
- Week 7: Local information from derivatives; moving from local to global (4.1- 4.4)
- Week 8: (strange schedule: Columbus Day) Newton's method (4.7); L'Hopital's rule (4.5)
- Week 9: Antiderivatives; implicit differentiation and related rates (4.8, 3.7, 3.10)
- Week 10: Exam 2; using second derivatives; quadratic approximation; curvature in the plane (supplement)
- Week 11: Integrals and area; careful definition (5.1-5.3)

- Week 12: Basic properties of integrals; difficulty of using definition to evaluate; total change of function over interval (5.2, 5.4, supplement, 5.3)
- Week 13: (short week) Fundamental Theorem of calculus; using the theorem in reverse: finding antiderivatives (5.4)
- Week 14: More on integration; Exam 3.
- Week 15: Integration using substitution (5.5-5.6); Final 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.

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.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/ General Education Quantitative Reasoning: This course is a Discovery-level course in Mason's Students as Scholars program. It also counts under the Mason Core as Quantitative Reasoning. 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. Similarly for Mason Core.

Getting Help in Other Ways: Mason has a Math Tutoring Center in the Johnson Center, room 344 and also online. 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. I encourage you to get to know some of your classmates and form inclusive and welcoming study groups that publicize their existence to all.