

Math 9600L - Atiyah-Singer Index Theorem for Pedestrians Summer 2021

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- *Course Outline:*

This is a very introductory course on Atiyah-Singer index theorem, one of the greatest achievements of mathematics in the 20th century, for graduate students. The course is self contained and all material beyond an undergraduate encounter with analysis, algebra and general topology, will be presented in class as we move forward towards the formulation of the theorem, some of its examples and its proof in special cases. The index theorem computes dimension of the space of solutions of a differential equation and can be understood as an infinite dimensional analogue of rank+ nullity theorem in linear algebra with some interesting nuances. As an application we shall derive a proof of the Gauss-Bonnet theorem. Lecture notes will be provided in class. The emphasis will be on giving good examples and intuitive explanation of concepts.

- *Course Website:*

OWL page for the course will be the course website. I shall post the relevant resources in this site.

- *Reference:*

John Roe: Elliptic operators, topology and asymptotic methods (first edition 1988). I won't be following this book, but it is a very nice and friendly presentation of many topics. Note: the first edition is much more user friendly and is out of print now (I shall post a copy on course site).

- *Topics covered:*

- 1) Clifford algebras and Dirac operators.
- 2) Formulation of the index problem and some basic analysis.
- 3) The Atiyah-Singer index theorem and some of its main cases, including the Gauss-Bonnet theorem.

- *Marking scheme:*

Regular class attendance and active class participation, asking questions, and making comments: %20.

Two take home assignments: %30.

A final essay of about 7 pages long on a topic chosen by the student and myself %50.

- *Time:*

MW, 2-4 PM, May 4-July 7.