

**SYLLABUS**  
**MATH 516 (3 credits)**  
**Real Analysis II**  
**Spring 2016**

**Instructor:** Timothy H. McNicholl, Ph.D.

**Phone Number:** 515-294-5865

**email:** mcnichol@iastate.edu

**Office Location:** Carver 412

**Office Hours:** Mondays, Wednesdays, Fridays: 1:10pm - 2:00pm

**Text:** Royden and Fitzpatrick, Real Analysis, Fourth Edition. The text will primarily be used as a source of homework problems. The primary source of information will be the class notes.

**Course Prerequisite** MATH 515. *In particular you are expected to know the material in Chapters 1 - ??? of the textbook.*

**Outcomes:** Upon successfully completing this course, the student will be able to construct reasonably complex proofs and counterexamples in the theory of metric spaces,  $L^p$  spaces, and Banach spaces.

**Course outline:**

I. Abstract measure and integration

- (1) Measure spaces
- (2) Measurable functions
- (3) How to make a measure: the Carathéodory construction
- (4) Abstract integration
- (5) Product measures; Tonelli and Fubini Theorems
- (6) Decomposition of measures
- (7) Differentiation of measures
- (8)  $L^p(\mu)$

II. Metric spaces

- (1) Basic definitions and facts

- (2) Density and Separability
- (3) Sequences
- (4) Completeness
- (5) Compactness
- (6) Connectedness
- (7) Continuity and limits
- (8) Homeomorphism and isometry
- (9) Uniform convergence
- (10) The contraction mapping theorem
- (11) Urysohn's Lemma and Tietze Extension Theorem
- (12) Baire Category Theorem
- (13) Measures on metric spaces

### III. Some results on integration and differentiation in $\mathbb{R}^n$

- (1) Approximation
- (2) Maximal functions and weak integrability
- (3) The Lebesgue Differentiation Theorem
- (4) Nicely shrinking sets
- (5) Absolutely continuous functions revisited
- (6) Change of Variables in  $\mathbb{R}^n$

### IV. Banach spaces

- (1) Basic definitions and facts
- (2) Series in a normed linear space
- (3) Linear operators on normed linear spaces
- (4) Bases
- (5) Duals, Riesz Representation Theorems.
- (6) Weak\* topologies, Alaoglu's theorem

### V. Hilbert spaces

- (1) Basic definitions and facts
- (2) Orthonormal bases
- (3) Trigonometric series, Fourier analysis

**Assessment:** Your grade in this course will be based on the following.

- Quizzes 10%
- Homework 20%
- 20% Exam 1
- 20% Exam 2
- 30% Final exam

**Grading scale:**

- 0 - 20%: F
- 20% - 40%: D
- 40% - 60%: C
- 60% - 80%: B
- 80% - 100%: A (cut off for A- at  $83\frac{1}{3}\%$ )

**Quizzes:** There will be a 10-minute quiz at the beginning of each class period except January 11, 2015. Each quiz will consist of two questions. Each question will concern one or more items from the class notes. e.g. a statement of a definition or theorem previously covered in class. Grading of these quizzes will be very picky and there will be little partial credit.

**Homework:**

- *Due dates:* See course calendar below for assignment dates and due dates.
- *Extensions:* You may have an extension on any two homework assignments, no questions asked, no excuse required. Requests for extensions should be made in a timely manner. Each extension is for one week beyond the due date. No more than two extensions will be granted (exceptions made for medical conditions).
- *Revisions:* You may *revise* your work on any *four* homework assignments. Requests for revisions should be made in a timely fashion. Each revision is due one week from assignment due date.
- *Grading:* each assignment will have 5 problems. Only two of these problems will be graded. One of these two problems will be designated in advance. The other will be chosen randomly after the homework is collected.
- *LaTeX'd electronic submissions are much appreciated!*

**Exams:**

- See course calendar below for all exam dates.
- Information about each exam will be posted on Blackboard at least one week prior to exam date.

**Makeups on exams and quizzes:**

- A make-up on an exam or quiz will be given only for one of the following reasons.
  - A very well documented medical excuse. A note from a doctor on a prescription pad is sufficient documentation as are hospital discharge papers.
  - A family emergency.
  - An official university function.
  - Military service.
  - Jury duty or other mandatory court appearances.
  - A conflict with another final exam or if you have three or more final exams on a given day. In each of these cases the exam with the fewest number of students must yield.

**Otherwise you are expected to take each exam and quiz at the scheduled date and time.**

**If you miss a class**, then you are entirely responsible for finding out any special announcements that were made.

**Policy on academic dishonesty:** Any attempt to represent another person's work as your own, in whole or in part, is academic dishonesty. *When you submit a homework assignment, you are representing that work as your own.* Any attempt to gain an unfair advantage over other students on a quiz or test is academic dishonesty. The first incident of academic dishonesty will result in a grade of F for the entire course. Please review the student handbook's statement on academic honesty at <http://catalog.iastate.edu/academiclife/regulations/#academicdishonestytext..>

**Policy on disabilities:** Reasonable accommodation will be made for students with documented disabilities. Such students must give me a letter from Disabled Student Services documenting their disability and the accommodation requested.

**Policies on classroom conduct:** Please review math department policies at <http://www.math.iastate.edu/Faculty/ClassPolicies.html>. *In particular, put away*

*mobile phones, laptops, ipads, etc. before entering classroom.*

**Course calendar:**

- Friday, January 15:
  - Homework 1 assigned
- Friday, January 22:
  - Homework 1 due at end of class
  - Homework 2 assigned
- Monday, January 25
  - Homework 1 returned
- Friday, January 29
  - Homework 2 due at end of class
  - Homework 3 assigned
- Monday, February 1
  - Homework 2 returned
- Friday, February 5
  - Homework 3 due at end of class
  - Homework 4 assigned
- Monday, February 8
  - Homework 3 returned
- Friday, February 12
  - Homework 4 due at end of class
  - Homework 5 assigned
- Monday, February 15
  - Homework 4 returned
- Friday, February 19

- Homework 5 due at end of class
- Monday, February 22
  - Homework 5 returned
- Friday, February 26
  - Exam 1
- Wednesday, March 2
  - Exam 1 returned
- Friday, March 4
  - Homework 6 assigned
- Friday, March 11
  - Homework 6 due at end of class
- Monday March 21
  - Homework 6 returned
- Friday, March 25
  - Exam 2
- Monday, March 28
  - Exam 2 returned
- Friday, April 1
  - Homework 7 assigned
- Friday, April 8
  - Homework 7 due at end of class
  - Homework 8 assigned
- Monday, April 11
  - Homework 7 returned
- Friday, April 15
  - Homework 8 due at end of class

- Homework 9 assigned
- Monday, April 18
  - Homework 8 returned
- Friday, April 22
  - Homework 9 due at end of class
- Monday, April 25
  - Homework 9 returned
- Wednesday, May 4
  - Final Exam 9:45am - 11:45am Carver 196
- Thursday, May 5
  - Semester grades posted on Blackboard
- Friday, May 6
  - Semester grades sent to registrar's office

**Finally** All policies in this syllabus are subject to change. Proper notice will be given for all changes.