

SYLLABUS
MATH 515 (3 credits)
Real Analysis I
Fall 2015

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Office Location: Carver 244

Office hours: Thursdays 1:10pm - 3pm

Text: Royden and Fitzpatrick, Real Analysis, Fourth Edition

Course Prerequisite MATH 414 or MATH 501. *In particular you are expected to know the material in Chapter 1 and pages 3 - 5 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 Lebesgue integration on the real line.

Course outline:

I. A quick review of Riemann integration and an overview of Lebesgue integration

- (1) Definitions and basic facts
- (2) Interchange of limit operations
- (3) Overview of Lebesgue integration

II. Measurable sets and their measure

- (1) Outer measure
- (2) Measurable sets
- (3) Approximating measurable sets; G_δ and F_σ sets
- (4) Lebesgue measure
- (5) Non-measurable sets
- (6) The Vitali covering lemma

III. Measurable functions

- (1) Definition and basic facts
- (2) Sums, products, and pointwise limits
- (3) Approximating measurable functions: simple functions
- (4) Uniform convergence: Egoroff's and Lusin's theorems
- (5) Non-measurable functions

IV. Lebesgue integration

- (1) Integrals of non-negative simple functions
- (2) Integrals of non-negative functions
- (3) Integrable functions; integrals of extended real-valued functions
- (4) Dominated convergence theorem and Vitali convergence theorem
- (5) Convergence in measure
- (6) Back to Riemann integration

V. Differentiation

- (1) Monotone functions
- (2) Bounded variation
- (3) Absolute continuity
- (4) Integrating derivatives
- (5) Differentiating indefinite integrals

VI. Convexity

- (1) Basic definitions and theorems
- (2) Derivatives of convex functions
- (3) Jensen's theorem

VII. L^p spaces

- (1) Normed linear spaces and Banach spaces
- (2) $L^p(\mathbb{R})$

VIII. Fubini and Tonelli Theorems in \mathbb{R}^n

- (1) Lebesgue measure and integration in \mathbb{R}^n
- (2) Iterated integration

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

Quizzes: There will be a 10-minute quiz at the beginning of each class period except for 8/24, 10/2, and 11/20. 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:

- See course calendar below for assignment dates and due dates.
- You may have an extension on any two homework assignments. 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).
- Each homework assignment covers only material previously covered in class or from Chapter 1.

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 use another person's work as your own, in whole or in part, is academic dishonesty. 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 August 28: Homework 1 assigned.
- Friday September 4:

- Homework 1 due by end of class.
 - Homework 2 assigned.
- Wednesday September 9: Homework 1 returned.
- Friday September 11:
 - Homework 2 due by end of class.
 - Homework 3 assigned.
- Wednesday September 16: Homework 2 returned.
- Friday September 18:
 - Homework 3 due by end of class.
 - Homework 4 assigned.
- Wednesday September 23: Homework 3 returned.
- Friday September 25:
 - Homework 4 due by end of class.
- Wednesday September 30: Homework 4 returned.
- Friday October 2:
 - Exam 1
 - Homework 5 assigned
- Friday October 9:
 - Exam 1 returned
 - Homework 5 due by end of class
 - Homework 6 assigned
- Wednesday October 14: Homework 5 returned
- Friday October 16:
 - Homework 6 due by end of class
 - Homework 7 assigned
- Wednesday October 21: Homework 6 returned
- Friday October 23:

- Homework 7 due by end of class
 - Homework 8 assigned
- Wednesday October 28: Homework 7 returned
- Friday October 30:
 - Homework 8 due by end of class
 - Homework 9 assigned
- Wednesday November 4: Homework 8 returned
- Friday November 6:
 - Homework 9 due by end of class
- Wednesday November 11: Homework 9 returned
- Friday November 13:
 - Exam 2
 - Homework 10 assigned
- Wednesday November 18: Exam 2 returned
- Friday November 20:
 - Homework 10 due by end of class
 - Homework 11 assigned
- Wednesday December 2: Homework 10 returned
- Friday December 4:
 - Homework 11 due by end of class
- Wednesday December 9: Homework 11 returned
- Tuesday December 15: Final exam 9:45 - 11:45a.m., Carver 196.

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