Syllabus

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2.1 Instructor and Basic Course Information

Instructor:	Dr. Bevin Maultsby
Moodle Page:	https://moodle-courses1819.wolfware.ncsu.edu/course/view.php?id=4751
Communication:	This term we will be using Piazza for class discussion and homework questions. You are encouraged to discuss concepts and homework (with discretion) on Piazza. You can post as yourself or anonymously. Look for the link "Piazza class forum" on Moodle.
Online Office Hours:	– Thursday, 7-8pm Eastern (must RSVP 24 hours ahead of schedule) – by appointment See the document posted on Moodle for instructions.
Instructor Contact:	bmaults@ncsu.edu, 919-515-1876 (no voicemail)

2.2 Course Prerequisites or Restrictive Statements.

Prerequisite: MA 341.

MA 225 is desirable but not required.

Credit is not allowed for both MA 425 and MA 511.

2.3 GEP Designation

None: this class does not satisfy a GEP requirement.

2.4 Student Learning Outcomes

Goal: MA 511 is an introduction to mathematical analysis. Students will

- develop an understanding of the theory underpinning the calculus.
- develop their proof skills in one-dimensional calculus,
- understand the concepts of the real number system, functions, limits, continuity, differential and integral calculus of one variable, and uniform convergence.

We will focus some attention on learning to write mathematical proofs. Proofs will be graded not only for content but also for writing and style. (A mathematically correct proof which is poorly written may receive a low grade.)

2.5 Student Expenses

2.5.1 Textbook information

Required: *Fundamental Ideas of Analysis* by Michael Reed, 1st edition.
ISBN: 9780471159964

We will cover all or parts of Chapters 1–6 and 9. Topics will be the real number system, functions and limits, topology on the real line, continuity, differential and integral calculus for functions of one variable, infinite series, uniform convergence, and Fourier series.

Optional: In addition to the assigned book, you may find the following books helpful

- *Understanding Analysis* by Stephen Abbott

  On Reserve at: D.H. Hill Course Reserves
- *The Way of Analysis* by Robert Strichartz

  On Reserve at: D.H. Hill Course Reserves
- *Principles of Mathematical Analysis* by Walter Rudin

2.5.2 Other expenses

Not applicable.

2.6 Course Overview (Catalog Description)

Fundamental theorems on continuous functions; convergence theory of sequences, series and integrals; the Riemann integral. Credit for both MA 425 and MA 511 is not allowed.

2.7 Course Structure

In general this course will consist of three interactive video lectures per week with a weekly quiz and a written homework assignment.

Lectures. During lectures, you will be asked the equivalent of "in-class quiz questions." These questions do not count towards your course grade, but give you a way to assess how well you are following the lecture. Some of these pop-up automatically, while others must be clicked on (typically look for a purple indicator both on the slides and along the progress bar).

- During "Interactive Video" lectures, you only get one attempt on these lecture questions– please read each one carefully. You cannot retry the lecture quiz questions.

- During "Interactive Slides" lectures, you may reattempt some questions, however you cannot reattempt summary questions.

I recommend you only begin a lecture if you can fully commit your attention to it. Note that you can pause and return at a later time. You can also speed up the pace of lecture (up to 2x speed).

You must complete the lecture to see the Moodle quiz covering lecture material. Thus I recommend that you try to complete all lectures by each Friday at the latest.

Student Choice Lectures. The required lectures cover the fundamental ideas of real analysis on $\mathbb{R}$. Since many of you are graduate students in other disciplines, you are likely interested in applying real analysis in various situations. Thus I have prepared nine additional topics from the textbook.

Throughout the semester, you must choose <u>two</u> of these "Student Choice" lectures. You will watch the lectures and complete the required assignment–there will be no examination questions on these topics. These lectures have been interspersed throughout the weeks based on when they are most relevant to the required material; however, the activity is not due until **the end of the last week of class**. Here is a list of these topics, together with my recommendations:

Section	Title	Recommended for those interested in...
2.3	Markov Chains	Statistics/Probability, Economics (Note: requires knowledge of linear algebra/eigentheory.)
2.7	Quadratic Map	General math - Dynamical Systems
Posted supplement	Compact Sets	General math - Analysis and Topology
3.4	Numerical Methods	Math education
4.4	Newton's Method	Math education
5.4	Integral Equations	General math - Differential Equations
5.5	Calculus of Variations	General math - Analysis
10.1	Discrete Random Variables	Statistics/Probability
10.2	Coding Theory	Statistics/Probability, Computer Science

If you see a section in the textbook which has not been mentioned but which piques your interest, you may request a different topic before April.

Quizzes. There are weekly ~30-minute quizzes on Moodle which becoming available following completion of the lectures. Quizzes will require you to demonstrate knowledge of definitions and theorems. You may be asked to provide specific statements and will be evaluated based on correct and precise wording; using a computer is likely more convenient than using a phone

for the quizzes. Although the quizzes are open notes/open book, your success in the course is closely linked to your familiarity with the terminology–heavy dependence during the quizzes on notes/books is discouraged.

On most quizzes you have two attempts per problem and one overall submission (so do not submit the entire quiz until you are done with each question). If your first attempt on a question is not correct, you can click on your answer and reattempt the question.

Homework. Homework assignments in real analysis are often challenging and lengthy. You should begin working on them as soon as possible. All homework assignments are posted on Moodle and are due by 11pm (Eastern) on the listed day.

Homework should be submitted online as a PDF via the link posted on Moodle. You may typeset your homework in LaTeX(and submit the PDF, not the tex file) or scan your homework and turn it into a PDF. (You may find "Save as PDF" or "Print to PDF" useful.)

You are responsible for tracking quiz and homework due dates.

2.8 Weekly Course Schedule

The course schedule is subject to change. Any changes to the class schedule will be announced on Moodle. Do not unsubscribe from the Announcements forum.

2.8.1 List of topics

The beginning of the course will slightly reorder some of the topics compared to Reed (mainly so that we introduce and use the Supremum Property as a foundational axiom). From Chapter 3 onwards, we will follow Reed's ordering.

The order of the sections will be: 1.1 (on your own), 1.4, 1.2, 2.5, 1.3, Supplement on open and closed sets, Supplement on the Cantor set, 2.1, 2.2, 2.4 & 2.6 (both in two lectures), 3.1, 3.2, 3.3 (two lectures), 3.5, 3.6, 4.1, 4.2 (two lectures), 4.5, 5.1 (two lectures), 5.2, 5.3, 5.6, 5.7, 6.2, 6.3, 6.4, 4.3, 9.1, 9.2, 9.3.

2.8.2 Projected schedule of assignments, quizzes, and tests

Overview. Here is a week-by-week schedule of major topics and events:

Date	Sections	Topics
Jan. 7-13	1.1, 1.4, 1.2	Introduction to real numbers. Logic and proof writing. Sets and functions.

Jan. 14-20	2.5, 1.3, Open and closed sets	Bounded sets (supremum and infimum) and the Nested Interval Property. Cardinality and density. The basic topology of open and closed sets.
Jan. 21-27	Cantor Set, 2.1	The Cantor set. Beginning of sequences–definition, convergence, and boundedness. *Note that 1/21 is MLK Jr. Day, so there are only two lectures this week.*
Jan. 28-Feb. 3	2.2, 2.4, 2.6	Limit theorems for sequences, Cauchy sequences, subsequences, the Monotone Subsequence Theorem, the Monotone Convergence Theorem, the Bolzano-Weierstrass Theorem.
Feb. 4-10	3.1	Continuity is the only required topic for this week. Review lecture for Test 1.
Feb. 11-17	Test 1, 3.2, 3.3	Test 1 must be taken Monday or Tuesday (see Moodle). The knowledge we get when a continuous mapping is over $[a, b]$. Partitions and lower/upper sums.
Feb. 18-24	3.3, 3.5,3.6	Integrability. Integrating discontinuous functions using the notion of measure. Improper integrals.
Feb. 25-Mar. 3	3.6, 4.1, 4.2	Differentiability. The Mean Value Theorem (+preliminary results). The Fundamental Theorem of Calculus.
March 4-10	4.2, 4.5	Inverse Functions. Sequences of Functions and the notion of pointwise convergence (not on Test 2). Review lecture for Test 2.
March 11-17	—	*Spring Break – University closed.*
March 18-24	Test 2, 5.1, 5.2	Test 2 must be taken Monday or Tuesday (see Moodle). Two lectures on sequences of functions, convergence, and limit theorems.
March 25-31	5.3, 5.6, 5.7	The Sup Norm. Metric spaces and examples. Contraction mapping.
April 1-7	6.2, 6.3, 6.4	Series of real constants. The Weierstrass M-test for series of functions. Power series and why they are useful.
April 8-14	4.3, Test 3	Taylor's Theorem. Review lecture for Test 3. Test 3 must be taken Thursday or Friday.
April 15-21	9.1, 9.2, 9.3	A look at Fourier series.
April 22-28	—	The last week of the semester at NCSU is "dead week." There will be no required lectures for this week; however, the final two student choice lectures will be available this week. There will also be a review lecture for the final exam.
May 6-7	Final Exam	See Moodle.

Homework schedule. A tentative schedule of homework assignments is provided below; occasion-

ally due dates may be adjusted. You are responsible for checking Moodle regularly to make timely progress through the assignments.

Homework Set	Due Date	Homework Set	Due Date
HW 1	1/18	HW 6	3/10
HW 2	1/25	HW 7	3/25
HW 3	2/1	HW 8	4/1
HW 4	2/22	HW 9	4/8
HW 5	3/1	HW 10	4/22

Two student choice assignments may be submitted anytime from the week they become available through 4/30.

These due dates are subject to change–changes will be announced on Moodle.

2.8.3 Required field trips

Not applicable.

2.8.4 Laboratory, studio, or problem sessions

Not applicable.

2.9 Statement on Transportation

Not applicable.

2.10 Statement on Safety and Risk Assumption

Not applicable.

2.11 How Grades are Determined

Your grades are entirely based on your performance on the assignments. Your grades will be posted on Moodle.

2.11.1 The relative value of the various evaluation components of the course

Lectures	0%
Quizzes	15%
Homework (incl. Student Choice)	15%
Midterm 1	15%
Midterm 2	15%
Midterm 3	15%
Cumulative Final	25%

Due to Moodle incorrectly storing some lecture scores, your lecture scores do not count towards your course grade. However, you are still expected to earn credit for each lecture to access the relevant quiz.

2.11.2 The conversion system from numerical to letter grading

The final grade will be assigned using the plus/minus grading system according to the following chart:

A+ : 98–100	A : 93–97.99	A– : 90–92.99
B+ : 88–100	B : 83–87.99	B– : 80–82.99
C+ : 78–100	C : 73–77.99	C– : 70–72.99
D+ : 68–100	D : 63–67.99	D– : 60–62.99
	F : 0–59.99	

This policy is strict–I will not move grade lines for individual students. For example, a score of 87.76 is a B, not a B+.

2.12 Late Assignments

If you are having a busy week, please let me know as occasional extensions are acceptable. Otherwise, written homework may be submitted late for a 10-point penalty.

2.13 Attendance/Absence Policy

Please consult `https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/`.

As this course is a distance course, no attendance is taken. However, you are expected to work through the material at the set pace in order to meet the quiz and homework deadlines. Any desired extensions should be communicated to me before the due date arises.

2.14 Academic Integrity

For the NCSU policy, see the Code of Student Conduct at https://policies.ncsu.edu/policy/pol-11-35-01/

Quizzes, Exams & Final: Students will neither give nor receive any assistance on any quiz, midterm, or the final exam. Use of cell phones and graphing calculators during exams is not permitted.

Homework: You are allowed to work together on homework assignments; however, each student must turn in his or her own work.

Utilization of the Honor Pledge: All exams and tests must be completed independent of assistance from other people. Implicit in any submission is the pledge that "I have neither given nor received unauthorized aid on this test or assignment."

Penalty for violations: Any violation of this policy will be reported to the Office of Student Conduct with a recommendation of a failing grade for the assignment and/or course.

2.15 Statement for students with disabilities

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Services Office at Suite 2221, Student Health Center, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01) (https://policies.ncsu.edu/regulation/reg-02-20-01/).

2.16 Electronic Course Components

Please be advised that office hours may be recorded for current and potential future educational purposes. By your continued participation in this recorded course, you are providing your permission to be recorded.

2.16.1 Electronically hosted course components

The course site for the class is hosted on Moodle, which includes the weekly quizzes. You must address the accessibility of this website for you during the course drop/add period.

2.16.2 Privacy or accessibility

Instructor is not responsible for ensuring privacy or accessibility of electronic materials that are not required components of the course (e.g., links to supplemental information that is not part of

the required reading list).

2.16.3 Required statement:

"Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics, and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course."

2.17 Your Rights and Responsibilities

Students are responsible for reviewing the NC State University PRR's which pertains to their course rights and responsibilities:

- Equal Opportunity and Non-Discrimination Policy Statement
  https://policies.ncsu.edu/policy/pol-04-25-05
  with additional references at https://oied.ncsu.edu/equity/policies/
- Code of Student Conduct https://policies.ncsu.edu/policy/pol-11-35-01
- Grades and Grade Point Average https://policies.ncsu.edu/regulation/reg-02-50-03
- Credit-Only Courses https://policies.ncsu.edu/regulation/reg-02-20-15
- Audits https://policies.ncsu.edu/regulation/reg-02-20-04