

MATHEMATICS 960/961 - FUNCTIONAL ANALYSIS
SPRING 2020/FALL 2020/

- **Instructor:** Professor Atanas Stefanov
- **Office:** Snow 514, Phone: 4-3009
- **Office Hours** T 1:30-2:30 or by appointment
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- **Prerequisite:** Math 646 or higher, Math 810 or consent of the instructor. Some familiarity with general topology (Math 820 or equivalent) will be helpful, but not necessary.
- **Goals:** To expose students to the techniques of the modern theory of functional analysis with applications arising in analysis, partial differential equations and applied mathematics.
- **Text:** Functional Analysis (Graduate Studies in Mathematics), by T. Bühler and D. Salamon, ISBN-10: 147044190X, ISBN-13: 978-1470441906
Freely available online at:
<https://people.math.ethz.ch/~salamon/PREPRINTS/funcana-ams.pdf>
- **Topics - Math 960:**
 - Foundations (Chapter I): Metric spaces, Banach spaces, Dual spaces, Hilbert spaces, Baire category theorem.
 - Principles of Functional Analysis (Chapter II) - the big three: Uniform boundedness principle, Hahn-Banach theorem, Open mapping/closed graph theorem, reflexive Banach spaces
 - The weak and weak* topologies (Chapter III) - Banach-Alaoglu's theorem, Krein-Milman's theorem.
 - Fredholm theory (Chapter IV) - dual operators, compact operators, Fredholm operators - index, Fredholm alternative.
- **Topics - Math 961**
 - Spectral theory (Chapter V) - Spectrum, operators on Hilbert spaces, Banach algebras (Section 1.5), functional calculus for self-adjoint operators, Gelfand theory for commutative C^* Banach algebras.
 - Unbounded operators (Chapter VI): unbounded operators on a Banach space, the dual of an unbounded operator, unbounded operators on a Hilbert spaces, functional calculus - spectral measures
 - Semigroups of operators (Chapter VII): C_0 semigroups, generators; Hille-Yosida theorem for the generators; Analytic semigroups, Banach space

valued measurable functions, Inhomogeneous equations, Duhamel's principle, maximal regularity.

- **Homework:** There will be five homework assignments per semester, consisting of about 6-10 problems each, covering specific portions of the material. No final exams will be given, but the final HW assignments will be in lieu of a final and it will be due on the day of the final exam.

Note that group work is preferred - groups of two-three students will submit one copy of their work and everybody will be assigned the same grade. Each student must be a lead on at least 2 problems!