SM121 Calculus I
Syllabus
Fall AY2020

Course coordinator: Max Wakefield, wakefiel@usna.edu

1 Overview

This course will roughly cover chapters 1-4 in the text book. The first chapter is basically precalculus review and we will spend a good chunk of time reviewing basic algebra and fun facts about elementary functions. The next chapter is setting up the machinery to compute derivatives and chapter 3 is the computations of derivatives for basic elementary functions. Finally we’ll conclude with an in depth study of applications of derivatives in chapter 4. This course is fast paced, in depth, and demanding with a cumulative common final exam. Please plan accordingly.

2 Learning outcomes

Upon successful completion of this course, students will be able to:

1. Interpret, analyze, create, and communicate mathematical models involving derivatives.
2. Carry out computations involving order of growth, limits and derivatives.
3. Describe relations between geometry, formulas, and data.
4. Recognize and apply mathematical procedures to solve applied problems, including related rates and optimization.
5. Write simple proofs of mathematical results.

3 Course Topics

The following is a more specific list of abilities or outcomes for this course. The final exam will be built from this list.

1. Describe functions numerically, algebraically, verbally, and graphically.
2. Find domain and range of functions.
3. Identify symmetry: even and odd functions.
4. Use and interpret the absolute value function.
5. Build new functions from old with function arithmetic.
6. Transform (by shift, stretch, and reflect) and compose functions.
7. Identify the geometry of combining or transforming functions.
8. Describe properties of exponential functions.
9. Use exponential functions to model growth and decay.
10. Describe inverse functions numerically, algebraically, verbally, and graphically.
11. Define logarithms and use properties of logarithms.
12. Test for one-to-one functions.
13. Describe the tangent line as a limit of secant lines.
14. Describe average versus instantaneous rates of change.
15. Describe the limit numerically, analytically, verbally, and graphically.
16. Evaluate limits using limit laws to break down complicated functions.
17. Compute two-sided and one-sided limits numerically, algebraically, and graphically.
18. Identify when limits don’t exist.
19. Define continuity algebraically, verbally, and graphically.
20. Determine points of continuity.
21. Give several types of examples of discontinuity.
22. Apply the Intermediate Value Theorem to obtain information about solutions of equations.
23. Define and find horizontal and vertical asymptotes.
25. Define the derivative as a limit.
26. Employ the definition to evaluate the derivative.
27. Find an equation for the tangent line.
28. Approximate the derivative given discrete data.
29. Verbally describe physical meanings of derivatives (first and second) with units.
30. Sketch the graph of the derivative from the graph of the original function.
31. Describe the derivative as a function rather than a single slope at a point.
32. Use the tangent line to linearly approximate a function.
33. Compute Taylor polynomials of functions and use them to obtain higher order approximations.
34. Use derivatives to determine monotonicity and concavity of the graph.
35. Use first and second derivatives to determine local extrema and points of inflection.
36. Sketch the graph of a function (up to vertical shift) from the graph of the derivative.
37. Differentiate polynomials, exponentials, trigonometric and logarithmic functions.
38. Use the product rule, quotient rule, and chain rule for differentiation.
39. Apply the derivative as a rate of change in the natural and social sciences.
40. Find derivatives implicitly and by logarithmic differentiation.
41. Solve related rates problems.
42. Find global extrema.
43. Be familiar with the Extreme Value Theorem.
44. Apply the Mean Value Theorem.
45. Use derivative information to sketch curves.
46. Use L'Hospital's rule to find the limit of certain quotients.
47. Solve optimization word problems.
48. Compute elementary antiderivatives.

4 Course ingredients

4.1 Homework
Your instructor may or may not use webassign. Regardless you NEED to enroll in WebAssign this semester so that you can use it next semester. Some problems are not in webassign but still should be worked.

A key ingredient for success in this course is communication of solutions. In homework you should practice writing the entire argument for your solutions instead of just recording “answers”.

4.2 Proofs
There will be a number of proofs on tests and the final exam. The proofs will be made available well before the tests.

4.3 Calculator
All students in this course are expected to have the TI-36X Pro calculator. There may be assignments that use such a calculator as well as questions on the common final exam on which it is expected that the student has such a calculator. There may also be problems for which no calculator is allowed.

4.4 Final exam
All students will take a common final exam. There will be a multiple choice section, a written answer section with a calculator, and a written answer section without a calculator (this section will include proofs).

5 Help
The Midshipmen Group Study Program provides regularly scheduled, out-of-class, peer-led group study sessions. Each session is facilitated by an MGSP leader, a competent student who has previously taken the course, been recommended by the course instructor, and chosen by the Academic Center. MGSP sessions for this course are available Sunday - Thursday evenings, 2000-2200. No appointment is necessary.

The Theodore J. Benac Mathematics Lab (“Math Lab”) will be located in Chauvenet 351 this semester. Math Lab is staffed by Mathematics Department instructors and will provide homework help during periods 1, 2, 3, and 5, Monday through Friday.
The Class of 1963 Center for Academic Excellence provides workshops on time management, test preparation, and other learning skills for all midshipmen. For Calculus I, they provide periodic extra review sessions (often before a test!), and they provide a one hour, non-credit Supplemental Instruction class for Calculus I (XS121). They also provide professional tutoring, both in evening walk-in sessions and in scheduled daytime one-on-one sessions. For more information visit their website (https://intranet.usna.edu/AcCenter/index.php).

The Math Department Website: Copies of old final exams and other resources, including the most up-to-date version of this document, are available on the Mathematics Department website (https://www.usna.edu/MathDept/).