

Syllabus for MAE289a

Mathematical Analysis for Applications - Fall 2015

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This is the syllabus for MAE289a – Mathematical Analysis for Applications, Fall 2015. Topics in mathematical analysis, with the emphasis on those of use in applications. The topics may include: metric spaces, open and closed sets, compact sets, continuity, differentiation, series of functions and uniform convergence, convex sets and functions, transforms, and Stokes theorem.

Instructor

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Teaching Assistant

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Course Objectives This course is the first one in a series of three, covering miscellaneous topics of mathematical analysis for real/vector-valued functions of one and/or several variables. Currently, the level of mathematics necessary for a successful path through much of the MAE graduate controls curriculum is above that with which students typically arrive. The goal of this sequence is to bring you to the point where you can more easily handle the material in more advanced courses of the program. While doing so, we aim to present applications of the theory to dynamical systems, optimization, and control. Special emphasis is put on proof techniques and rigor. Obviously this course is math intensive.

By the end of the course, you would/should have:

1. learned about a broad range of basic concepts in mathematical analysis
2. learned about different proof techniques, what constitutes a proof, and the level of mathematical rigor that goes with it
3. been exposed to multiple examples of the application of basic mathematical techniques in a variety of domains in engineering

Prerequisites

Knowledge of linear algebra is assumed. Familiarity with simulation software of your choice (e.g., Matlab/Mathematica/Maple).

Text

Any good book in mathematical analysis should be useful. Our main reference will be:

- W. Rudin. *Principles of Mathematical Analysis*. McGraw-Hill, 3rd edition, 1976

Additional recommended readings

Depending on the specific topic we are dealing with, we will complement the book above with the following material

- [A1] M. H. Protter and C. B. Jr. Morrey. *A First Course in Real Analysis*. Undergraduate Texts in Mathematics. Springer, New York, 2nd edition, 1997
- [A2] S. Boyd and L. Vandenberghe. *Convex Optimization*. Cambridge University Press, 2004. Freely available at <http://stanford.edu/~boyd/cvxbook>

Course webpage

<http://carmenere.ucsd.edu/jorge/teaching/mae289a/f15/>

The webpage contains this syllabus and the list of homework due. Please check it periodically for updates and other announcements related to the course.

Calendar

- Notes in logic. Notes on basic proofs. Notation.
- Ordered sets, supremum and infimum, the Archimedian property. Fields, the real, extended real, and complex fields.
- Finite, countable, and uncountable sets. Metric spaces. Compact sets. Connected Sets.
- Convergent sequences. Subsequences. Cauchy sequences and complete spaces. Supremum and infimum. The Bolzano-Weirstrass theorem. Series.
- Limits of functions. Continuity. Compactness and continuity. Continuity and connectedness. Discontinuities. Uniform continuity. Lipschitz continuity.
- Differentiation. Mean value theorems. L'Hospital rule. Taylor's theorem.
- Convex sets and convex functions. Convex optimization problems and duality.
- Applications in approximation and fitting, statistical estimation, geometric problems.
- Algorithms: unconstrained minimization and equality constrained minimization. Applications in optimal control.

Homework

There will be a set of homework problems per week. Homework assignments are due weekly, on Thursdays (specific dates for your reference are included in the webpage). No late homework will be accepted.

Exams The midterm will be on **October 29**. The final exam will be a take-home.

Grading policy

Homework: 20% Midterm: 35% Final: 45%

ted

Your grades will be available via ted at <http://ted.ucsd.edu>

Room location and hours

Lectures take place at Herbert F. York Undergraduate Sciences Building (Map Building #137), room 4050B, Tuesdays and Thursdays, from 11:00am to 12:20pm.

Office hours

Instructor: Tuesdays, from 3:30pm to 4:30pm, at EBUI, room 1603 (conference room). Please, send me an email describing the problem before coming to office hours. I will try to respond as quickly as possible. Additionally, I will share questions that are particularly good (and their answers) with the rest of the class by broadcasting my answer to the entire class.