SYLLABUS
Math 414
Analysis I
Summer 2015

Meeting Times: MTWRF 11:00am – 12:00pm, 0032 Carver

Instructor: Paul Tokorcheck
Webpage: http://orion.math.iastate.edu/ptokorch/
Contact: ptokorch@iastate.edu - 515.294.2521
Office Location: 443 Carver Hall
Office Hours: TTh 2 – 3pm, or by appointment.

Grader: Thang Tran
Email: huythang@iastate.edu
Office Location: 244 Carver
Office Hours: W 12 – 1pm

Reading Materials:
Murray Protter, Basic Elements of Real Analysis (Required)
Jiří Lebl, Basic Analysis: Introduction to Real Analysis (Free Download)

Classics:
Walter Rudin, Principles of Mathematical Analysis
Hermann Weyl, The Continuum
Bernard R. Gelbaum, John M.H. Olmsted, Counterexamples in Analysis
David Berlinsky, A Tour of the Calculus

Prerequisites: A grade of C- or better in both Math 201 and Math 265.

Grading: Your grade for the course will be calculated as follows:

- Homework: 30%
- Participation: 20%
- Exam 1: 25%
- Exam 2: 25%

Last Updated: June 19, 2015
Homework: Homework will be due each Monday, at the beginning of lecture. Anything submitted after this deadline will receive half-credit, regardless of circumstances.

Problem Sessions: Once a week, we will meet to discuss homework exercises and present some proofs. We’ll discuss basic proofwriting techniques, such as Induction, and also issues of style and format. To “participate”, you should be showing up, and adding your constructive and polite opinions to the discussion. You should also have a few proofs prepared that you’re willing to share with the class. Every student should present at least one proof over the course of the eight weeks, preferably more than one.

Exams: There will be exactly two exams, occurring on the Fridays of the fourth and eighth weeks. If you cannot be there on the date of an exam, you must contact me before the exam date to make other arrangements. If you no-show for an exam and attempt to contact me afterward, you should not expect to be allowed a make-up exam.

Policy on academic dishonesty: I encourage you to make friends, talk to each other, and exchange ideas about the proofs that we see in class and in the homeworks. However, the work you turn in should be your own. That is, the work that you turn in should be written by you, by yourself. If you talk to someone about a problem, hear a good idea, and go home to write it up, that’s collaboration. If you find yourself writing a proof while holding someone else’s work, that’s cheating. You may also want to review the University’s policies on plagiarism and academic dishonesty at http://www.public.iastate.edu/~catalog/2009-2011/geninfo/dishonesty.html

Policy on disabilities: Please address any special needs or special accommodations with me at the beginning of the semester or as soon as you become aware of your needs. Those seeking accommodations based on disabilities should obtain a Student Academic Accommodation Request (SAAR) form from the Student Disability Resource (SDR) office (phone 515-294-7220). SDR is located on the main floor of the Student Services Building, Room 1076. Please also review the Mathematics Department Student Disability Accommodation Policy at http://www.math.iastate.edu/Undergrad/AccommodationPol.html
Course Calendar: The following is a rough outline of topics.

Week One: The Field Axioms. Order, intervals, and inequalities. The construction of the Rational and Real Numbers. Completeness. Basic topological facts, such as the Cauchy-Schwarz and Triangle Inequalities.
(Sections 1.1, 1.2, 1.3, 1.4, 3.2, 6.1, 6.2)

Week Two: More Topology of \( \mathbb{R} \). Continuity of functions. Limits of functions and “epsilon/delta” proofs. Convergence of functions and sequences. The Squeeze Theorem.
(Sections 2.1, 2.2, 2.3, 2.4, 2.5)

Week Three: The Nested Intervals Theorem and the Bolzano-Weierstrass Theorem. Cauchy Sequences and the Cauchy Criterion.
(Sections 3.1, 3.3, 3.6)

(Sections 3.7 and 6.4. Sections 3.1 and 3.4.)

Week Five: EXAM 1 ON MONDAY. Uniform Continuity. The definition of the Derivative, and the Derivative Rules.
(Sections 3.5, 4.1, 4.2)

(Sections 4.2, 5.1, 5.2)

(Sections 5.3, 8.1, 8.2, 8.3)

Week Eight: Uniform convergence for Series. The Weierstrass \( M \)-Test. Taylor Series. Any unfinished business, Review. EXAM 2 ON FRIDAY.
(Section 8.4.)
LEARNING OUTCOMES

The Construction and Topology of $\mathbb{R}$

- Understand the basic operations on sets, such as unions and intersections.
- The field axioms, and being able to determine whether or not a given set is a field.
- Understand partial orderings, equivalence relations, and equivalence classes.
- Know how $\mathbb{Q}$ is defined as equivalence classes of ordered pairs of integers.
- Know the definitions of normed spaces and inner product spaces, with examples.
- Understand basic definitions for metric spaces, such as open/closed balls, open/closed sets, and limit points.
- Understand the idea of a Dedekind cut, and how it is used to form $\mathbb{R}$.

Limits and Continuity

- Understand the $\epsilon/\delta$-definition of the limit, and be able to prove that a function has a limit using the definition.
- Understand the definitions for one-sided limits and limits at infinity.
- Understand the definition of a limit of a sequence.
- Apply the limit laws to calculate limits.
- Use the limit concept to determine where a function is continuous.
- Understand and be able to use foundational lemmas such as the Bolzano-Weierstrass Theorem and the Nested Intervals Theorem.
- Cauchy sequences and the Cauchy Criterion.
- Compact sets and the Heine-Borel Theorem.
Continuous Functions and Differentiation

- Understand and use the Intermediate Value Theorem as a foundational lemma.
- Use the limit definition to calculate a derivative, or to determine when a derivative fails to exist.
- Be able to prove any of the standard rules of differentiation.
- Rolle’s Theorem and the Mean Value Theorem for derivatives.
- The Inverse Function Theorem for derivatives.
- Uniform continuity of functions.
- L’Hôpital’s Rule.

Integration

- The Darboux and Riemann integrals.
- The Fundamental Theorem of Calculus.
- Basic theorems about integrals and integrability.
- The definitions of logarithmic and exponential functions via integrals.

Infinite Series and Convergence

- Infinite series and convergence tests.
- The limit supremum and limit infimum.
- Sequences of functions and convergence.
- Uniform convergence for sequences of functions.
- The Weierstrass M-test.
- Taylor series.