The Atiyah-Singer Index Theorem is a profound theorem intertwining geometry, topology, and analysis. I will discuss the statement, applications, and give an outline of the proof, concentrating on the examples of the DeRham, Signature, and Dirac operators.

Along the way we will touch on topological K-theory, elliptic differential operators, Hodge theory, Clifford algebras, characteristic classes, and Sobolev spaces. A reference is the book *The Atiyah-Singer Index Theorem: an Introduction* by Shanahan. We will follow the approach of Atiyah-Singer, Index of Elliptic Operators I, III and the book *Spin Geometry* by Lawson and Michelsohn. A reference that emphasizes analysis is *Topology and Analysis* by Booss.

Prerequisites include a solid grasp of differential manifolds, vector bundles, the cohomology of topological spaces, and basic functional analysis.

There will be presentations by students. Possible topics include:

1. Clifford algebras and Spin groups
2. The deRham operator, deRham cohomology, and Hodge theory.
3. The signature operator and the Hirzebruch Index Theorem.
4. The Dirac operator and positive scalar curvature
5. Orientations and topological K-theory
6. Characteristic classes
7. Sobolev theory and pseudodifferential operators
8. Atiyah-Patodi-Singer and eta invariants
9. The heat kernel approach to the Index Theorem