

## APPM 5440, Applied Analysis I, Fall 2016

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**Meeting times:** MWF 10.00 - 10.50, ECCR 257 (the “Newton lab”).

**Text:** The main text is *Applied Analysis* by John K. Hunter and Bruno Nachtergaele. I would also recommend *Introductory Real Analysis* by Kolmogorov and Fomin; it is a beautifully written, very readable book (and cheap, about \$11 on Amazon). Finally, if you find that you’d like to refresh your knowledge of advanced calculus, I would recommend *Principles of Mathematical Analysis* by Walter Rudin.

**Office hours:** Wednesdays 15:00-16:45. A third office hour will usually be devoted to an instructor led problem solving session. Attendance is completely voluntary. We will decide on a time once everyone’s schedules get sorted out.

**Exams and grading:** There will be three midterms and a final. The final is worth 40% of the grade, and the midterms are worth 20% each.

**Home work:** A weekly home work will be assigned. It will not be collected or graded, but the midterms will consist mostly of problems very similar to the home work problems.

**Web-resources:** There is a class website with up-to-date information about the syllabus, homework assignments, class handouts, and so on. See:

[http://amath.colorado.edu/faculty/martinss/Teaching/APPM5440\\_2016f/](http://amath.colorado.edu/faculty/martinss/Teaching/APPM5440_2016f/)

**Remark 1:** You have probably heard this said many times before, but please keep in mind that for most of us, learning mathematics is a matter of *doing* mathematics rather than reading. So try to work as many of the examples as you can stomach (more than just the assigned home work problems if at all possible). I still often try to learn new material by sitting down comfortably and read, but in my experience, this really only works if the new material is very close to something I already know. Everybody is different, but few of us can learn mathematics without working out examples.

**Remark 2:** It is very important that you not fall behind in this class. Many students find the material challenging, and almost all concepts introduced will build on concepts that were presented earlier in the semester. If you find that you do not understand, please ask for help as early as possible!

**Scope:** In this two-semester class we will cover a collection of topics from real analysis, functional analysis, measure and integration theory, and Fourier analysis. The choice of topics is guided by the needs of an applied mathematician or a mathematically inclined engineer or scientist. However, the principal object of the class is to teach mathematics; the goal is to learn not only the results that are covered, but also to learn how to construct a correct mathematical proof. We will from time to time mention application areas, and connect the abstract results to real world phenomena, but this is by no means the main focus of the course.

The techniques we will learn will be applicable to a wide range of topics (probability theory, signal processing, economics, quantum physics, etc) but in order to give a very brief idea of the essence of the class, let us assume that we wish to determine whether a given partial differential equation (such as the Maxwell equations, the Schrödinger equation, the Navier-Stokes equation, ...) has a solution, and if so, determine what properties such a solution will have (is it a smooth function? a bounded function? ...). A very successful technique for doing so has proved to be to introduce sets of functions within which we believe that a solution should be located (such as: “the set of all continuously differentiable functions on an interval”, “the set of all probability distributions for the locations of the two electrons in a Helium atom”, “the set of all elastic displacements of a plate that is clamped along one edge”, ...) and to study the geometry of such sets. The difficulty is that such sets are almost invariably infinite dimensional, and it turns out that concepts such as “distance between points”, “open and closed sets”, “convergence of sequences”, “compactness”, etc, which have fairly obvious meanings in  $\mathbb{R}^n$ , are not trivial to define in more general situations (there are, as we shall see, several different ways of doing so). In some sense, the task of defining and describing the geometry of infinite dimensional spaces, can be said to form the core of the class.

Specifically, we will during the Fall semester cover the following topics: metric and normed spaces, continuous functions, the contraction mapping theorem, the implicit function theorem, topological spaces, Banach spaces, Hilbert spaces.

During the Spring semester, we will cover: Fourier series, bounded linear operators on Hilbert space, spectral theory for bounded linear operators (with a focus on compact and/or self-adjoint ones), the Fourier transform, distributions, measure theory and  $L^p$  spaces, Sobolev spaces.

**Disability:** If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu. If you have a temporary medical condition or injury, see Temporary Injuries guidelines under the Quick Links at the Disability Services website and discuss your needs with your professor.

**Religious observances:** Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please see the instructor in case of a conflict at least 10 days in advance (preferably earlier).

**Classroom behavior:** Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veterans status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on classroom behavior and the student code.

**Sexual harassment:** The University of Colorado Boulder (CU Boulder) is committed to maintaining a positive learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, discrimination, harassment or related retaliation against or by any employee or student. CU's Sexual Misconduct Policy prohibits sexual assault, sexual exploitation, sexual harassment, intimate partner abuse (dating or domestic violence), stalking or related retaliation. CU Boulder's Discrimination and Harassment Policy prohibits discrimination, harassment or related retaliation based on race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been subject to misconduct under either policy should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding sexual misconduct, discrimination, harassment or related retaliation can be found at the OIEC website: <http://www.colorado.edu/institutionalequity/>.

**Honor code:** All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the academic integrity policy of the institution. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access, clicker fraud, resubmission, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at [honorcode.colorado.edu](http://honorcode.colorado.edu).